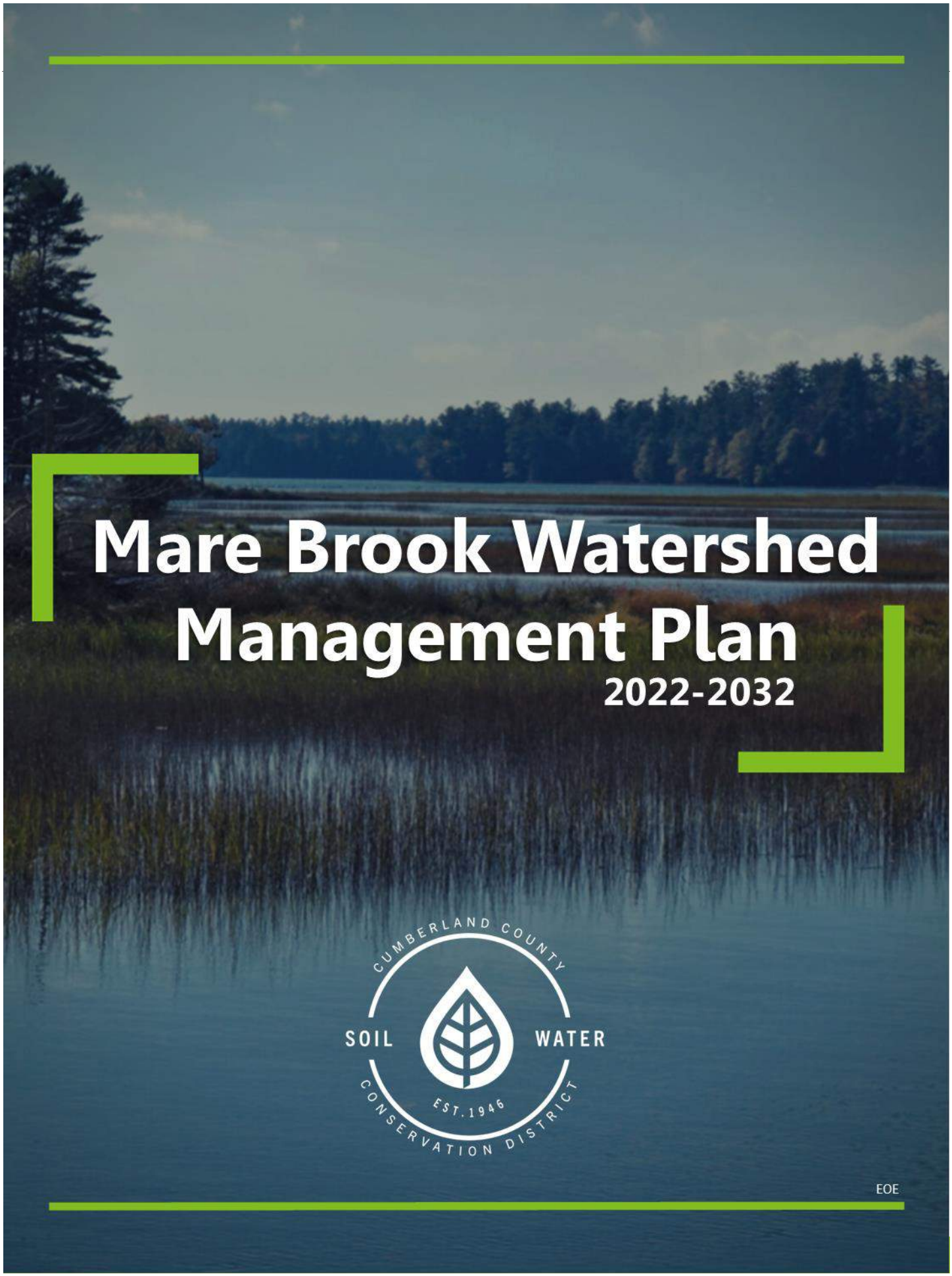

Mare Brook Watershed Management Plan

2022-2032

CUMBERLAND COUNTY SOIL WATER CONSERVATION DISTRICT EST. 1946

EOE

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Project Staff:

Maine DEP

- Kristin Feindel, 604(b) Grant Project Agreement Administrator
- Jeff Dennis, Biologist

Town of Brunswick

- Jared Woolston, Town Planner and 604(b) Grant Coordinator
- Matt Panfil, Director of Planning and Development
- Ryan Barnes, PE, CPESC, Town Engineer
- Matthew Pelletier, PE, Assistant Town Engineer

Cumberland County Soil and Water Conservation District

- Heather Huntt, Project Manager
- Christopher Baldwin, PE, CPESC, District Engineer

Field Geology Services

- John Field, PhD

Steering Committee Members and Affiliations

- Curtis Bohlen, Casco Bay Estuary Partnership Director
- Lee Cataldo, Brunswick-Topsham Land Trust
- Dan Devereaux, Town of Brunswick Coastal Resource Manager
- Catherine Ferdinand, Bowdoin College
- Meryl Grady, Maine Department of Marine Resources
- Steve Levesque, Midcoast Regional Redevelopment Authority
- Bryant Lewis, Maine Department of Marine Resources
- Marty McMahon, US Navy, Base Realignment and Closure Committee
- Jennifer Nicholson, Brunswick Sewer District
- David Page, Brunswick Area Citizens for a Safe Environment, Restoration Advisory Board
- Sandy Stott, Brunswick Conservation Commission, Brunswick-Topsham Land Trust Board, and Friends of Mare Brook and Coffin Pond
- Ben Sturtevant, Midcoast Regional Redevelopment Authority
- Steve Walker, Brunswick Town Councilor

- Carol White, Consulting Hydrogeologist, C.A. White & Associates

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Findings and recommendations are based on recent survey work as well as previous studies some of which are referenced throughout this document. For more information on additional and past studies, please contact the Town of Brunswick[1].

This Plan will be implemented under the direction of the Town of Brunswick with continued local community involvement.

Funding for this project, in part, was provided by the U.S. Environmental Protection Agency under Section 604B of the Clean Water Act. The funding is administered by the Maine Department of Environmental Protection in partnership with EPA. EPA does not endorse any commercial products or services mentioned.

[1] Town of Brunswick, 2021 Mare Brook Watershed Plan https://www.brunswickme.org/233/Mare-Brook-Watershed-Planning

Contents

1 Executive Summary and Purpose 7
2 EPA's 9 Elements for Watershed Management Plans 8
3 Mare Brook and Watershed 10
3.1 Location 10
3.2 Soils and Topography 10
3.3 Climate 11
3.4 Habitat and Ecosystems 12
3.5 Town of Brunswick 13
3.6 Historical and Current Land Uses 14
3.7 Mare Brook's Water Quality 16
4 Watershed Data and Assessments 17
4.1 2015 and 2016 Preliminary Assessment 17
4.2 2020 and 2021 Supplemental Assessments 18
4.2.1 Geomorphic Assessment 19
4.2.2 Culvert and Outfall Survey 26
4.2.3 Stormwater Retrofit Review 30
4.2.4 Combined Structural and Instream Recommendations 32
4.3 Review of Legacy Pollutants 38
4.3.1 Coffin Ice Pond 38
4.3.2 Former Brunswick Naval Air Station (BNAS) 38
4.3.3 Addressing Legacy Contamination 45
4.4 Review of Continuous Stream Water Quality Data 46
4.5 Data Gaps 50
5 Stream Stressor Identification 50
6 Remediation Action Items 57
7 Preventing Stressor Increases 61
8 Complete Action Plan and Timeline 63
9 Evaluating Project Success 82

9.1 Pollutant Load Reduction Targets 82
9.2 Measurable Milestones 85
10 Implementing the Plan 89
10.1 Ownership and Community Involvement 89
10.2 Funding 90
10.3 Monitoring and Adaptive Management 97
10.4 Next Steps 97
10.5 Appendices 99

Figures

Figure 1. Mare Brook Watershed 9
Figure 2. Mare Brook Watershed Topography (modelmywatershed.org) 11
Figure 3. Brunswick's Recreation and Open Spaces 15
Figure 4. Geomorphic Assessment Reaches 20
Figure 5. Surveyed Culverts and Outfalls 27
Figure 6. Map of Stream Reaches for Combined Recommendations 37
Figure 7. Former Brunswick Naval Air Station Property and Restoration Areas 40
Figure 8. Map of Eastern Plume, waste areas and stormwater infrastructure on the Former BNAS Property 43
Figure 9. Maine DEP Stream Water Quality Monitoring Sites 46
Figure 10. Dissolved Oxygen Readings - June 16-July 1, 2016 47
Figure 11. Specific Conductivity Readings - June 16-July 1, 2016 48
Figure 12. Temperature Readings - June 16-July 1, 2016 49
Figure 13. Stream Sections 51
Figure 14. Example of using the causal pathway to identify the causes/sources of low dissolved oxygen. 52
Figure 15. Dominant Stressors per Stream Section Map 53

Tables

Table 1. Location of EPA's 9 Elements 8

Table 2. Geomorphic Reach Findings and Recommendations 21
Table 3. Culverts Recommended for Upgrading (* denotes a H&H survey is necessary prior to implementation) 28
Table 4. Outfalls Recommended for Upgrading 29
Table 5. Preliminary Stormwater Retrofit Recommendations 31
Table 6. Combined Structural BMPs and Instream Work Recommendations 33
Table 7. Dominant Stressors per Stream Section. See Guide to Identifying Stream Stressors (MDEP, October 2019) for details on Stressor IDs. (e.g. V3, DO7, H23, etc.). 53
Table 8. Causes/Sources of Stressors by Stream Section. 54
Table 9. Stressors, Causes, and Actions per Stream Section 55
Table 10. Remediation Action Items Based on Assessments 58
Table 11. Town Planner's Suggestions for Specific Ordinances to Review 62
Table 12. Goal Objectives and Action Items/Management Measures 67
Table 13. Land Cover Distribution for Mare Brook Watershed (National Land Cover Database 2011) 82
Table 14. Average Annual Pollutant Loads in the Mare Brook Watershed 83
Table 15. Average Annual Loads in the Mare Brook Watershed by Source 83
Table 16. Pollutant Load Reduction Estimates 85
Table 17. Measurable Milestones 85
Table 18. Potential Action Item Funding Sources 91

1 Executive Summary and Purpose

Mare Brook (also referred to as Mere Brook) is a 5.7-mile stream with a 4.9 square mile drainage area located entirely within the Town of Brunswick, Maine (**Figure 1**). The watershed includes the area of land draining into Mare Brook and its main tributary, Merriconeag Stream. Mare Brook is a Class B stream currently impaired due to poor macroinvertebrate sampling results and poor macroinvertebrate habitat. To address the Brook's impairment, over the past several years the Town of Brunswick, working with a large group of invested stakeholders, have sought to explore the causes of the Brook's impairment and solutions to restore its water quality.

In 2019, the Town applied for and was awarded grant funds by the Maine Department of Environmental Protection (Maine DEP) to compile this Watershed-based Management Plan (WMP) under U.S. Environmental Protection Agency's Section 604(b) Clean Water Act funds. Creating the WMP was a two-year project (2020-2021) implemented by the Town with support from CCSWCD, Maine DEP, and Mare Brook Watershed stakeholders. In creating the WMP, past studies and information were reviewed, and additional assessments of stream culverts, stormwater outfalls, and geomorphic conditions were done. Gathered information was then used to conduct a stream stressor analysis to determine primary stressors of different sections of the watershed that could be linked to most practical causes. Solutions to address these causes were then discussed by experienced staff and specialists and a steering committee / technical advisory committee that guided the activities of the grant. This process was presented to the public to obtain input and provide information through a series of three broadcasted events in the fall of 2021 prior to finalizing this completed WMP.

The Mare Brook Watershed Management Plan (WMP) is primarily geared towards stakeholders and local community members who:

- Have a basic knowledge of watershed management concepts
- Want to better understand the proposed actions needed to restore Mare Brook and the methodology used to determine those actions, and/or
- Are interested in taking an active role in restoring Mare Brook

This plan is intended to be used as a tool to help direct limited resources and funds from a variety of involved stakeholders and different priority interests towards restoration activities that are likely to have the biggest impact in improving the Brook's impairment status. The WMP is to be implemented over a 10-year period (2022-2032) with oversight of a town-appointed leadership team or advisory committee. This leadership team will work through the steps of the WMP's action items which call for a yearly review of the WMP's progress and a method to update it as new information becomes available, allowing the WMP to be dynamic. This WMP also includes approaches to fund remediation activities, recommendations for increasing public awareness, and suggestions for consideration to prevent future stressor increases.

The primary goal of this plan is for Mare Brook, including Merriconeag Stream, to meet its State-designated Class B standards by 2037.

2 EPA's 9 Elements for Watershed Management Plans

This Mare Brook Watershed Management Plan (WMP) incorporates the US Environmental Protection Agency's 9 elements in creating a watershed management plan. **Table 1** lists EPA's 9 elements and where these elements are included within the WMP. For more information on EPA's 9 elements, please refer to their website Handbook for Developing Watershed Plans to Restore and Protect Our Waters | US EPA[2].

Table 1. Location of EPA's 9 Elements

EPA's 9 Elements		Location included in this Plan
1.	Identification of causes that will need to be controlled to achieve the load reductions described in (2.)	Section 5
2.	Estimates of load reductions expected for the management measures described in (3.)	Section 9.1
3.	Description of management measures that will need to be implemented to achieve load reductions described in (2.)	Section 6 Section 8
4.	Estimate of technical and financial assistance needed to implement this plan	Section 10.1 Section 10.2
5.	Information/education component that will be used to enhance public understanding of this plan	Section 10.1 Section 8- Action Item 5
6.	Schedule for implementing management measures described in (3.)	Section 8
7.	Description of interim, measurable milestones for determining whether management measures described in (3.) are being implemented	Section 9.2
8.	Set of criteria that can be used to determine whether load reductions described in (2.) are being achieved	Section 9.2
9.	Water quality monitoring component to evaluate effectiveness of implementation measured against the established criteria described in (8.)	Section 10.3 Section 8- Action Item 6

[2] Environmental Protection Agency, 2021. Handbook for Developing Watershed Plans to Restore and Protect Our Waters https://www.epa.gov/nps/handbook-developing-watershed-plans-restore-and-protect-our-waters

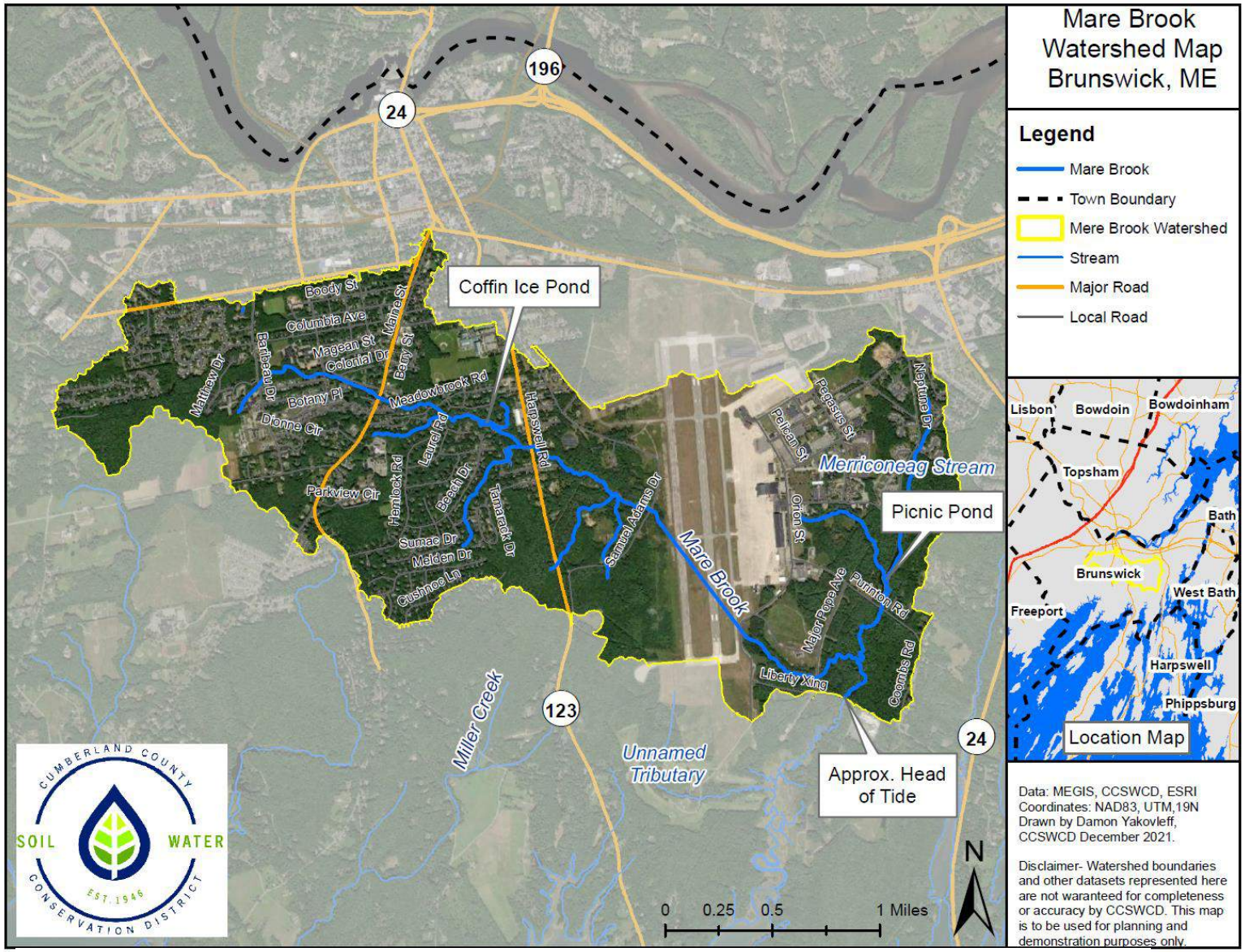

Figure 1. Mare Brook Watershed

3 Mare Brook and Watershed

3.1 Location

Mare Brook near its headwaters above Baribeau Drive. Photo: David Page

Mare Brook (also referred to as Mere Brook) is a 5.7-mile stream with a 4.9 square mile drainage area located entirely within the Town of Brunswick, Maine (**Figure 1**). The watershed includes the area of land draining into Mare Brook and its main tributary, Merriconeag Stream. The headwaters of Mare Brook begin in the northwest corner of the watershed above Baribeau Drive in a dense residential area. The brook flows east through neighborhoods, across Maine Street and into Coffin Ice Pond, a dammed portion of the brook just upstream of Harpswell Road. The brook then flows through land owned by the Midcoast Regional Redevelopment Authority (MRRA) which includes flowing through a ¾ mile long culvert under the runway of MRRA's Brunswick Executive Airport. The brook connects with Merriconeag Stream less than a mile downstream of the airport. Merriconeag Stream begins at Beaver Road in the northeast corner of the watershed and flows into Picnic Pond, a dammed portion of the stream just upstream of the Purinton Road crossing, before flowing into Mare Brook. A tributary comprised of three stormwater ponds (Pond A, B, and C) along the developed area of MRRA's property also flows into Picnic Pond. Head of tide is located downstream of the confluence of Mare Brook and Merriconeag Stream near Liberty Crossing where it becomes part of the Harpswell Cove estuary in Upper Harpswell Neck. This section of the brook passes through land owned by the U.S. Navy and the Town of Brunswick's Kate Furbish Preserve.

Merriconeag Stream is the main tributary to Mare Brook. Photo: David Page

3.2 Soils and Topography

Soil types and topography are important to water quality due to their strong influence on the brook's environment and ability to maintain designated water quality standards despite external stressors. These factors are considered when investigating pollutant loading to a stream (from surface runoff, from and into groundwater, and from the soils themselves) and when analyzing the stability of stream banks (their erodibility and ability to support vegetation for stabilization).

Using an inquiry from USDA's Natural Resources Conservation Service's 'Web Soil Survey'[3], nearly half of the Mare Brook Watershed is comprised of Group A hydrologic soil types (Windsor and Deerfield) which are sand, loamy sand, or sandy loam soils that have low runoff potential and high infiltration rates. Windsor loamy sands is the most predominant soil type within the watershed representing slightly over one-third of the watershed. About 10 percent of the watershed is Group D soils which have the highest runoff potential (predominantly Lamoine (which is C/D), Lyman-Tunbridge, and Scantic). Over 10 percent of the watershed that includes the former Brunswick Naval Air Station is "man-made". Exact locations of these soil types may vary, and thus in-the-field verification should be done when analyzing and/or remediating a specific site.

The Mare Brook Watershed is relatively flat with an average watershed slope of 1% and a maximum slope of 15.8% (**Figure 2**).

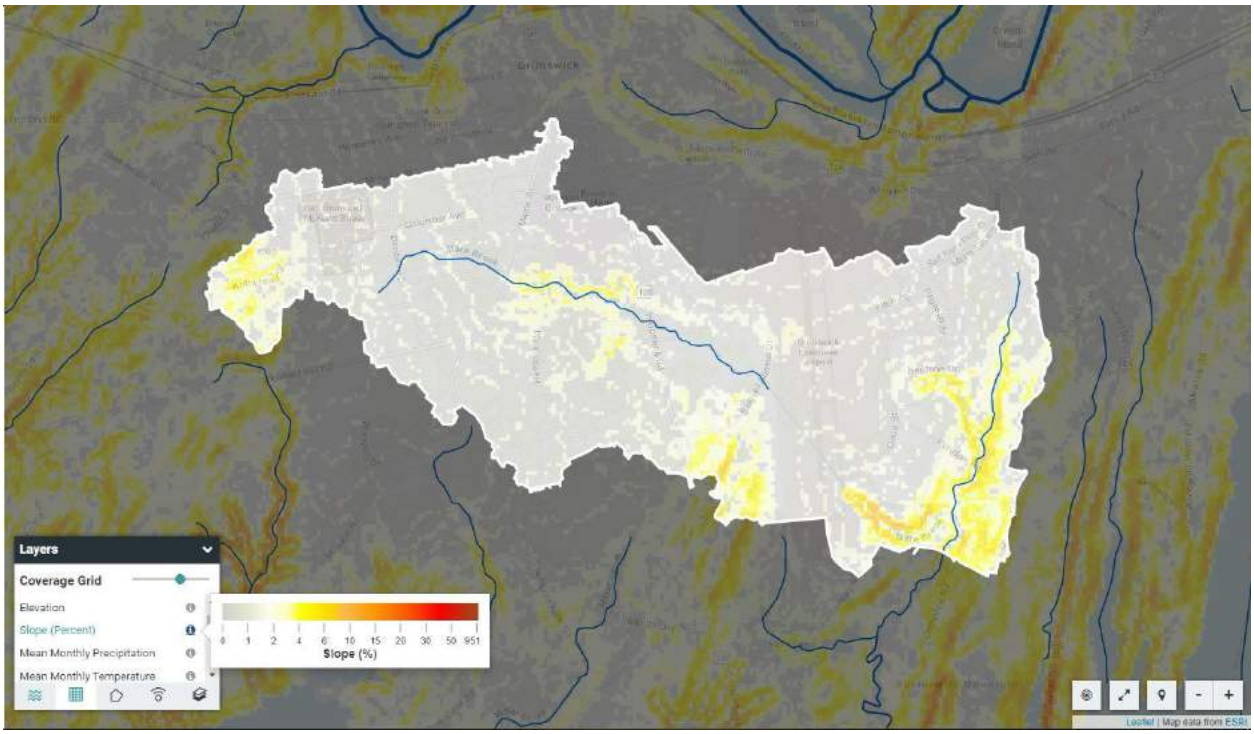

Figure 2. Mare Brook Watershed Topography (modelmywatershed.org)

3.3 Climate

Like soils and topography, climate can impact water quality by affecting pollutants entering the system. The amount of rainwater and the duration of time that it falls within can impact water quality. Lots of stormwater entering the waterbody within a short amount of time can cause flooding and stream bank erosion. This impacts the amount of pollutants washing into the stream as well as contributing to habitat decline. For Mare Brook, a serious concern in addition

[3] United States Department of Agriculture, 2021. Web Soil Survey https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

to increased pollutants and loss of benthic macroinvertebrate habitat is the physical displacement of actual aquatic macroinvertebrate individuals due to high stormwater flows. Temperature impacts water quality by increasing stream temperatures in the summer months and affecting the amount of sand and salt used on roadways, driveways, and parking lots in the winter months. Changes in landscapes and weather patterns can intensify water quality impacts in numerous ways: For example, an increase in the number of storms and the amount of rainwater falling within a given timeframe can lead to unfiltered rainwater washing directly into a stream. This is further intensified in landscapes in which vegetation has been replaced with hardened surfaces (roads, driveways, parking lots) further preventing the rainwater being absorbed and slowed down.

The Town of Brunswick receives on average 49 inches of rain per year with November, December, April, and June being the wettest months of the year (about 5 inches of rain on average); January, August, and September are the driest months (about 3-3.5 inches of rain on average); July and August average the highest temperatures of the year (around 69-70 degrees Fahrenheit) and December - February averages the lowest (around 24-30 degrees Fahrenheit)[4].

3.4 Habitat and Ecosystems

The upland sandpiper is one of several State of Maine Endangered Species with habitat in the Mare Brook watershed. Photo: Bradley Hacker

Despite areas of impaired aquatic macroinvertebrate habitat, Mare Brook and Merriconeag Stream support a variety of fish including native brook trout, ninespine stickleback, American eel, and lake chub. Sea run brook trout are seasonally fished along Merriconeag Stream up to the outlet at Picnic Pond's dam. To the West of Route 123, South of Mare Brook, within the wetlands off Melden Drive and Cushnoc Lane, there is State designated habitat for Acadian swordgrass moth (*Xylena thoracica*) which is a State Species of Special Concern. This is located within pitch pine heath barren and bog which has been also designated by the State as an exemplary natural community. Just to the East of Merriconeag Stream within Brunswick-Topsham Land Trust's 63-acre Neptune Woods, there is a State-listed candidate for deer wintering areas. The former Brunswick Naval Air Station contains habitat for the grasshopper sparrow (*Ammodramus savannarum*), a State of Maine Endangered Species, and the upland sandpiper (*Bartramia longicauda*), a State of Maine Endangered Species. The former air base also contains little bluestem-bluestem sandplain grassland along the northern portion of its parcel which has been listed by the State as an exemplary natural community. Other areas of valuable habitat and ecosystems include the documentation of a significant vernal pool on the western side of the

[4] National Weather Service, 2000-2021 "Monthly Mean Average Temperature for Portland Area, ME", https://www.weather.gov/wrh/Climate?wfo=gyx

former air base just south of the inlet to the runway culvert and Brunswick-Topsham Land Trust's Crystal Spring Farms of which a portion resides in the headwaters of the watershed and it too provides areas of conserved native habitat lands[5].

Invasive species, both floral and faunal, can affect water quality and stream systems and should be taken into consideration regarding remediation efforts. Limited data exists on invasive plants and animals within the Mare Brook Watershed, yet invasives that have been documented and observed include[6]:

- Hemlock Wooly Adelgid (*Adelges tsugae*) – feeds on and damages/possibly kills hemlock trees
- Asiatic Bittersweet (*Celastrus orbiculatus*) – can change soil chemistry and leaf litter decomposition rates, prevent natural forested revegetation, host bacteria that can cause tree diseases
- Burning Bush (*Euonymus alatus*) – Creates dense thickets that shade out native plants and have been shown to reduce spider abundance and diversity (fish food)
- Morrow's Honeysuckle (*Lonicera morrowii*) – Invades intact forest understory
- Japanese Barberry (*Berberis thunbergii*) – Can crowd out native forest understory plants

In the lower watershed:

- Japanese Knotweed (*Fallopia japonica*) – completely shades out native plants with dense thickets
- Common Reed / Phragmites (*Phragmites australis*) – can alter plant diversity, soils, sedimentation rates, fish and bird habitat use, and food webs.

3.5 Town of Brunswick

The Town of Brunswick operates under a Town Charter and Municipal Code of Ordinances which is overseen by Town Council. The Town's government includes a Town Manager with departments for assessing coastal resources, economic/community development, engineering, finance, parks and recreation, planning and development, public works, police, fire, and school and others. In addition, the Town supports a number of active citizen-involved boards and committees including a School Board, Assessment Review Board, Bicycle and Pedestrian Advisory Committee, Brunswick Development Corporation, Cable Television Committee, Comprehensive Plan Committee, Conservation Commission, Finance Committee, Marine Resource Committee, Planning Board, Recreation Commission, Recycling and Sustainability Committee, River and Coastal Waters Commission, Tree Committee, amongst others.

The Town's population has slightly increased over the past decade. According to 2020 United States Census data, Brunswick's population was 21,756, an increase of about 7% since 2010. The

[5] Maine Department of Inland Fisheries & Wildlife, 2021. Beginning with Habitat https://www.maine.gov/ifw/fish-wildlife/wildlife/beginning-with-habitat/index.html

[6] Maine Department of Agriculture, Conservation & Forestry, 2019. Maine Natural Areas Program, https://www.maine.gov/dacf/mnap/features/invasive_plants/invsheets.htm

population density is approximately 465 inhabitants per square mile, with 9,235 housing units at an average density of 198 per square mile. The Town's racial makeup was 90.6% White, 1.9% African American, 0.1% Native American, 2.7% Asian, and 4.3% from more than one race with Latino or Hispanic representing 3.4% of the population of any race.

In 2020, the Town's median age was 44 years with 16.6% of residents under the age of 18. Median household income (based on 2015-2019 data in 2019 dollars) was $59,922 which amounted to $37,197 per person[7].

3.6 Historical and Current Land Uses

The Town of Brunswick has a rich history dating back to the early 1700s. Historically known as a prosperous seaport, the Town had a vibrant industry producing goods including lumber, paper, soap, flour, carriages, plows, furniture, shoes, and eventually bricks, cotton, and textiles[8]. It became the home to Bowdoin College in 1794, Maine's first institution of higher learning, which also housed the Medical School of Maine from 1820-1921. From the early 1940s through the 2011, the U.S. Navy established and operated the Brunswick Naval Air Station (BNAS) on an over 3,000-acre parcel within the watershed. BNAS was officially designated as a Superfund site in 1987 and although several of the known sources of contamination have been remediated, the former base remains an active Superfund site and remedial investigations and clean ups are on-going. Caution signs and security fencing can still be observed on the former base particularly in locations that are currently held by the Navy due to unmitigated environmental concerns.

The Mare Brook Watershed is approximately 61% urban and 39% forest with wetland complexes. The watershed hosts a variety of residential, commercial, and industrial land uses. Natural and cultivated vegetated areas are interspersed along transportation corridors and moderately dense development within the urban core of Brunswick. In the Mare Brook Watershed, the amount of hardened surfaces, commonly referred to as impervious cover (IC), is about 21%[9]. This IC percentage is of concern and a strong contributor to Mare Brook's water quality impairment. Typically, watersheds with more than 10% IC are unable to meet required water quality aquatic life standards with sensitive species of fish declining with just 4-6% IC.[10]

A map of Brunswick's outdoor recreation and open spaces is shown in **Figure 3**. Recreational areas in the watershed include Meadowbrook Park, Brunswick Recreation Park, and Coffin Ice Pond. In addition, there are several bike trails with Bowdoin College having trails accessible to the public along the north, west, and southern boundaries of Pickard Field Complex. The Midcoast Regional Redevelopment Authority (MRRA), which now owns and operates much of

[7] United States Census Bureau, 2020. Quick Facts Brunswick town, Cumberland County https://www.census.gov/quickfacts/brunswicktowncumberlandcountymaine
[8] Town of Brunswick Maine, 2019 History of Brunswick Maine https://digitalcommons.library.umaine.edu/cgi/viewcontent.cgi?article=1166&context=mainehistory
[9] Department of Environmental Protection, 2012. Mere Brook TMDL Assessment Summary https://www.maine.gov/dep/water/monitoring/tmdl/2012/Appendix_17_Mere_Brook.pdf
[10] FB Environmental, 2012. Maine Impervious Cover Total Maximum Daily Load Assessment (TMDL) for Impaired Streams, 2021 https://www.maine.gov/dep/water/monitoring/tmdl/2012/IC%20TMDL_Sept_2012.pdf

the former Brunswick Naval Air Station, is looking into ways to increase recreational opportunities on the former base as the area is being redeveloped for civilian use.

Figure 3. Brunswick's Recreation and Open Spaces

Along the main stem of Mare Brook just northwest of Harpswell Road is Coffin Ice Pond, a six-acre spring-fed, dammed portion of the Brook. According to historic newspaper articles, Coffin Ice Pond served as an ice pond for nearly 100 years from the late 1800s through the early 1960s. Known for providing "hard, clean, and clear" ice it provided jobs to locals who delivered ice to homes, stores, restaurants, seafood shippers, and railroad cars. Ice would be cut in early January when it reached a thickness of 12 to 15 inches. In the early 1950s, Coffin Pond was used in an emergency by the Brunswick and Topsham Water District to fulfill a water shortage[11]. To the

[11] Information provided by Steve Moss, Friends of Coffin Ice Pond to Town of Brunswick in October 2021.

southeast of the former Brunswick Naval Air Station is the Picnic Pond Stormwater System. This System includes Pond A, Pond B, Pond C Area, and Picnic Pond which were used by the Navy as a stormwater retention system to channel and control stormwater drainage on the naval air station base. Pond A, Pond B, and Pond C Area are part of an unnamed tributary flowing into Merriconeag Stream with Picnic Pond being part of Merriconeag before it flows into Mare Brook.

Coffin Ice Pond is currently enjoyed by the public for fishing, kayaking, birdwatching, and ice skating. Coffin Ice Pond is owned by the Town of Brunswick who is responsible for maintaining the dam at Coffin Ice Pond in accordance with the Town's general maintenance programs. It has been slowly "filling in" with collected sediment, debris, and vegetation and is becoming more of wetland than a pond. The dam, managed by Town's Parks and Recreation Department, is currently needing repair along with the gravel road accessing the dam. Local residents have formed a Friends of Coffin Ice Pond group to assist in preserving this easily accessible Pond for its history, beauty, wildlife, recreational opportunities, and economic value.

Baxter Pond, an impoundment of a tributary a few hundred yards from Coffin Ice Pond also sees birdwatchers and skaters during the winter. Waters from Baxter Pond join Mare Brook just before it passes beneath Harpswell Road.

Mare Brook drains into Harpswell Cove, an economically significant resource to the Town of Brunswick as an important shellfish growing area with 2,500 bushels of softshell clams are harvested annually. For the last few years, Harpswell Cove has also been used as an experimental quahog propagation area. Unfortunately, non-point source (NPS) pollution has restricted harvesting in certain areas of the cove in recent years past.

3.7 Mare Brook's Water Quality

Mare Brook is listed by the State as a Class B waterbody. Class B waters are the third highest classification for fresh surface waters out of four class options. Class B waters must have dissolved oxygen levels of 7 parts per million or 75% saturation (whichever is higher), must have unimpaired aquatic habitat, and must support all aquatic species indigenous to the receiving water with no detrimental changes to the resident biological community.

Unfortunately, Mare Brook currently does not meet Class B standards and is listed as impaired[12] for aquatic life. Mare Brook has been listed as an

Sandy Stott assisting with water quality sampling in Mare Brook. Photo: Maine DEP

[12] Maine Department of Environmental Protection, 2019. Integrated Water Quality Monitoring and Assessment Reports https://www.maine.gov/dep/water/monitoring/305b/index.html

impaired stream since 2012 due to benthic-macroinvertebrate bioassessments and habitat assessment. Mare Brook is also considered an Urban Impaired Stream under the Stormwater Management Law. It is considered an Urban Impaired Stream because urban stormwater is a significant cause of why the waterbody is not meeting its designated Class standards. The impairment includes all of Mare Brook, its tributaries (including Merriconeag Stream), and its impounded ponds.

4 Watershed Data and Assessments

In general, what happens on the land, both currently and historically, can greatly affect stream water quality. Natural forested lands, with uneven terrain and spongy organic ground cover functions effectively in slowing down and infiltrating rainwater and snow melt. This natural environment helps to prevent erosion, filter out pollutants, and create stable, clean and cool streams. When natural landscapes are developed with roads, parking lots, and buildings, there is less area to absorb and infiltrate rainwater and snowmelt. The smooth hard surfaces cause this stormwater to wash away quickly causing erosion channels and unfiltered stormwater, often with additional pollutants from the hardened surfaces or impervious cover, to enter stream systems. The stormwater also tends to be warmer coming off pavement and hardtops unfiltered. Lack of trees and shade cover further creates warmer stormwater and waterways.

Common factors that influence stream habitat include:

- Impervious cover
- Altered riparian zones
- Loss of floodplains
- Altered stream channels
- Temperature increase
- Loss of wetlands
- Winter salt use
- Improperly placed and sized culverts
- Increased nutrient loading
- Bare soil
- Livestock
- Legacy pollutants

Numerous water quality studies have occurred in the Mare Brook Watershed, many involving the groundwater impacts of the former Brunswick Naval Air Station. To further investigate the watershed-wide causes of the brook's impairment, recent studies and assessments have been conducted throughout the watershed and stream corridor.

4.1 2015 and 2016 Preliminary Assessment

Recent assessments of Mare Brook's water quality impairments include investigations conducted in 2015 and 2016 through a Maine Coastal Communities Grant awarded to the Town of Brunswick[13]. This preliminary assessment provided baseline data on bacteria readings, fish passage, geomorphic conditions, and riparian habitat. Recommendations were made for

[13] Town of Brunswick Maine, 2015. 2015 Mare Brook Watershed Assessment https://www.brunswickme.org/480/2015-Mare-Brook-Watershed-Assessment

additional monitoring and assessment work with some initial restoration recommendations provided. This baseline assessment provided the foundation for the Town to engage the public in a facilitated and locally-guided planning process to determine next steps in addressing Mare Brook's water quality impairments.

The following information was obtained from this baseline assessment:

- Most of the riparian corridor of Mare Brook contained intact floodplains and vegetative buffers
- A variety of fish live in Mare Brook and Merriconeag Stream including brook trout, ninespine stickleback, American eel, and lake chub
- Poor aquatic macroinvertebrate populations were suspected because of an influx of sand and mass movement of sandy substrate
- Fish passage was limited by existing culverts and dams
- Legacy pollutants remained in areas around the former Brunswick Naval Air Station.

Overall, the baseline assessment recommended the need for habitat restoration, education and outreach, watershed surveys, and an action plan for improving Mare Brook's water quality. These recommendations suggested that a watershed-based management plan was the needed next step to bring all these recommendations together with a planned approach for improving Mare Brook.

4.2 2020 and 2021 Supplemental Assessments

Based on the findings and recommendations from the baseline assessment in 2015-2016, the Town of Brunswick applied for and was awarded grant funds from Maine DEP to continue investigation efforts and create a watershed-based management plan to remediate water quality impacts. Working with Maine DEP, needed supplemental data to pursue through this grant-funded project included:

Upstream view of granite blocks and Maine Street culvert outlet of Reach 9 during the geomorphic survey. Photo: John Fields

- Assessment work extending to areas upstream of Baribeau Drive
- Additional geomorphic assessment work to determine required in-stream restoration recommendations
- Detailed review of road crossing and culvert outfall impacts and restoration recommendations
- Identification of proximate stressors along specific stream reaches to target impairment causes
- Basic review of water quality data, including legacy pollutants, and their role to the Brook's current water quality impairment.

The following is an overview of the supplemental assessments conducted with supporting documentation included in **Appendices A and B.**

4.2.1 Geomorphic Assessment

Through a request for qualifications, the Town of Brunswick selected and hired Field Geology Services, LLC. to conduct a geomorphic assessment covering the length of Mare Brook from the headwaters above Baribeau Drive to Liberty Crossing but did not include Merriconeag Stream or other tributaries. The assessment consisted of:

- Preparing and following of the *Quality Assurance Project Plan for Mare Brook Fluvial Geomorphic Assessment in Brunswick, Maine* prepared by John Field of Field Geology Services, May 2, 2020
- Subdividing the stream into 17 stream reaches for surveying
- Completing Maine Inland Fisheries and Wildlife Rapid Geomorphic Assessment while walking the entire stream and noting other conditions
- Topographic surveying in Summer 2020 of four selected locations
- Preparing a final report including a summary table of all reaches with additional information and concept designs for three sites.

Figure 4 is of the approximate geomorphic survey reaches assessed. **Table 2** is an overview of the geomorphic assessment done by John Field of Field Geology Service, LLC in 2020 and 2021. This table includes the location / reach of the assessment, an overview of conditions and alterations observed, restoration recommendations, and estimated degree of project complexity based on type of improvements and cost. The reaches are color coded based on the stream sections broken out in the Stream Stressor Analysis (**see Figure 13**). A full summary of this geomorphic assessment can be found in **Appendix A** including photos and concept designs for three sites.

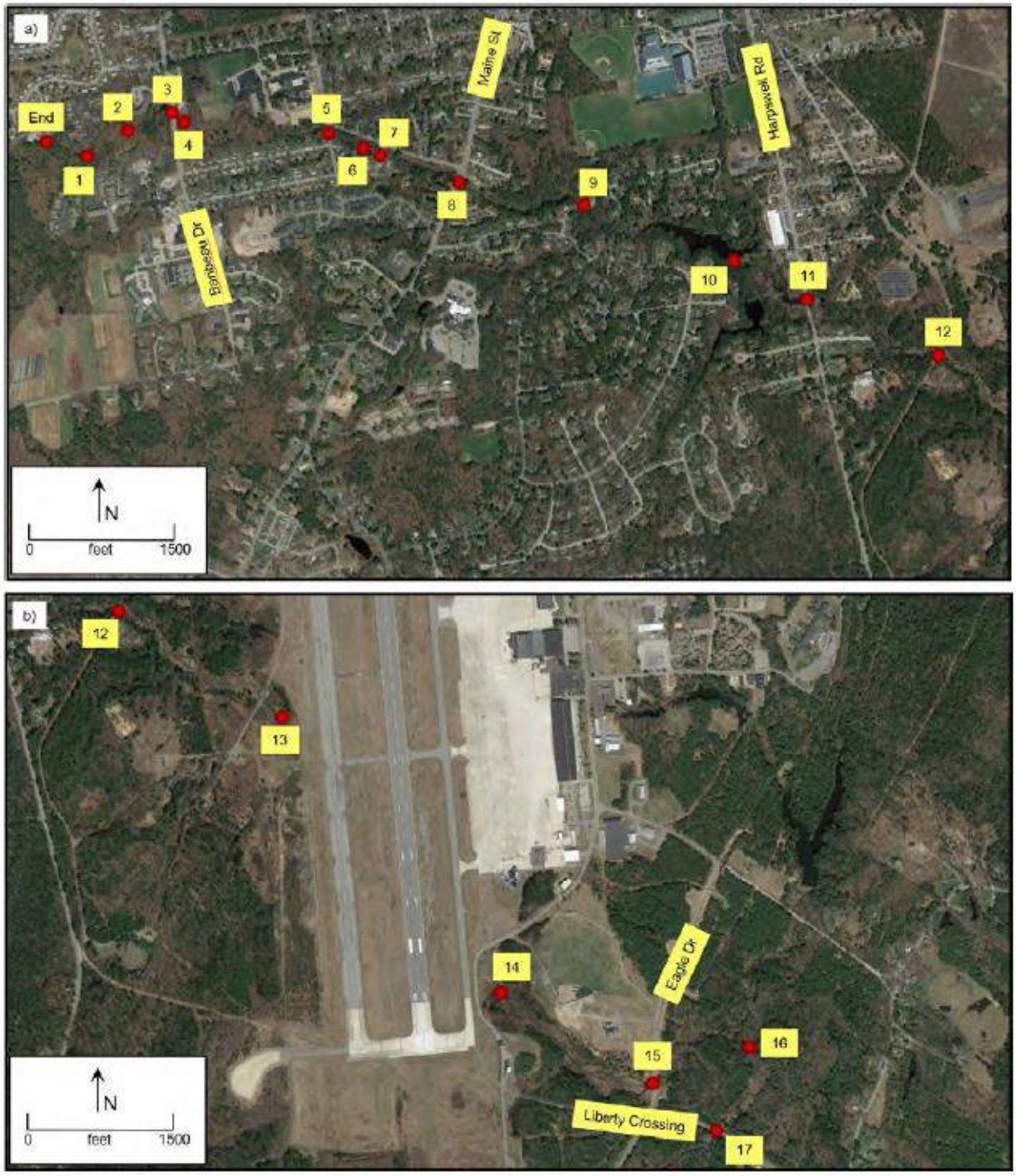

Figure 4. Geomorphic Assessment Reaches

Map from Field Geology Services, LLC's "Geomorphic Assessment and Restoration Recommendations for Mare Brook in Brunswick, Maine", November 2021. Location of reach breaks shown as red dots with reach number placed at downstream end of each reach. Map a) of upper watershed, Map b) of lower watershed.

Table 2. Geomorphic Reach Findings and Recommendations

	Location	Length (ft)	Conditions	Human alterations	Restoration options[14]	Degree[15]/Type of improvements	Complexity/Cost[16]
Above Baribeau Drive	Windorf Circle to Matthew Drive	527	• Floodplain access • Good tree canopy • Wide channel • Minimal log cover • Soft substrate	• Undersized culverts • Armoring of bed downstream of Windorf Circle • Fine sediment upstream of culverts	1) Chop and drop 2) Replace undersized culvert w/footbridge	1) Moderate - narrow channel and improve flow complexity 2) Moderate - flow impoundment eliminated; coarsen substrate	1) Very low ($20K) 2) Very low ($20K)
	Matthew Drive to backside of senior housing center	564	• Floodplain access • Meandering planform • Narrow channel • Minimal log cover • Good tree canopy	• Slight incision downstream of culvert	1) Chop and drop	1) Moderate - reduce incision and improve flow complexity	1) Very low ($20K)
	Backside of senior housing center to Baribeau Drive	655	• Floodplain access • Good tree canopy • Wide channel • Fair wood loading • Sandy substrate	• Straightened(?) • Impounded reach due to undersized culvert	1) Resize Baribeau Drive culverts - multiple small culverts	1) High - extensive flow impoundment eliminated	1) Watch list - wait until culverts to be replaced ($250K)

[14] Note: Suggestions for stream crossing resizing are mentioned for only the upstream reach but typically will also be beneficial for the downstream reach.
[15] Categorized as low, moderate, or high. A "low" ranking does not imply the reach is in poor condition as little improvement may result from restoring a reach already in good condition.
[16] Categorized as very low (<$50k), low ($50k-$100k), moderate ($100-$200k), high ($>200k), watch list (cost and complexity likely too high to complete for restoration purposes so will need to await an additional reason to arise to complete work such as a bridge replacement to properly resize a stream crossing).

	Location	Length (ft)	Conditions	Human alterations	Restoration options[14]	Degree[15]/Type of improvements	Complexity/Cost[16]
Above Maine St.	Baribeau Drive to area of no access	301	• Floodplain access • Narrow channel • Fair wood loading • Good tree canopy	• Armoring of bed downstream of Baribeau Dr. culvert • Slight incision downstream of culvert	1) Remove armor	1) Low - naturalize substrate over short length	1) Very low ($15K)
	No access area downstream to Barrows Street	1,889	• Floodplain access • Meandering planform • Good wood loading • Good tree canopy	• Floodplain in lower half constricted by fill • Barrows St. culvert undersized	1) Remove fill and replace foot bridge 2) Resize culvert	1) Moderate - flow impoundment reduced and restore floodplain 2) High - extensive flow impoundment eliminated	1) Low to moderate - depends on amount of fill removed ($100k) 2) Watch list - wait until culvert to be replaced ($200k)
	Barrows Street to a point even with Colonial Drive	389	• Narrow floodplain • Fair wood loading • Some canopy loss • Soft substrate • Multi-thread channel in places	• Armoring of bed downstream of Barrows St. culvert • Homes and road nearby	1) Remove armor 2) Wood additions or chop and drop	1) Low - naturalize substrate over short length 2) Low - increase complexity but good condition already	1) Very low ($15k) 2) Very low ($25k)
	From a point even with Colonial Drive to MacMillan Drive	206	• Narrow floodplain • Meandering planform • Narrow channel • Poor log cover • Limited canopy	• Limited wood in channel • Homes and road nearby	1) Anchored wood additions 2) Biostabilization by homes	1) Moderate - increase flow complexity and cover habitat 2) Low - only short length to be treated	1) Very low to low - need to anchor wood ($50k) 2) Very low to low - depending on length to be treated ($35k)

[14] Note: Suggestions for stream crossing resizing are mentioned for only the upstream reach but typically will also be beneficial for the downstream reach.
[15] Categorized as low, moderate, or high. A "low" ranking does not imply the reach is in poor condition as little improvement may result from restoring a reach already in good condition.
[16] Categorized as very low (<$50k), low ($50k-$100k), moderate ($100-$200k), high ($>200k), watch list (cost and complexity likely too high to complete for restoration purposes so will need to await an additional reason to arise to complete work such as a bridge replacement to properly resize a stream crossing).

	Location	Length (ft)	Conditions	Human alterations	Restoration options[14]	Degree[15]/Type of improvements	Complexity/Cost[16]
	MacMillan Drive to Maine Street	903	• Floodplain access • Good tree canopy • Upper half largely meandering • Lower half impounded with soft substrate	• Localized scour downstream of MacMillan Dr. culvert • Ponded upstream of culvert at Maine St. • Fill constricts channel at Maine St.	1) Chop and drop 2) Replace Maine St. culvert	1) Moderate - improve flow complexity 2) High - eliminate flow impoundment; coarsen substrate	1) Very low ($20k) 2) Watch list - wait until culvert to be replaced ($250)
Above Harpswell Road	Maine Street to Meadowbrook Road	1,544	• Floodplain access • Good tree canopy • Meandering • Good wood loading • Firm sand and fine gravel substrate	• Severe scour downstream of Maine culvert • Fill constricts channel at Maine St.	1) Chop and drop 2) Remove fill to restore floodplain	1) Low - increase complexity but good condition already 2) High - reduce scour in narrow channel downstream of Maine St.	1) Very low ($20k) 2) Moderate ($125k)
	Meadowbrook Road to Coffin Pond	982	• Floodplain access • Good tree canopy • Meandering • Fair wood loading	• Channel widens as approach pond	1) Chop and drop 2) Dam removal	1) Moderate - increase complexity and cover 2) High - eliminate impoundment and restore stream flow continuity	1) Very low ($20k) 2) Watch list - wait until costly dam repairs needed to discuss removal ($200k)
	Coffin Pond Dam to Harpswell Road	976	• Floodplain access • Good tree canopy • Swampy shallow channel • Numerous dead standing trees	• Entire reach largely impounded by undersized culvert at Harpswell Rd.	1) Resize Harpswell culvert	1) High - eliminate impoundment and restore stream flow continuity	1) Watch list - wait until culvert to be replaced ($250k)

[14] Note: Suggestions for stream crossing resizing are mentioned for only the upstream reach but typically will also be beneficial for the downstream reach.
[15] Categorized as low, moderate, or high. A "low" ranking does not imply the reach is in poor condition as little improvement may result from restoring a reach already in good condition.
[16] Categorized as very low (<$50k), low ($50k-$100k), moderate ($100-$200k), high ($>200k), watch list (cost and complexity likely too high to complete for restoration purposes so will need to await an additional reason to arise to complete work such as a bridge replacement to properly resize a stream crossing).

	Location	Length (ft)	Conditions	Human alterations	Restoration options[14]	Degree[15]/Type of improvements	Complexity/Cost[16]
Below Harpswell Road	Harpswell Road to Navy Base fence	1,854	• Floodplain access • Good tree canopy • Meandering planform • Good wood loading	• Scour downstream of Harpswell Rd. culvert • Lower half swampy due to culvert at fence	1) Resize culvert at fence	1) High - eliminate impoundment and restore stream flow continuity	1) Moderate to high ($125k)
	Navy Base fence to runway culvert	2,307	• Floodplain access • Limited canopy • Highly sinuous channel • Minimal log cover • Logs buried in bank	• Armoring downstream of culvert at fence • Impounded at higher level and for long duration in past	1) Remove armor 2) Wood additions in channel and on floodplain 3) Plant forested buffer	1) Low - naturalize substrate 2) Moderate - increase complexity and raise streambed 3) High - canopy for shade	1) Very low ($15K) 2) Moderate to high - long length could be done in phases ($200K) 3) Very low - for initial test plot ($50K)
	Runway culvert	3,922	N/A	• Entire reach enclosed in culvert	1) Daylight culvert	1) High - restore natural stream processes	1) Watch list - wait for major change in land use or airfield operations
Runway to Head of Tide	Runway culvert to Eagle Drive	2,112	• Higher banks than elsewhere • Limited canopy • Upper half straightened • Deep pools where wood present	• High banks due to incision downstream of runway culvert • Impounded upstream of Eagle Dr. culvert	1) Wood additions in channel and on floodplain 2) Plant forested buffer 3) Replace Eagle Dr. culvert	1) Moderate - increase complexity and raise streambed 2) High - canopy for shade 3) High - eliminate impoundment	1) Moderate- long length could be done in phases ($150K) 2) Very low - for initial test plot ($15K) 3) Moderate to high ($125K)

[14] Note: Suggestions for stream crossing resizing are mentioned for only the upstream reach but typically will also be beneficial for the downstream reach.
[15] Categorized as low, moderate, or high. A "low" ranking does not imply the reach is in poor condition as little improvement may result from restoring a reach already in good condition.
[16] Categorized as very low (<$50k), low ($50k-$100k), moderate ($100-$200k), high ($>200k), watch list (cost and complexity likely too high to complete for restoration purposes so will need to await an additional reason to arise to complete work such as a bridge replacement to properly resize a stream crossing).

	Location	Length (ft)	Conditions	Human alterations	Restoration options[14]	Degree[15]/Type of improvements	Complexity/Cost[16]
	Eagle Drive to confluence with Merriconeag Stream	1,547	• Floodplain access • Fair tree canopy • Meandering planform • Good wood loading	• Scour downstream of Eagle Dr. culvert	1) Chop and drop	1) Low - increase complexity but already in good condition	1) Very low ($20K)
	Merriconeag Stream confluence to Liberty Crossing	1,270	• Floodplain access • Tidally influenced • Limited canopy • Poor log cover	• Forested berm crosses floodplain and rock crosses channel (old dam?)	1) Wood additions 2) Remove berm	1) High - increase complexity and cover 2) Moderate - restore floodplain continuity	1) Low to moderate - depends on length and ease of access ($100K) 2) Moderate - difficult to access for fill removal ($175K)

[14] Note: Suggestions for stream crossing resizing are mentioned for only the upstream reach but typically will also be beneficial for the downstream reach.
[15] Categorized as low, moderate, or high. A "low" ranking does not imply the reach is in poor condition as little improvement may result from restoring a reach already in good condition.
[16] Categorized as very low (<$50k), low ($50k-$100k), moderate ($100-$200k), high ($>200k), watch list (cost and complexity likely too high to complete for restoration purposes so will need to await an additional reason to arise to complete work such as a bridge replacement to properly resize a stream crossing).

4.2.2 Culvert and Outfall Survey

Upstream view of culvert outlet under the former Brunswick Naval Air Station runway. Photo: John Fields

CCSWCD's Engineer, Chris Baldwin, P.E. worked with the Town of Brunswick's Engineering Department, specifically Matt Pelletier, Assistant Town Engineer, to conduct a culvert and outfall survey. The survey focused on stream culvert crossings along the main stem of Mare Brook and Merriconeag Streams and public stormwater outfalls emptying into the main stem of Mare Brook. The survey, conducted in 2020 and 2021, reviewed culvert and outfall conditions and those that were affecting natural stream conditions (undersized, hanging, misaligned). This information is to be used in conjunction with the geomorphic survey recommendations to prioritize and determine cost, extent, and method for remediations. The collected information will also be used by the Town of Brunswick to start a database of town-wide needs including outfall mapping which will be needed should/when the Town becomes a stormwater-regulated municipality through EPA's National Pollution Discharge Elimination System[17]. The culvert and outfall survey consisted of:

- Preparing and following the *Survey Implementation Plan for Mare Brook Watershed-Based Plan Development, Project #20190012: Subtask 4c. – Culvert and Outfall Ground-truthing Studies*, prepared by Heather Huntt of Cumberland County Soil and Water Conservation District, 10/30/2020.
- Creating an application to electronically record culvert and outfall conditions and locations to then upload into the Town of Brunswick's mapping software for ongoing updates and additions
- Surveying all main stem stream crossings and known public stormwater outfalls
- Preparing a summary report and table of all culverts and outfalls surveyed

Figure 5 shows the locations of the culvert and outfalls surveyed. The Town of Brunswick houses this data which links these locations to site-specific survey results.

Table 3 and **Table 4** are overviews of the culverts and outfalls recommended for upgrading. This includes culvert and outfall reference numbers, locations, general recommendations, and requirements needed prior to conducting recommendations, and estimate of costs. An * denotes a H&H survey is necessary prior to implementation. A summary of the survey methods, detailed table of all culverts and outfalls surveyed with photos, and datasheets for each culvert/outfall are included in **Appendix B**.

[17] Environmental Protection Agency, 2021. Stormwater Discharges from Municipal Sources https://www.epa.gov/npdes/stormwater-discharges-municipal-sources

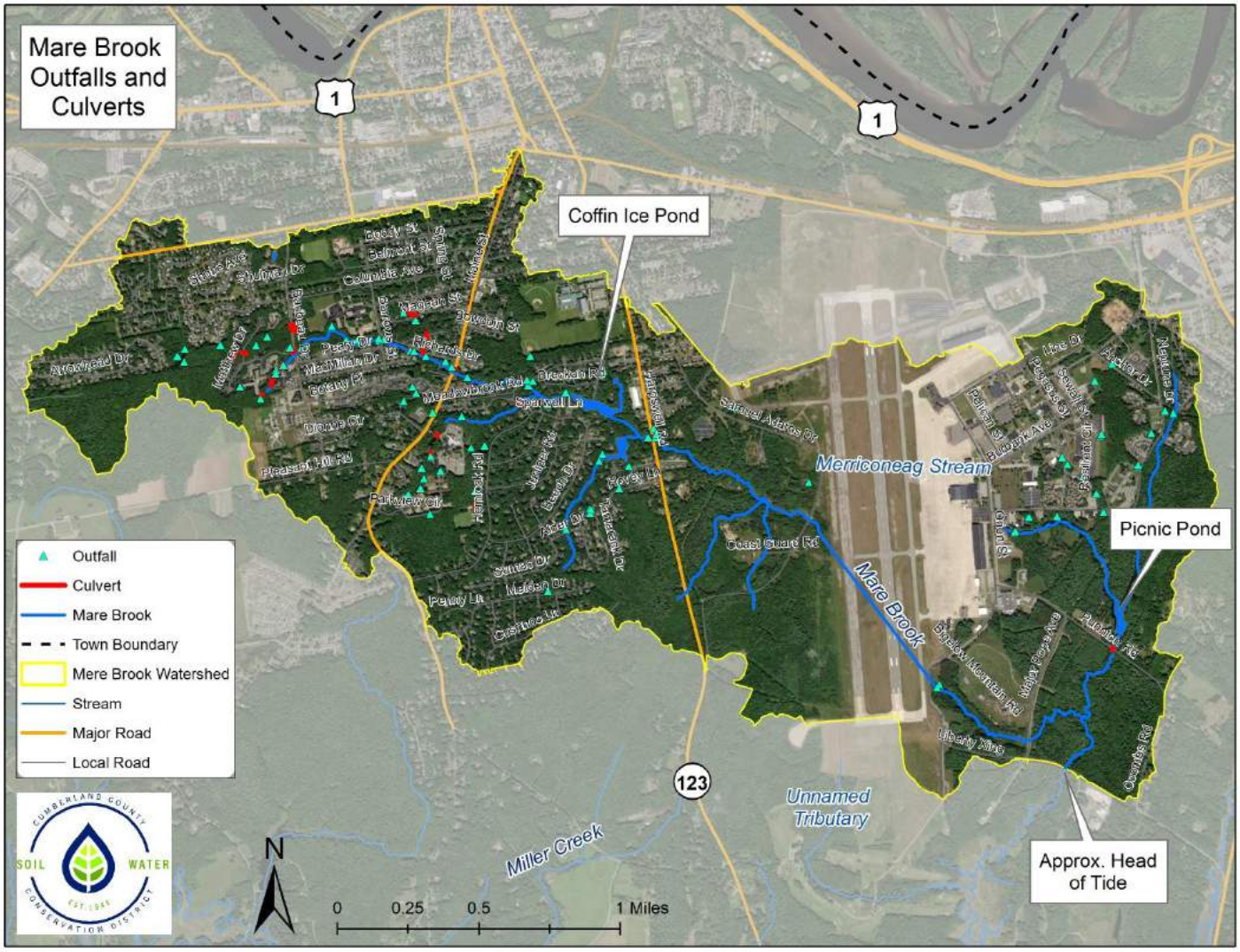

Figure 5. Surveyed Culverts and Outfalls

Table 3. Culverts Recommended for Upgrading (denotes a H&H survey is necessary prior to implementation)*

	ID#	Location	Recommendation	Requirements	Estimated Cost
Above Baribeau	1	Thornton Oaks Trail Network	• Remove culverts, restore channel • Replace with footbridge	• Local permitting • Private landowner coordination	$4K-5K with landowner labor
	2	Thornton Oaks Trail Network	• Remove culverts, restore channel • Replace with footbridge	• Local permitting • Private landowner coordination	$4K-5K with landowner labor
	9	Western Thornton Oaks Property - Southern Tributary	• Upgrade inlet/outlet • Replace culvert	• Local/Private landowner coordination	$2K-$2.5K with landowner/Town labor
Above Maine Street	4*	Baribeau Drive Crossing Flood Control	• Remove culvert along with Culvert 5 • Restore channel • Replace with open bottom culvert	• Federal, State permitting • H&H Model needed	$175K-200K
	5*	Baribeau Drive Crossing Main Pipe	• Remove culverts along with Culvert 4 • Restore channel • Replace with open bottom culvert	• Federal, State permitting • H&H Model needed	$175K-200K
	6	Baribeau Drive Southern Tributary Crossing	• Remove vegetation at inlet & outlet • Add riprap armor as needed	• None	$1K-1.5K with Town labor
	10*	Barrows Street Crossing	• Remove undersized culverts, restore channel • Replace with larger opening	• Federal, State permitting • H&H Model needed	$65K - 80K with Town labor
	13	Colonial Drive Tributary Crossing	• Add riprap at outlet	• Town labor	$500 with Town labor
	14*	Macmillan Drive Crossing	• Remove culverts, restore channel • Replace with open bottom culvert	• Federal, State permitting • H&H Model needed	$75K-100K with Town labor
	15	Richards Drive Tributary Crossing	• Remove culverts, restore channel • Upsize culvert	• Local permitting • Town labor	$25K-35K with Town labor
Above Harpswell Road	16*	Maine Street Crossing	• Remove culverts, restore channel • Replace with open bottom culvert	• Federal, State permitting • H&H Model needed	$200K-225K
	17*	Meadowbrook Road Crossing	• Remove culvert, restore channel • Upsize culvert	• Federal, State permitting • H&H Model needed	$100K-125K
	18*	Sparwell Lane Tributary Crossing	• Upsize culvert • Rebuild road	• Federal, State permitting • H&H Model needed	$100K-125K
^	23*	Harpswell Road Crossing	• Remove culvert, restore channel	• 23*	Harpswell Road Crossing

^ "Below Harpswell Road"

Table 4. Outfalls Recommended for Upgrading

		Location	Condition	Recommendation	Requirements	Estimated Cost
^	12	At Harpswell Road Crossing	• Significant sediment at inlet • Pipe structure in fair shape • Restricted flow due to sediment build-up	Clear sediment at inlet and outlet	Town labor	$500
Above Harpswell Road	17	Off Sparwell Lane	• Adequately sized • Pipe structure in bad shape • Pipe section missing and erosion at outlet	Retrofit outlet with new section and outlet protection	Town permitting and labor	$10-12K with Town Labor
	18	Off Hemlock Road	• Adequately sized • Pipe structure in fair shape • Sediment at outlet	Remove sediment build-up and retrofit outlet with riprap protection	Town permitting and labor	$500-1K with Town Labor
	19	Off Breckam Road	• Adequately sized • Pipe structure in poor shape • Submerged at outlet, heavy vegetation	Replace outfall pipe and provide outlet protection	Town permitting and labor/Private land	$10K-15K with Town Labor
Above Maine Street	13	Macmillan Drive Crossing	• Significant sediment at inlet • Pipe structure in good shape • Restricted flow due to sediment build-up	Clear sediment at catch basin and pipe	Town labor	$500
	20	Off MacMillan Drive	• Concrete foundation failing • Sediment at outlet and in stream	Remove outfall and replace with road catch basin	Town permitting and labor	$12.5K-17.5K with Town Labor
	21	Off Magean Street	• Pipe rusted and failing • Outlet structure needs to be replaced	Replace outfall pipe and add new structure	Town permitting and labor/Private land	$15K-20K with Town Labor

^ “Below Harpswell Road”

4.2.3 Stormwater Retrofit Review

CCSWCD's Engineer reviewed the watershed and previously identified hotspots and recommended stormwater retrofits for key areas of the watershed. The list of retrofits presents various types of upgrades and stormwater best management practices assigned to address immediate stressors and offer examples of the types of projects that could benefit the stream. Recommended retrofits largely address the undersized culverts and aging stormwater infrastructure such as the public outfalls and roadways. However, there is also an opportunity to provide stormwater management in the form of storage and treatment at existing properties that currently have none.

Table 5. Preliminary Stormwater Retrofit Recommendations lists examples of the projects being considered for implementation. The examples include small culvert removals and bridge building on private property in the upper watershed and large-scale culvert replacements on the main crossroads. Stormwater management retrofit examples are provided in the form of a grassed underdrained soil filter to treat and manage stormwater runoff from an existing impervious surface (e.g., roof and parking lot) and the conversion of an existing deep water detention basin to a gravel wetland to provide additional treatment. There is also a recommended public road rehabilitation project and the consideration of the Coffin Ice Pond Dam.

The table is not meant to be inclusive of all projects to be considered within the watershed but a presentation of the types of projects that watershed managers will consider in the future. Other retrofit opportunities exist and will be brought forward as funds are appropriated and projects found feasible. Cost estimates provided are order-of-magnitude planning costs only. No detailed study or design has been undertaken for any of the retrofits presented.

Table 5. Preliminary Stormwater Retrofit Recommendations

		Location	Retrofit Recommendation	Cost Estimate
Above Baribeau	1	Headwaters: Thornton Oaks Walking Trails	There are several undersized, failing CMPs used at walking trail crossings that could be removed from the stream and replaced with pedestrian footbridges. The facilities manager at Thornton Oaks has offered to work with the Town.	$52,000
Above Maine Street	2	Barrows and McMillan Street Outfalls/ Down chutes	There are at least two locations with half-cut CMPs that were installed as down chutes to convey road runoff down to the stream. These have failed and are resulting in significant sediment loss through erosion and deposition in the stream. These could be replaced with deep sump catch basins with hooded outlets.	$23,000
	3	Maine Street Baptist Church: Under Maine Street	There is a large parking lot and roof with no current stormwater management that sheds large amounts of runoff during storm events. The runoff concentrates at a 24-inch concrete cross culvert on the NW side of Maine Street and results in a fire hose on the SE side of the road. Considerable incising of the tributary occurs as it flows between Meadowbrook Road to the north and the Hospital to the south. Providing stormwater management in the form of a gravel wetland or under drained soil filter with some storage below the church parking lot and roof would control flow at the concrete cross culvert and reduce excessive flow and erosion at the outlet.	$62,200
	4	Baribeau Drive, Maine Street, and Harpswell Road Culvert Crossings	Three road crossings for the main stem are all nearing the end of their design lives and are undersized. The culverts also offer very little opportunity for aquatic organism passage. These culverts should be replaced with larger, open bottom culverts or bridges. However, these replacements should be directed by a stream calibrated hydrologic and hydraulic (H&H) model to predict flooding and flow scenarios based on their removals.	$552,000
Above Harpswell Road	5	Sparwell Road Crossing	This road crossing is on a main tributary of the main stem approximately 500-feet upstream of the confluence with the Mare Brook main stem. The culvert is undersized and failing and can be observed to be crushed and limiting passage of water and aquatic organisms. There are also large sediment deposits at both the inlet and outlet of the culvert. The road above is damaged with the west side of the road unraveling and excessive erosion on the downslope. Within the road are sewer and gas lines that are also in danger of failing. Attempts to repair the road in the past have been patchwork. The proposed fix would involve rebuilding approximately 300-feet of the road (elevate and provide proper drainage), culvert upsizing and lengthening, and stabilization of the roadside downslopes above the stream.	$103,000
	6	Bowdoin College Athletic Field Deep Water Detention Basin	The existing detention basin provides flood control for runoff from the athletic fields at Bowdoin College. The basin provides very limited water quality treatment to the runoff. The retrofit would involve the conversion of the deep-water detention basin to a gravel wetland. The gravel wetland could be sized to still provide flood control while offering significantly greater water quality treatment.	$104,000

4.2.4 Combined Structural and Instream Recommendations

The geomorphic assessment, culvert and outfall survey, and stormwater retrofit review resulted in many overlapping recommendations. Structural BMP and instream recommendations from each of these assessments were combined by stream reach to assist with planning and for a holistic look at construction recommendations. See **Table 6.** for a table of combined structural BMP and instream work recommendations and **Figure 6** for a map of reach locations

Table 6. Combined Structural BMPs and Instream Work Recommendations

	Reach	Description	Includes Road Crossing	Individual Recommendations				All Recommendations for Reach Combined
				Culvert	Outfall	Instream	Stormwater Retrofits	
Above Baribeau Drive	1	Windorf Circle to Matthew Drive		Cul02	Out23	Chop & Drop	Remove culvert, replace with footbridge (retrofit 1a)	Remove culvert, replace with footbridge (Cul02); Chop & Drop
	T1	Arrowhead Dr and western basin to confluence with Reach 1		Cul01	Out22, Out11		Remove culvert, replace with footbridge (retrofit 1b)	Remove culvert, replace with footbridge (Cul01)
	2	Matthew Drive to backside of senior housing center	Matthew Dr	Cul03		Chop & Drop		Chop & Drop
	3	Backside of senior housing center to Baribeau Drive	Baribeau Dr	Cul04, Cul05			Replace crossing with open bottom culvert (retrofit 4a)	Remove culverts (Cul04 & Cul05), restore channel, replace with open bottom culvert
	T4	Baribeau Drive southern tributary	Baribeau Dr southern trib	Cul06, Cul07, Cul08, Cul09				Remove vegetation at inlet & outlet, add riprap (Cul06); replace culvert (Cul09)

	Reach	Description	Includes Road Crossing	Individual Recommendations				All Recommendations for Reach Combined
				Culvert	Outfall	Instream	Stormwater Retrofits	
Above Maine Street	4	Baribeau Drive to area of no access				Remove armor downstream of Baribeau crossing		Remove armor downstream of Baribeau crossing
	5	No access area downstream to Barrows Street	Barrows St	Cul10		Remove fill and replace footbridge	Replace downchutes with deep sump catch basins with hooded outlets (retrofit 2a); Replace tree in tree box filter (retrofit 8)	Remove culvert (Cul10), restore channel, replace with larger opening; at footbridge, remove fill and replace footbridge; catch basins with hooded outlets; tree box filters
	6	Barrows Street to a point even with Colonial Drive				Wood additions or Chop & Drop		Wood additions or Chop & Drop
	7	From a point even with Colonial Dive to MacMillan Drive	Macmillan Dr	Cul14		Anchored wood additions, biostabilizatio n by homes	Replace downchutes with deep sump catch basins with hooded outlets (retrofit 2b)	Remove culverts (Cul14), restore channel, replace with open bottom culvert; Anchored wood additions, biostabilization by homes; catch basins with hooded outlets
	T8	Tributary crossing Richards Dr	Colonial Dr, Richards Dr	Cul13, Cul15				Add riprap at outlet (Cul13); Remove culverts, restore channel, upsize culvert (Cul15 - Richards Dr)
	8	MacMillan Drive to Maine Street	Maine St	Cul16		Chop & Drop	Replace crossing with open bottom culvert (retrofit 4b)	Remove culvert (Cul16), restore channel, replace with open bottom culvert; Chop & Drop

	Reach	Description	Includes Road Crossing	Individual Recommendations				All Recommendations for Reach Combined
				Culvert	Outfall	Instream	Stormwater Retrofits	
Above Harpswell Road	9	Maine Street to Meadowbrook Road	Meadowbrook Rd	Cul17	Out13	Chop & Drop; Remove fill to restore floodplain	Retrofit athletic field deep water detention basin to gravel wetland to provide water quality treatment along with flood control (retrofit 6)	Remove culvert (Cul17), restore channel, upsize culvert; Chop & Drop; Remove fill to restore floodplain; Retrofit detention basin
	T10	Tributary from Parkview and crossing Sparwell Ln	Sparwell Ln	Cul18, Cul19, Cul22, Cul21			Gravel wetland or underdrained soil filter for upper Maine Street church parking lot and roof (retrofit 3); upsize and lengthen culvert (Cul18), rebuild road and stabilize road downslopes near stream (retrofit 5)	Upsize culvert (Cul18), rebuild road; stormwater treatment for church parking lot and roof
	10	Meadowbrook Road to Coffin Ice Pond			Out17, Out19	Chop & Drop		Chop & Drop; Retrofit outlet with new section and outlet protection (Out17); Replace outfall pipe and provide outlet protection (Out17)
	CIP	Coffin Ice Pond		DamCIP			Address failing pond dam; Address access road to prevent soil loss to stream (retrofit 7)	Address failing pond dam; Address access road to prevent soil loss to stream
	11	Coffin Ice Pond Dam to Harpswell Road	Harpswell Rd	Cul23, Cul20			Replace crossing with open bottom culvert (retrofit 4c)	Remove culvert (Cul23), restore channel, replace with open bottom culvert

	Reach	Description	Includes Road Crossing	Individual Recommendations				All Recommendations for Reach Combined
				Culvert	Outfall	Instream	Stormwater Retrofits	
Below Harpswell Road	12	Harpswell Road to Navy Base fence/Perimeter Dr	Perimeter Dr	CulPD	Out12			Resize culvert at Perimeter Dr (CulPD - not yet in culvert mapping)
	13	Navy Base fence/Perimeter Dr to Samuel Adams Dr	Samuel Adams Dr			Remove armor downstream of Perimeter Dr; Wood additions in channel and on floodplain; Plant forested buffer		Remove armor downstream of Perimeter Dr; Wood additions in channel and on floodplain; Plant forested buffer
	14	Runway culvert	Runway crossing			Daylight culvert		Explore opportunities to Daylight culvert
Runway to Head of Tide	15	Runway culvert to Eagle Drive	Eagle Dr / Major Pope Ave	CulED		Wood additions in channel and on floodplain; Plant forested buffer		Resize culvert at Eagle Dr (CulED - not yet in culvert mapping); Wood additions in channel and on floodplain; Plant forested buffer
	16	Eagle Drive to confluence with Merriconeag Stream				Chop & Drop		Chop & Drop
	17	Merriconeag Stream confluence to Liberty Crossing				Wood additions; Remove berm		Wood additions; Remove berm
Merriconeag Stream	TM	Merriconeag Stream downstream of Picnic Pond outlet to confluence with Mare Brook	Purinton Rd	Cul28; DamPP			Install stormwater retrofits for Brunswick Landing impervious cover	Stormwater retrofits for Brunswick Landing impervious cover; Explore opportunities to reduce negative impacts of Picnic Pond on stream

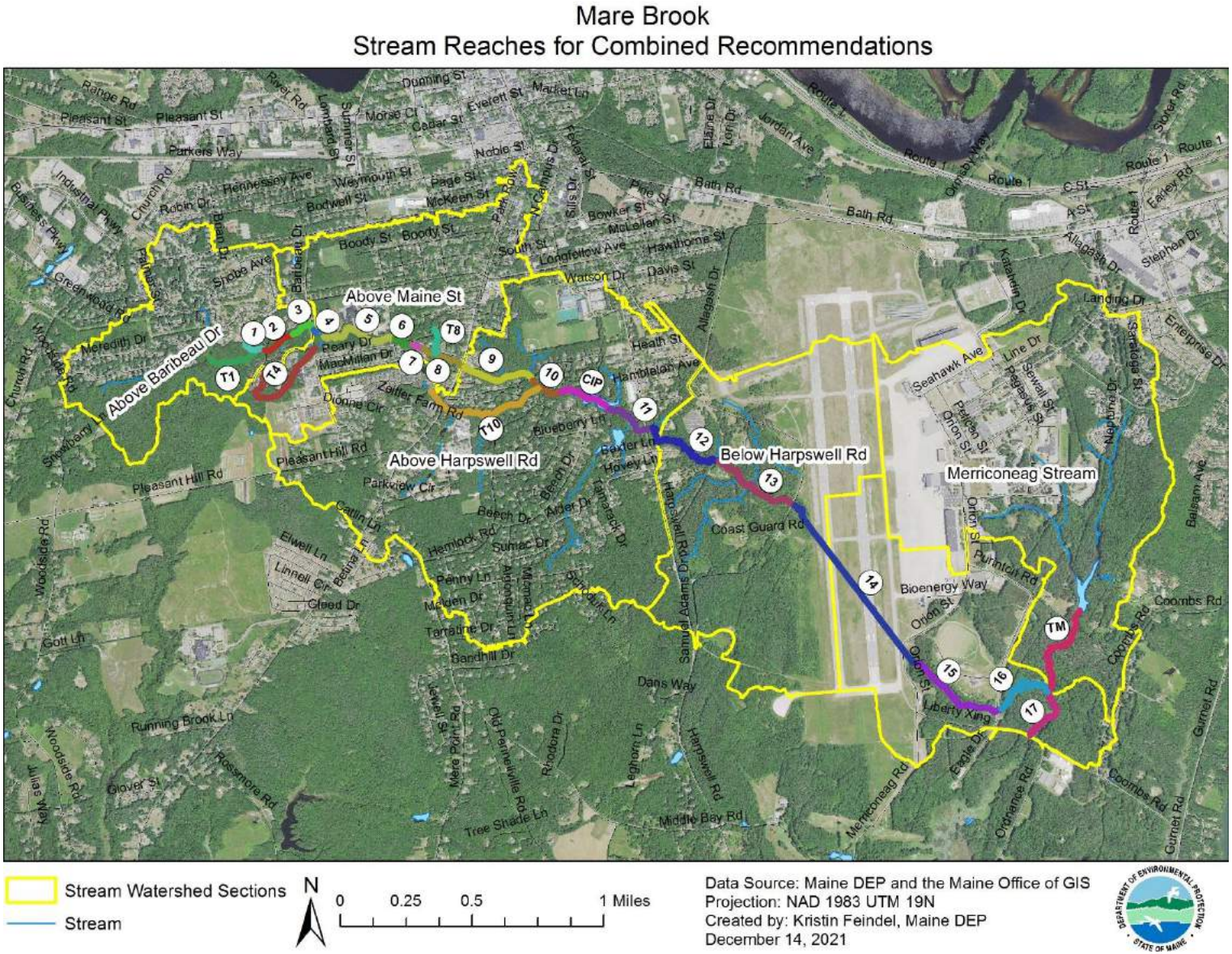

Figure 6. Map of Stream Reaches for Combined Recommendations

4.3 Review of Legacy Pollutants

4.3.1 Coffin Ice Pond

Coffin Ice Pond is a dammed section of Mare Brook that is a popular recreation area. Photo: David Page

In September 2009 and, again, in April, 2010, U.S. Navy consultants sampled surface waters and sediments at eight stations in Coffin Ice Pond with the intent of using the Pond as a clean reference for Picnic Pond of which the former Brunswick Naval Air Station drains into. The study[18]provided a detailed characterization of Coffin Ice Pond's sediments and surface waters. The concentrations of contaminants were below risk thresholds in surface waters. In sediments, total polycyclic aromatic hydrocarbon (TPAH) concentrations exceeded the Probable Effects Concentration (PEC)[19] (NOAA, 2008) in six of eight stations, with the highest concentrations in the western-most samples. The TPAH levels decreased in sediments moving from west to east. Sediment levels of chlorinated pesticide, DDT, did not exceed the PEC, but its breakdown products, DDE and DDD did, with DDD exceeding the PEC at all stations. The data suggest upstream runoff as being the source of the contamination.

In 1987, extensive removal of oil-contaminated soil was done at the site of an engineering company on Harpswell Road (US Navy 2016). While it is possible that leachate could have reached Coffin Ice Pond, the 2009/2010 data suggest that such was not the case since the sediment stations closest to Harpswell Road had the lowest TPAH concentrations. Looking at the individual PAH compounds present in the highest amounts in the 2009/2010 Coffin Ice Pond sediments, it is most likely that the source is asphalt particulate and coal tar-based driveway sealer, which has now been banned from consumer sales in Maine[20].

4.3.2 Former Brunswick Naval Air Station (BNAS)[21]

In 1943 during World War II, the U.S. Navy established the Brunswick Naval Air Station which operated until 1949 yet re-commissioned in 1951 and operated until final decommission in 2011. The boundary of the former base is shown in **Figure 7**. During operations, the Brunswick Naval Air Station (BNAS) encompassed approximately 3,094 acres of developed and undeveloped land. The former base supported the Navy's operations with several squadrons of P-3 maritime patrol aircraft. BNAS was officially designated on U.S. Environmental Protection Agency's National Priorities List as a Superfund site in 1987.

[18] U.S. Navy, August 8, 2016. "Investigation Summary Report: Former Picnic Pond Stormwater Retentions System, Former Naval Air Station (NAS) Brunswick"

[19] National Oceanic and Atmospheric Administration, Screening Quick Reference Tables. NOAA OR&R Report 08-1.

[20] David Page communication, 10/25/21

[21] Majority of information regarding legacy pollution of the former BNAS, including references, provided by Carol White, C.A. White & Associates

In 2005, BNAS was identified by the Base Realignment and Closure (BRAC) Commission for closure and the base was formerly deactivated on May 31, 2011[22]. As of 2020 approximately 90% of the former base property has been transferred out of Navy ownership to the Midcoast Regional Redevelopment Authority (MRRA) (42%), the Town of Brunswick (30%) and into private and public ownership (17%)[23].

The Brunswick Naval Air Station permanently closed in 2011 but chemicals used during its operation are still present.

The Navy's historical activities at the former BNAS have resulted in the contamination of soil, sediment, stormwater, surface water, and groundwater with a variety of chemical contaminants. The concentration and distribution of these contaminants vary across the base, but include metals (especially arsenic, cadmium, chromium, and lead), pesticides, polycyclic aromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPH), 1-4 dioxane, chlorinated volatile organic compounds including, among others, perchloroethylene (PCE), 1,1,1-trichloroethane (TCA), and trichloroethylene (TCE). Per- and polyfluoroalkyl substances (PFAS) are also known to be present on the former BNAS. PFAS are the result of the use or spills of fire-fighting foam in areas around the runway and between the airplane hangars. Determining the nature and extent of PFAS in various media across the former base will be the subject of further study by the Navy over the next 3 to 5 years.

To date, a total of 22 contaminated sites have been or are being investigated at the former BNAS in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Superfund Amendments and Reauthorization Act (Navy 2020). In 2021, USEPA designated a new site, OU-13 due to the widespread detections of PFAS in the soils, sediments, groundwater, surface water and stormwater on and off the former base. This new site OU-13 encompasses the entire base including Mare Brook and Merriconeag Stream.

The sites and contaminants of relevance to Mare Brook are summarized below. **Figure 7** shows the sites and restoration areas on the Former BNAS.

[22] Steve Levesque, 2016. Revitalization: The Journal of Urban, Rural & Environmental Resilience "Guest article: Redeveloping a Navy Base into a Great New Place in Brunswick, Maine". https://revitalization.org/article/guest-article-redeveloping-navy-base-great-new-place
[23] Midcoast Regional Redevelopment Authority (MRRA), 2020. http://mrra.us/

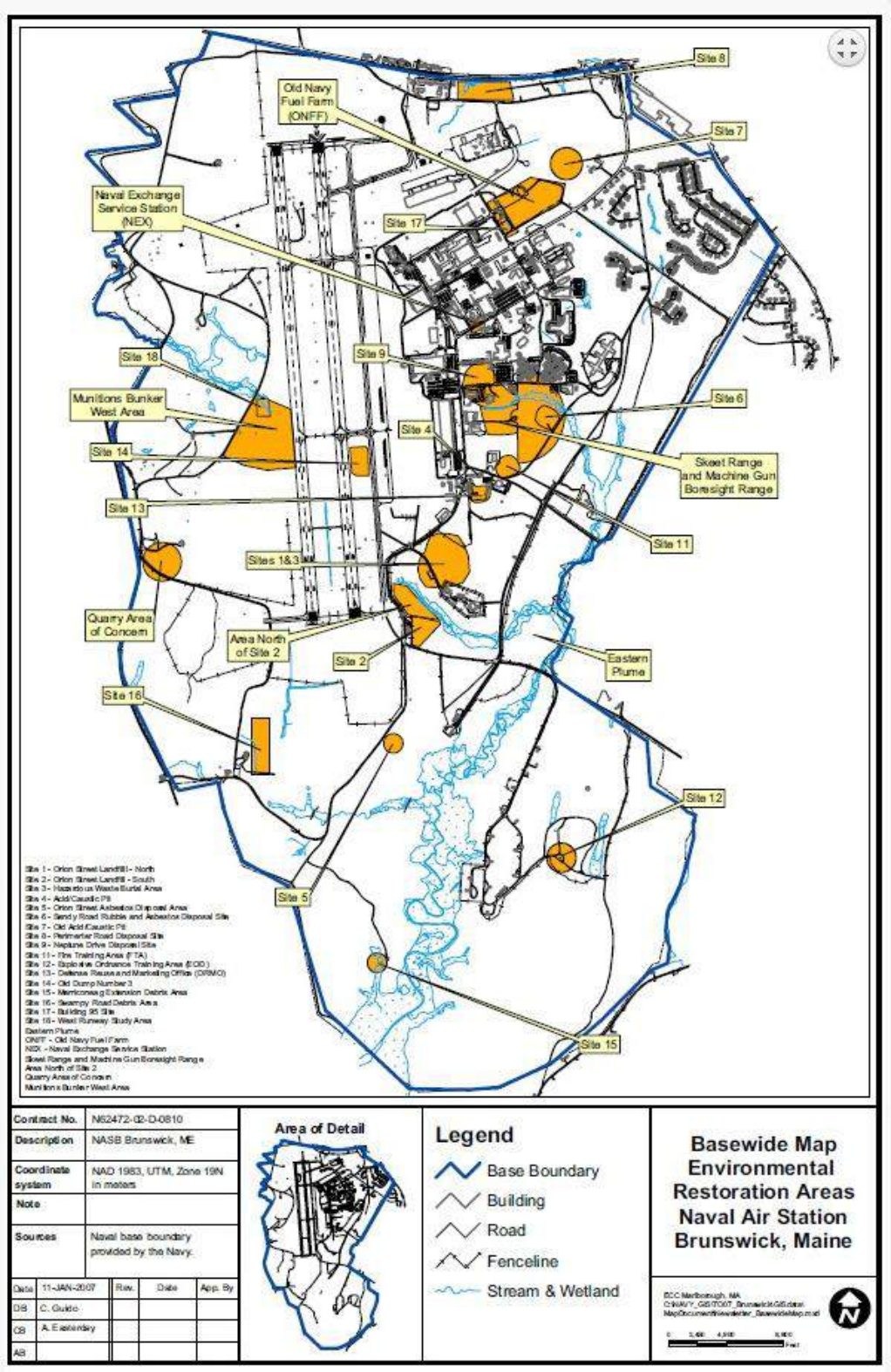

Figure 7. Former Brunswick Naval Air Station Property and Restoration Areas

4.3.2.1 Landfills 1 and 3

Site 1, the Orion Street Landfill-North and Site 3, Hazardous Waste Burial are located adjacent to Mare Brook just east of Orion Street. According to the Navy, the Site 1 landfill was used from 1955 to 1975 for disposal of materials including garbage, food waste, refuse, waste oil, solvents, pesticides, petroleum products, paint wastes, aircraft and automobile parts, and various chemicals. Site 3 operated from 1960 to 1973 as a disposal area for solvents, paints, and isopropyl alcohol. Due to their proximity and hydrogeologic characteristics Sites 1 and 3 were combined into a single" site" for the purposes of the remediation and Record of Decision (ROD) (U.S. Navy, 1992). Sites 1 and 3 are currently owned by the Navy and the landfills are closed – i.e. no waste is being disposed. Studies suggest that groundwater in the overburden aquifer flows from the landfills southeast towards Mare Brook discharging directly into Mare Brook and as leachate seeps along the banks of Mare Brook. (Navy, 2020)

In 1992, the ROD was approved for Sites 1 and 3. The ROD outlines the remedial actions and land use restrictions for a specific site. The selected remedy for the landfills allowed for the waste to remain in place but required construction of a cap and slurry wall to minimize groundwater contact with landfill waste materials. As part of the remedy, institutional controls including soil and groundwater restrictions were implemented to prevent uncontrolled human exposure to contaminated soil and groundwater. Land use controls prohibit all uses of groundwater and soils in the area except for investigative and remedial purposes (Tetra Tech, 2016).

Long term monitoring of the groundwater, leachate seeps, surface water and sediment in the vicinity of Sites 1 and 3 has been ongoing for a limited number of parameters since the combined sites were closed. In addition to groundwater samples, the monitoring includes collection of three leachate seep and sediment samples, two surface water and sediment samples (Navy, 2021). The result of the most recent monitoring event indicates that elevated levels of some contaminants, principally metals, are present in the leachate seeps, sediments, and surface water. In leachate samples, elevated levels of metals including aluminum, barium, iron, lead arsenic, beryllium, cadmium, chromium, cobalt, copper, mercury, nickel, vanadium, and manganese have been detected. Of particular concern is the detection of arsenic at 12,900 µg/L at Seep-9 and according to the Maine Department of Marine Resources, Upper Harpswell Cove is currently closed to shellfish harvesting due high arsenic levels. In leachate sediment samples, several metals were detected including elevated concentrations of barium and cobalt. (Navy 2021) In the leachate sediment samples elevated concentrations of arsenic, beryllium, mercury, nickel, manganese and selenium were reported. Elevated levels of several metals including aluminum, barium, iron, lead, and manganese were reported for surface water samples although the Navy reported that with the exception of lead and manganese, most were below or only slightly above what they consider to be background concentrations (Navy 2021). It's important to note that samples used to establish "background levels" are from developed sites and not all stakeholders, including Maine DEP, agree with the background levels established for the former base.

4.3.2.2 Landfill 2

Site 2, the Orion Street Landfill–South, is a former borrow pit and inactive landfill located near the southern end of the main runway adjacent to Mare Brook and south of Sites 1 and 3. According to the Navy, Site 2 was used as the primary landfill for the former BNAS from 1945 until 1955. The wastes with Site 2 have not been characterized, but reportedly include: solvents, paint, oil, toluene, methyl ethyl ketone, and medical supplies

and incinerator ash. The ROD for Site 2 was signed in 1998, and at that time it was determined that the landfill did not to pose an unacceptable human health or ecological risk, so no remedial actions were undertaken.

Limited environmental monitoring was initiated in April 2000, and similar to Sites 1 and 3, monitoring includes groundwater, surface water, leachate and sediment samples. In recent monitoring events, leachate and surface water samples were only analyzed for metals. These monitoring results indicate elevated levels of several metals including of barium, beryllium, copper, iron, manganese, and silver in these media. (Navy, 2021)

4.3.2.3 Eastern Groundwater Plume

The Eastern Plume is an extensive groundwater plume formed by multiple contamination sources. The location and areal extent of the Eastern Plume is shown in **Figure 8**. Investigations of the discharge of contaminants from the eastern plume to Mare Brook and Merriconeag Stream has been evaluated through testing of seeps, porewater, and surface water samples. Detailed porewater investigations near the confluence of Mare Brook and Merriconeag Stream conducted in 2005 and 2008 determined that chlorinated volatile organic compounds (VOCs), including vinyl chloride and 1 4-dioxane were present in the groundwater near the Mare Brook and Merriconeag Stream confluence and floodplain area in exceedance of state health guidelines (ECC, 2008). The studies concluded that in the Eastern Plume the groundwater flow and contaminant migration is generally in an east-to-southeast direction toward Merriconeag Stream and Mare Brook. Upward vertical hydraulic gradients in the vicinity of Merriconeag Stream and Mare Brook and higher heads in wells on the eastern side of these streams indicate that the streams are natural groundwater discharge areas. This discharge to the surface water is controlled by the subsurface geology. As the lower sandy unit approaches the stream floodplain area, it rises in elevation following the top of clay, resulting in groundwater discharge into the surface water system. (ECC,2008).

A ROD was issued for the Eastern Plume in 1992 which included the installation a groundwater extraction and treatment system to help control the migration of the chemical contamination in the Eastern Plume. The system has been operating for about 30 years and has been modified over the years by adding and removing extraction wells and by reconfiguring the treatment technology. In 2018 the Navy added carbon treatment to the system after it was discovered that PFAS was present in Eastern Plume ground water and extraction well effluent. The Navy is proposing additional changes to the pump and treat system in hopes of capturing more of the PFAS contamination in the groundwater (Navy, 2021)

The primary contaminants of concern in the Eastern Plume include the chlorinated volatile organic compounds (PCE, TCE, 1,1,1-TCA and associated their breakdown products), and 1,4-dioxane. Based on the proximity of Sites 1 and 3, Site 2, and the Eastern Plume, their land use control boundaries were combined into a single area, with groundwater restrictions across the entire combined area. This zone, referred to as the Groundwater Management Zone (GMZ), along with soil restrictions, were established to try and minimize human exposure to these contaminants.

Recent monitoring of Eastern Plume has included only groundwater samples. Although concentrations of some contaminants have decreased over time, other such as 1,4-dioxane have shown increasing concentrations in shallow groundwater pore water samples.

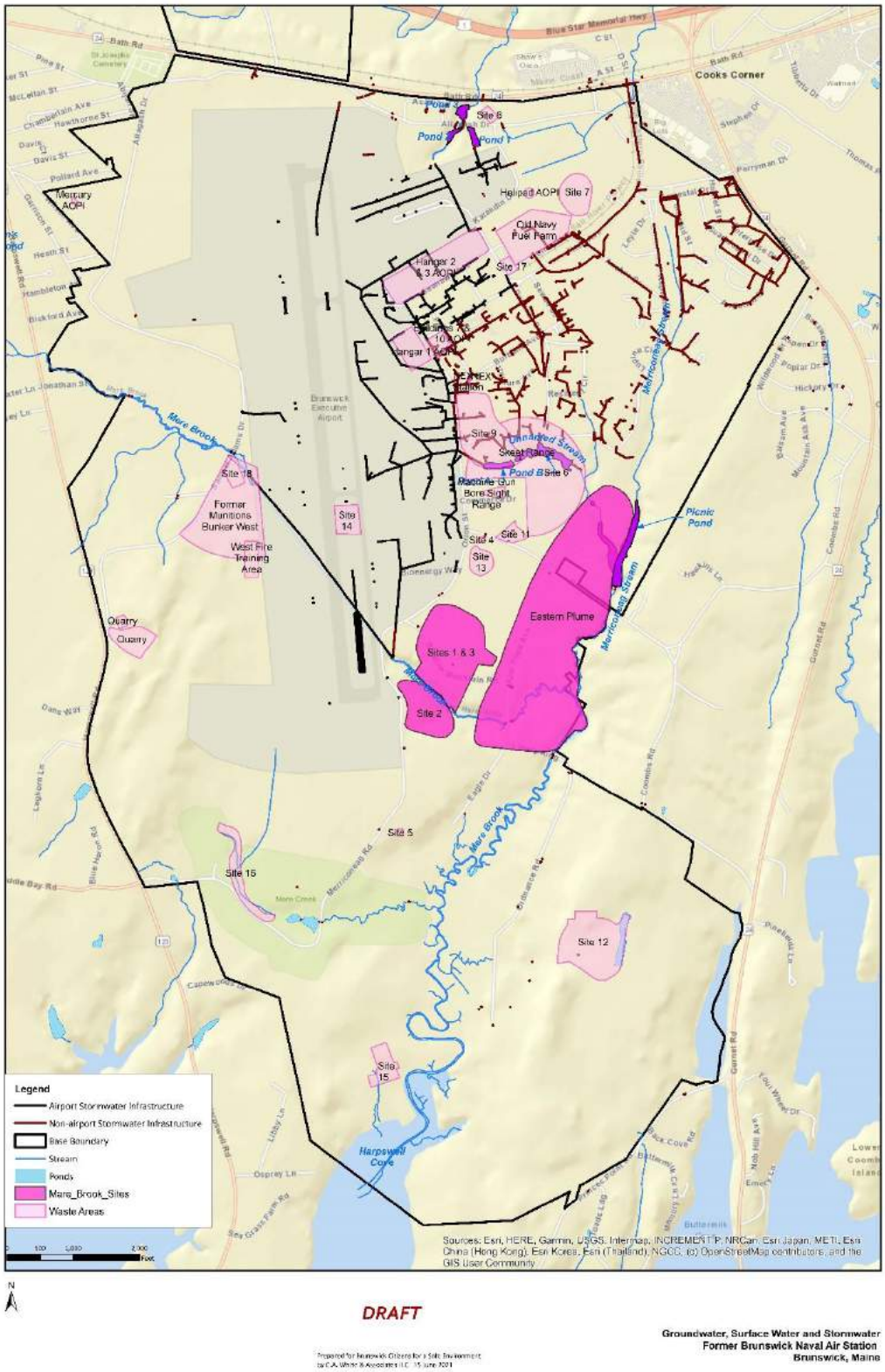

Figure 8. Map of Eastern Plume, waste areas and stormwater infrastructure on the Former BNAS Property

4.3.2.4 Picnic Pond Stormwater System

Picnic Pond Stormwater System is located at the former Brunswick Naval Air Station.

To the southeast of the former Brunswick Naval Air Station is the Picnic Pond Stormwater System. This System includes Pond A, Pond B, Pond C Area, and Picnic Pond and was used by the Navy as a stormwater retention system to channel and control stormwater drainage on the naval air station base. Pond A, Pond B, and Pond C Area are part of an unnamed tributary flowing into Merriconeag Stream with Picnic Pond being part of Merriconeag before it flows into Mare Brook. The Picnic Pond System was once part of the sanitary sewer system prior to 1954 and was estimated as capturing more than 80% of stormwater discharged from the industrial portions of the former base when it was in operation[24]. The western branch of the system receives the stormwater discharge from the airport as well as surface runoff from adjacent developed and undeveloped areas. The eastern branch, fed by Merriconeag Stream, runs north to south beginning at Brunswick Landing, the area of former base housing now consisting of growing commercial and residential uses. The largest and southern-most retention pond, Picnic Pond is approximately 3.7 acres in size with an average depth of about 5 feet and a maximum depth of 12 feet (U.S. Fish and Wildlife Service ,1999). In 1997, dikes were constructed to create the separate retention ponds (Ponds A, B and C) along the Unnamed Stream just south of the airport.

Historically, while an operating base, the Navy maintained a National Pollution Elimination System (NPDES) permit for discharge to Mare Brook. In 2011, when the base was decommissioned, the Navy transferred the stormwater system to the Midcoast Regional Redevelopment Authority (MRRA). Currently MRRA has an industrial Multisector General Permit (MSGP) that covers the airport portion of the stormwater system. Two outfalls discharge from MRRA's stormwater system: Outlet 9 which discharges to Pond A, and Outlet 3 which discharges directly to Mare Brook at the southern end of the airfield.

Studies conducted by the Navy have determined that contaminants are present in the stormwater discharging from these outfalls, in sediments in the retention ponds, and in the groundwater that discharges and surface that flows into Merriconeag Stream and Mare Brook. Contaminants of particular concern in the Picnic Pond System include synthetic volatile organic compounds (VOCs), total petroleum hydrocarbons (TPH), metals, pesticides, polyaromatic hydrocarbons (PAH) and per- and polyfluoroalkyl substances (PFAS). In 2020 U.S. EPA and Maine DEP approved a Record of Decision for remediation of the contaminated sediments in the four retention ponds: Ponds A, B, C and Picnic Pond. The Navy is planning to start the remediation of the contaminated sediments in 2022.

4.3.2.5 PFAS Operable Unit (OU-13)

As previously mentioned, Site OU-13 was established by U.S. Environmental Protection Agency in 2021 and includes the entire former BNAS including Mare Brook and Merriconeag Stream. This site was established due

[24] United States Navy, October 2019. Proposed Plan: Former Picnic Pond Stormwater Retention System Former Naval Air Station Brunswick, Maine https://www.brunswickme.org/DocumentCenter/View/1623/US-NAVY-Proposed-Plan-Former-Picnic-Pond-Stormwater-Retention-System-Former-Naval-Air-Station-

to the widespread detections of PFAS in the soils, sediments, groundwater, surface water and stormwater on and off the former base. PFAS is a component in aqueous film-forming foam (AFFF), which was routinely used at various military installations, including the former BNAS. Multiple PFAS substances have been detected in samples, including perfluorooctanoic acid (PFOA) and perfluoroctane sulfonate (PFOS). PFAS released into the environment creates potential concerns for human health and the environment because of their persistence, mobility, and toxicity (Tetra Tech 2021). Over a ten-year period from 2010 to 2020 the Navy conducted several investigations at former BNAS to delineate the extent of PFAS impacts across the former base. The results of these investigations are summarized in the PFAS Investigation Summary Report (Resolution, 2020). Based on the data in the PFAS Summary report it has been determined that PFAS is present in the surface water in Mare Brook in concentrations ranging from 200 parts per thousand (ppt) to over 4,000 ppt.

In the summer of 2020, the Navy completed a study which identified the extremely elevated levels of PFAS in stormwater samples collected from the airfield stormwater system and in stormwater discharging and flowing through the retentions pond and ultimately to Mare Brook (TetraTech 2021). Concentrations of a single PFAS compound, PFOS, in stormwater samples from the airfield exceeded 8,000 ng/L and water samples from the retention ponds exceeded 1,000 ng/L.

Perfluorooctaine sulfonate (PFOS), associated with the use of firefighting foam at the former Brunswick Naval Air Station, has been detected in blue mussels sampled by Maine DEP in 2014 and 2016 at 1-1.6 miles south of the outlet of Mare Brook into Harpswell Cove and in ribbed mussels sampled by David Page through the Brunswick Area Citizens for a Safe Environment in September of 2020[25]. These findings suggest that historic PFOS deposits at the former air station are continuing to be released and reaching downstream biological communities.

4.3.3 Addressing Legacy Contamination

Legacy contamination associated with the former Brunswick Naval Station Superfund site is impacting the water quality in Mare Brook and Merriconeag Stream. Although remedial actions have been ongoing for over 20 years, contamination continues to be transported through the stormwater system to Mare Brook and Merriconeag Stream and through discharge of contaminated groundwater into the surface water system on the former base. Legacy contaminants include metals (especially arsenic, cadmium, chromium, and lead), pesticides, polycyclic aromatic hydrocarbons (PAHs), total petroleum hydrocarbons (TPH), 1-4 dioxane, chlorinated volatile organic compounds including, among others, perchloroethylene (PCE), 1,1,1-trichloroethane (TCA), and trichloroethylene (TCE) and per-and polyfluoroalkyl (PFAS) compounds.

It is difficult to quantify the effects of these contaminants on the stream ecology, but it is likely that the presence of these contaminants in the surface water and sediments contributes to the chronic non-attainment of this portion of Mare Brook. As the responsible party under the U.S. EPA Superfund site designation, the U.S. Navy is responsible for cleaning up the legacy contamination resulting from former base activities. The Mare Brook Leadership Team should appoint members to participate in the Navy's discussions of the clean-up at the former naval air station. These members would serve as a crucial connection between the two working groups to ensure effective collaboration on watershed-wide remediation efforts. Particular interests of the Mare Brook Leadership Team may include:

[25] David S. Page for Brunswick Area Citizens for a Safe Environment, 11/27/2020. Summary of PFOS Results: September 2020 Ribbed Mussel Sampling

- Remedial actions undertaken by the Navy to address contamination in the Picnic Pond Stormwater System may result in slightly improved water quality in Mare Brook.
- The existing stormwater system was installed by the Navy in the 1950's and is known to be in poor condition. Video surveys of stormwater pipes indicate that contaminated groundwater is infiltrating into the stormwater system through cracks in the stormwater conveyance system (MRRA, 2020). The stormwater system needs structural repair and replacement. Monitoring and treatment of contaminants at the outfalls would result in improved water quality in the retention system and Mare Brook.
- Accurate delineation and effective remediation of the PFAS contamination could also improve the water quality in Mare Brook. In particular, interception of the contaminated groundwater before it discharges into Mare Brook and Merriconeag Stream could significantly reduce the mass PFAS and other contaminants in the Mare Brook system.
- The remedies for the landfills were selected over 25 years ago and potential impacts of the landfills on the water quality of Mare Brook were not fully considered. Based on limited data, it appears that contaminated groundwater and leachate continued to discharge to the Mare Brook system over this period. The Mare Brook Leadership Team, in coordination with Remediation Bureau of Maine DEP, should request that the potential impact of landfills on Mare Brook be further evaluated.

4.4 Review of Continuous Stream Water Quality Data

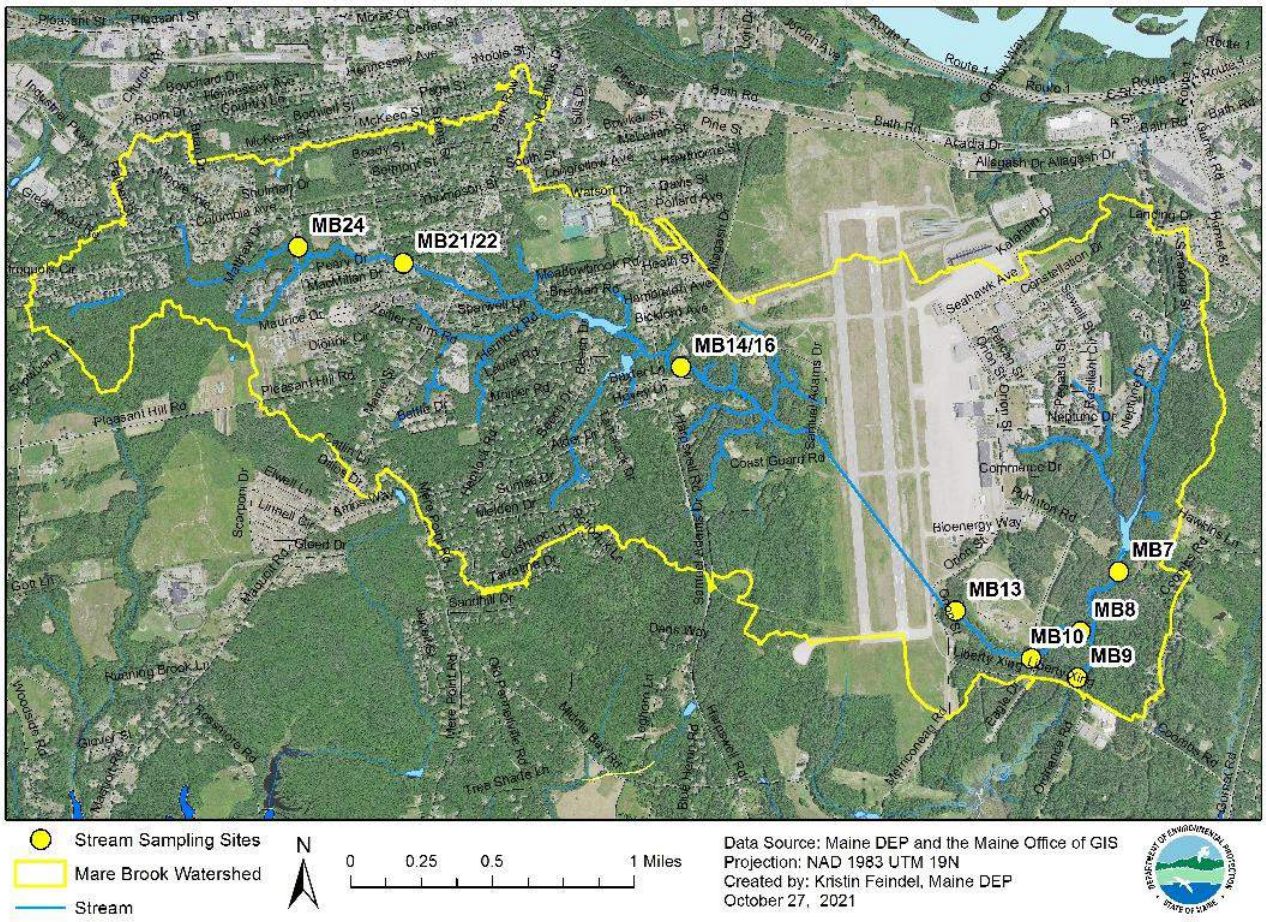

Figure 9. Maine DEP Stream Water Quality Monitoring Sites

Continuous monitoring devices were deployed by the Maine DEP Watershed Unit at four locations on Mare Brook and Merriconeag Stream from July 29 to August 18, 2015, and at six locations from June 16 to June 30, 2016 (**Figure 9**). The devices recorded temperature, dissolved oxygen, and specific conductivity at 15-minute intervals. In 2015, the deployment sites were below Barrows Street (MB21/S-1064), Jonathan Street (MB14/S-143), above Major Pope Road (MB10), and Merriconeag Stream (MB7/S-330). In 2016, the deployment sites were three of the same locations (MB21, MB14, MB7) as well as Baribeau Drive (MB24), below Major Pope Road (MB8) and Liberty Crossing (MB9/S-144).

Overall, low dissolved oxygen or diurnal swings of dissolved oxygen do not appear to be a major concern for the stream. However, some the upper sites (MB24, MB21, MB14) and above Major Pope Road (MB10) were very affected by rain events such as on 6/29/16 and 8/12/15, with highly variable dissolved oxygen levels. This may be due to turbidity, pulses of low oxygen water from stormwater ponds or other sources, and/or the sensor getting buried periodically. Specific conductivity appeared typical of an urban stream and does not seem to indicate a problem with chloride at any of the stations at this time. Temperature was not a concern during the sampling period at most stations, though the readings were a bit high at Merriconeag Stream (MB7) and Jonathan Street (MB14).

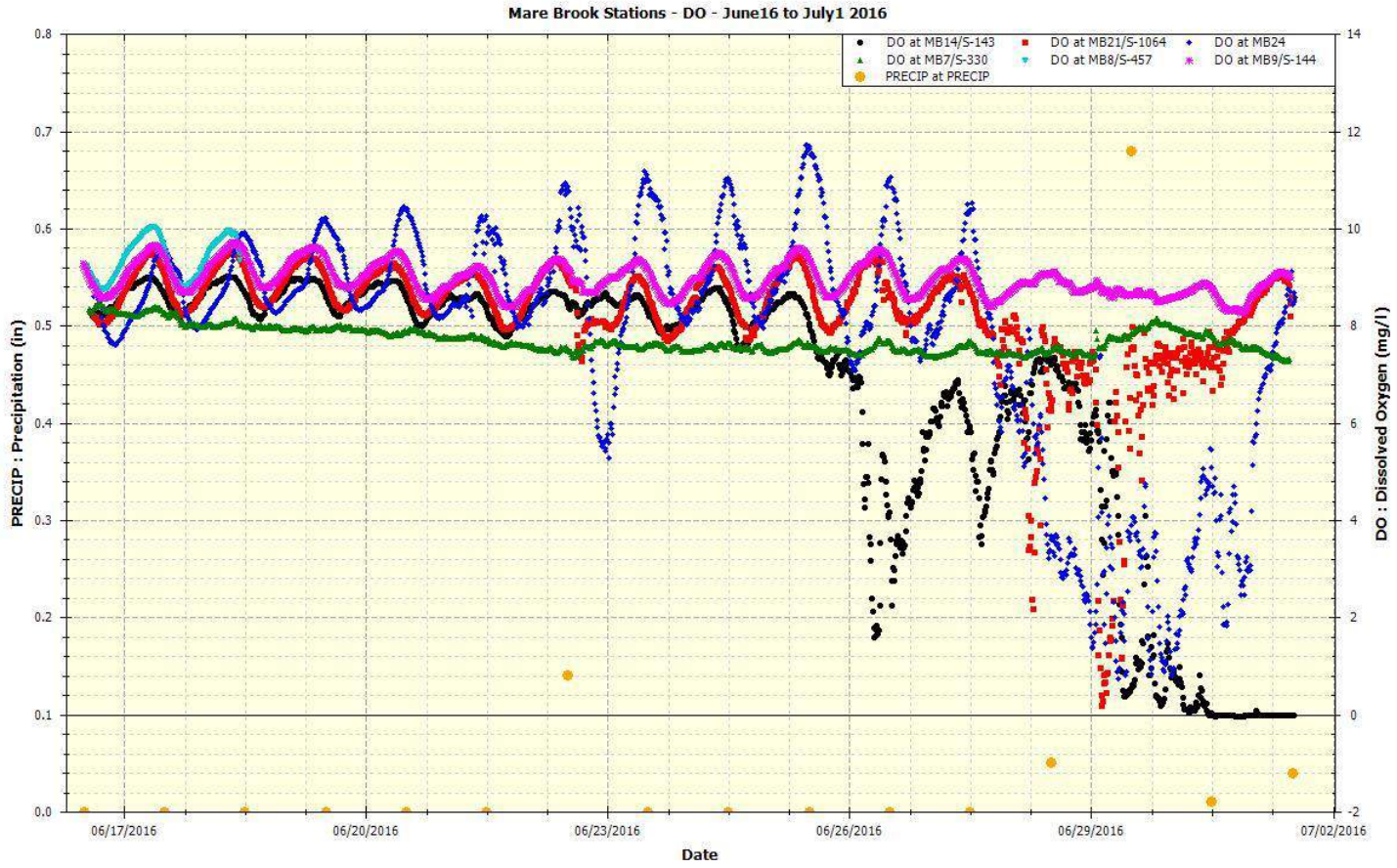

Figure 10. Dissolved Oxygen Readings - June 16-July 1, 2016

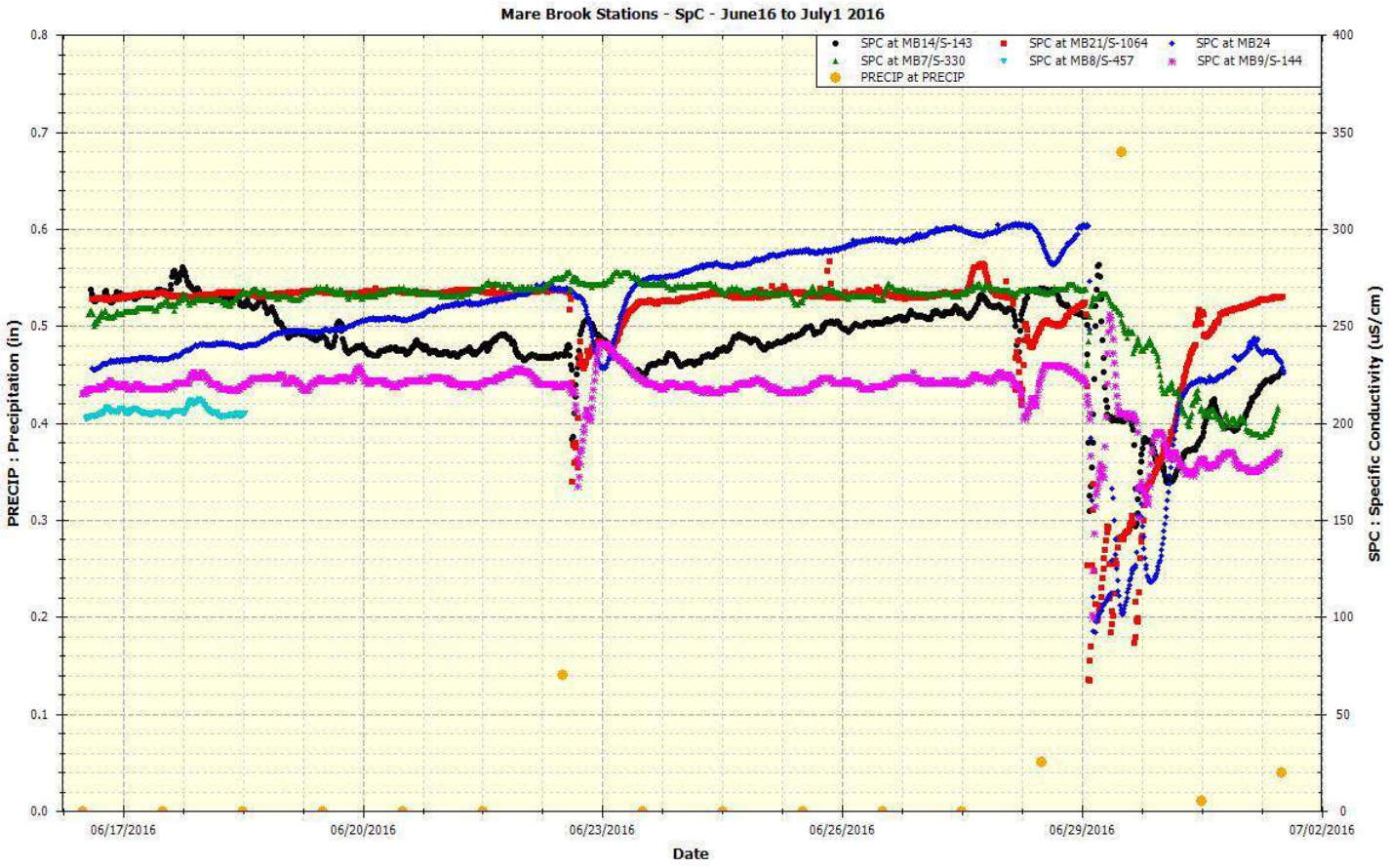

Figure 11. Specific Conductivity Readings - June 16-July 1, 2016

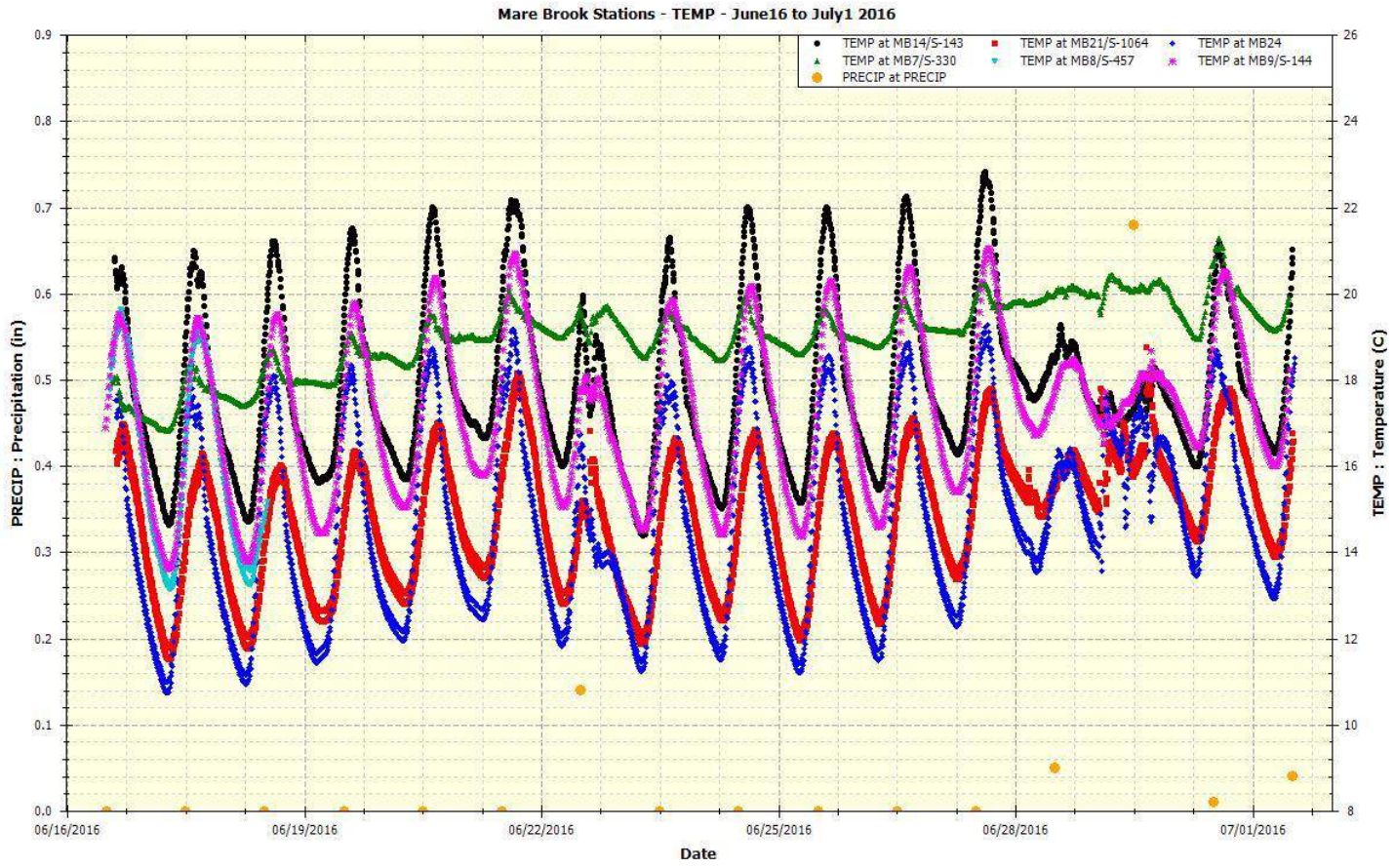

Figure 12. Temperature Readings - June 16-July 1, 2016

Some other findings are as follows:

- Dissolved oxygen at Merriconeag Stream (MB7) appears moderated due to the pond, and Liberty Crossing (MB9) also had moderated DO.
- In 2016, the loggers at Below Major Pope (MB8 – downstream of the road crossing, but before the confluence with Merriconeag) were buried in less than 2 days, even without a rain event. The data for when it appeared to be buried was removed. At retrieval, the logger had to be dug out from about 6 inches of sand. While this could be in part due to logger siting, it is telling that there was so much movement of sediment.
- Baribeau Drive (MB24) had some big DO spreads, and likely was in stagnant water at times since it appeared to be in stagnant water at retrieval in 2016.
- Jonathan Street (MB14) had a dip in DO around 6/26/16 which is not connected to a rain event and the source of this is unknown.

Continuous monitoring devices for dissolved oxygen, specific conductance, and temperature were also deployed by the Maine DEP Watershed Unit from July 16 to August 13, 2021 on Merriconeag Stream at a location just upstream of its confluence with Mare Brook (this site is not included in Figure 9). The dissolved oxygen monitoring device was partially buried at retrieval and therefore its readings are not reliable. Specific

conductance had a high of 488 µS/cm and an average of 367 µS/cm during the deployment period. Temperature had a maximum of 23°C (73.4°F) and an average of 20°C (68°F).

4.5 Data Gaps

Several areas deserve more investigation to refine or modify the understanding of primary stream stressors and their causes for Mare Brook.

There is very little stream flow data available on any section of the Mare Brook. This data would be useful in assessing the status of and any improvements in hydrology of the brook. Continuous flow data of the stream below the runway culvert, below Picnic Pond and at the confluence of Merriconeag Stream and Mare Brook is needed to get an understanding of the hydrology of those sections. This would help better understand the impact of Picnic Pond on the stream and the interaction of groundwater and the stream.

Not much is known about the health of the northern section of Merriconeag Stream above Picnic Pond. The current road crossings of the stream have very little water and were not able to be sampled when visited during previous stream assessment work. Given the increased development in the subwatershed of that section of Merriconeag Stream, investigation of the stream health between the road crossings and Picnic Pond is warranted.

While there is extensive data on toxics in groundwater associated with the former Brunswick Naval Air Station, a better understanding of the connection with brook is needed. This includes a better understanding of its likely impact on macroinvertebrates in the areas of contamination. In particular, sampling of volatile organic compounds (VOCs) around the confluence of Mare Brook and Merriconeag Stream would be useful in understanding the impact of the contaminated groundwater and the health of the stream. The potential impact of the old base landfills on Mare Brook should also be further evaluated.

High *E. coli* bacteria was detected in the "Above Maine Street" section in 2016. The highest readings were bracketed to just upstream of the Barrows Street crossing. While high bacteria is not a stressor to macroinvertebrate communities, high bacteria can be a concern for the health of anyone playing in the stream and can be an indicator of high nutrients or other pollutants. Sampling of *E. coli* in this area of the stream should occur to determine if there are still concerns to be addressed.

5 Stream Stressor Identification

Following Maine DEP's *Guide to Identifying Stream Stressors* (October 2019), collected watershed assessment data was used to identify specific proximate (or primary) stressors that are most likely contributing to Mare Brook's impairment. Addressing the exact cause(s) of a stream's impairment is the most effective way for a waterbody to attain designated Class standards and greatly helps in targeting limited time and resources.

Kristin Feindel and Jeff Dennis of Maine DEP took the lead in conducting the stressor analysis, presenting their initial findings to the management plan steering committee for input. To help pinpoint specific stressors, the Mare Brook Watershed was broken into six stream sections (**Figure 13**). The sections are labeled as follows and includes the drainage area of the following areas:

- **Above Baribeau Drive** = Headwaters downstream to Baribeau Drive
- **Above Maine Street** = Baribeau Drive downstream to Maine Street

- **Above Harpswell Road** = Maine Street downstream to just below Harpswell Road
- **Below Harpswell Road** = Just below Harpswell Road to the inlet of the ¾-mile culvert crossing under the former Brunswick Naval Air Station runway
- **Runway to Head of Tide** = Entire stream running through the ¾-mile culvert under the former Brunswick Naval Air Station runway downstream to the head of tide (where salt water becomes predominant)
- **Merriconeag Stream** = Headwaters of Merriconeag Stream downstream to confluence with Mare Brook

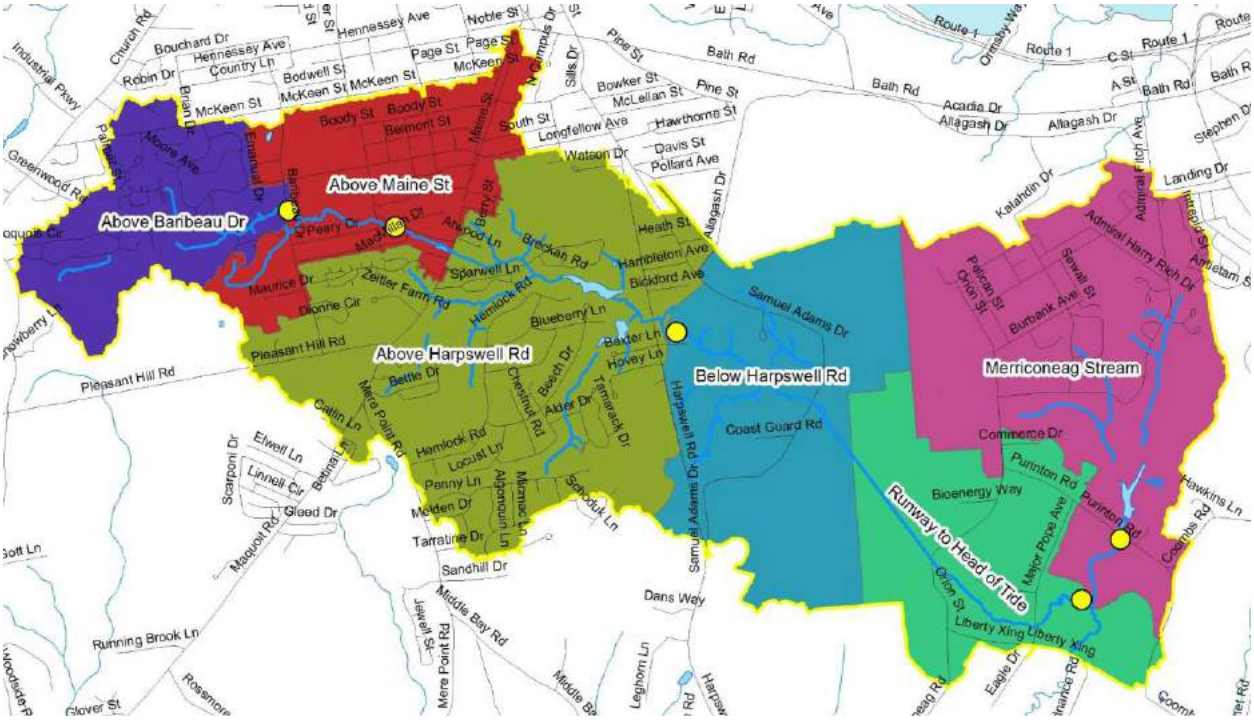

Figure 13. Stream Sections

Data for each stream section was analyzed to determine proximate stressors or primary environmental conditions (pollutants or habitat) causing the biological impairment. Then, using the Causal Pathway of the stream stressor guide, the likely cause or source of each of those stressors was identified for each stream section. **Figure 14** shows an example of the causal pathway method from the stream stressor guide. The method works 'backwards' from right to left, includes secondary stressors and results in a specific source type. See the MDEP stream stressor guide for more details on this tool to assist in determining stressor sources.

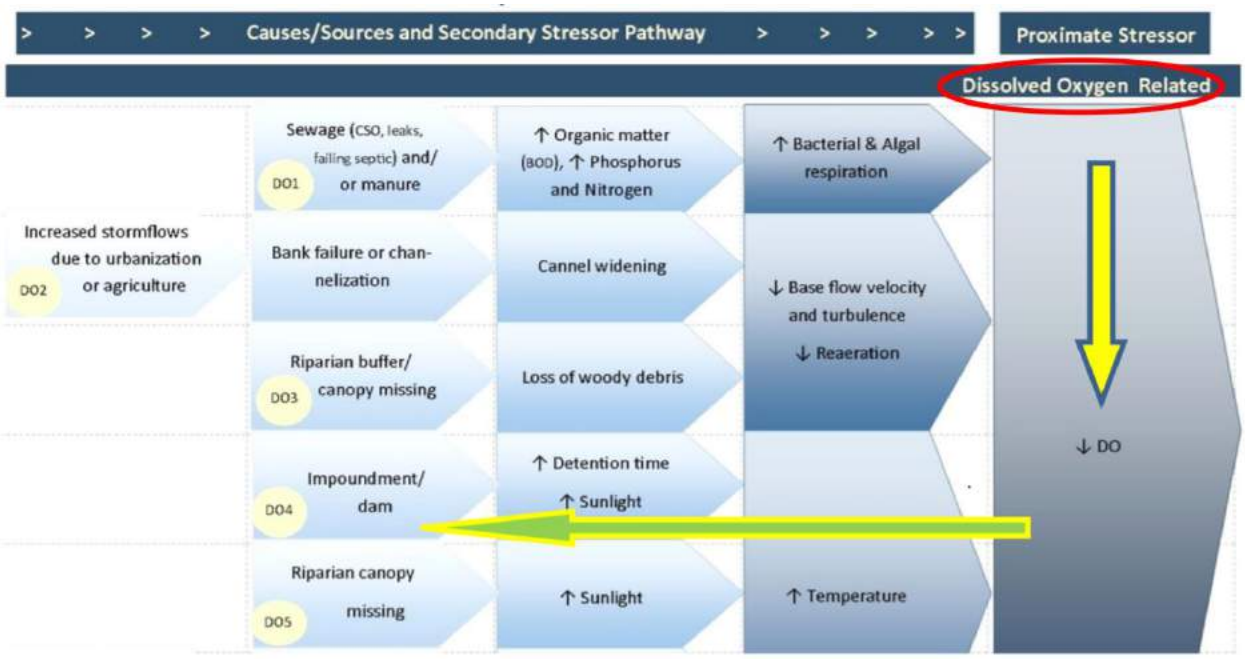

Figure 14. Example of using the causal pathway to identify the causes/sources of low dissolved oxygen.

Proximate stressors identified for sections of Mare Brook included physical habitat alterations, low recruitment potential for macroinvertebrate and fish populations, toxicity threats, increased stormwater velocity, high stream temperatures and low dissolved oxygen. Of these stressors, physical habitat alterations were present watershed-wide with low recruitment/possible low recruitment of concern for four of the stream sections. An overview of the primary/dominant stressors identified per stream section are shown in map and table form in **Figure 15** and **Table 7.**

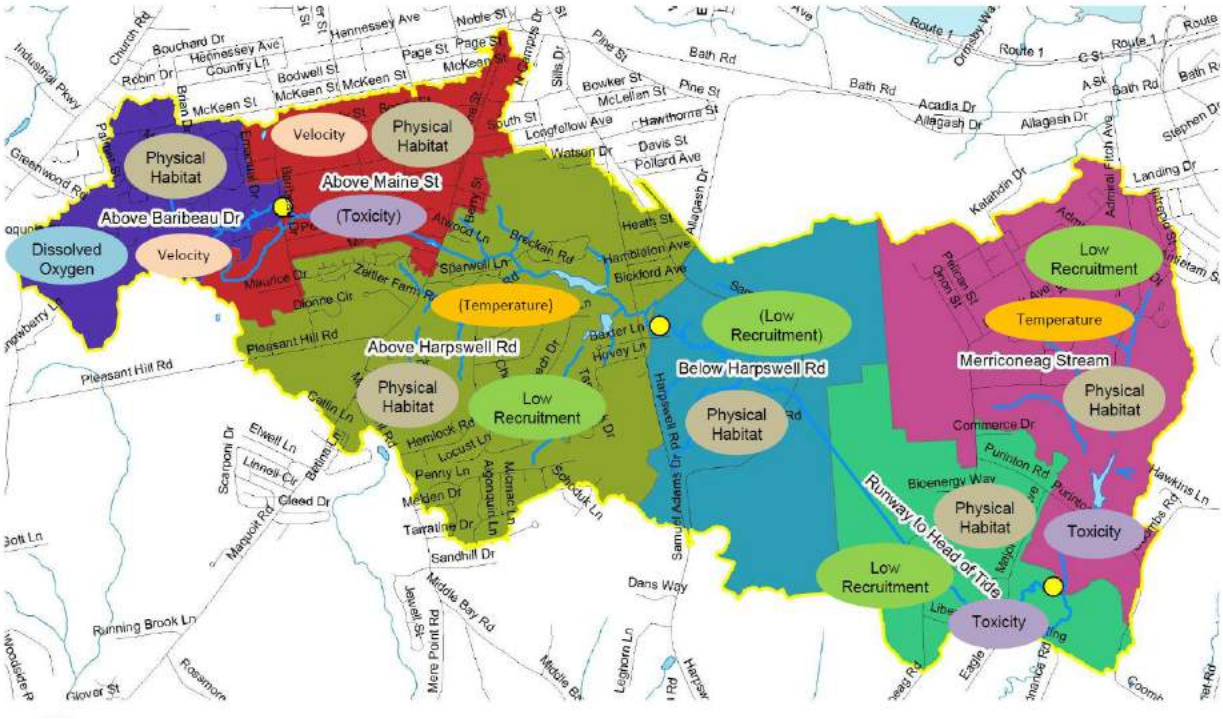

Figure 15. Dominant Stressors per Stream Section Map

Table 7. Dominant Stressors per Stream Section. See Guide to Identifying Stream Stressors (MDEP, October 2019) for details on Stressor IDs. (e.g. V3, DO7, H23, etc.).

Section	Temp	Velocity	Dissolved Oxygen	Altered Physical Habitat	Low Recruitment Potential	Toxicity	Other
Above Baribeau Dr		**V3**	**DO7, DO8**	**H23**			
Above Maine St		**V7, V8**		**H1, H2, H3, H12, H23**		**TO5** *possible*	Bacteria?
Above Harpswell Rd	**T1** *possible*			**H1, H3, H23**	**LR5**		
Below Harpswell Rd				**H3, H14, H23**	**LR4** *possible*		
Runway to Head of Tide				**H1, H2, H12, H14, H24**	**LR5**	**T06**	
Merriconeag Stream	**T1**			**H1**	**LR5**	**T06**	

Causes, or sources of stressors included undersized and/or misaligned culverts, urbanization and/or alteration of drainage, dams and inadequate fish stream crossing, toxicity, channelization, loss of floodplain access, decreased riparian canopy, increased stormflow from urbanization and nutrients from runoff. Many of these caused more than one stressor. For example, an undersized or misaligned culvert could cause velocity, dissolved oxygen and altered physical habitat stressors. **Table 8** shows the primary stressor causes for each stream section.

Table 8. Causes/Sources of Stressors by Stream Section.

Section	Culverts undersized and/or misaligned	Loss of floodplain access	Urbanization and/or alteration of drainage	Channelization	Toxicity	Dams and inadequate fish stream crossing	Other
Above Baribeau Dr	X						Nutrients from runoff
Above Maine St	X	X	X	X	possible		Increased stormflow from urbanization
Above Harpswell Rd	X		X			X	
Below Harpswell Rd	X					X	Decreased riparian canopy
Runway to Head of Tide		X	X	X	X	X	Decreased riparian canopy
Merriconeag Stream			X		X	X	

Once the proximate stressors and causes were determined for each stream section, action items were recommended to address the causes and therefore reduce the stressors. **Table 9** is an overview of the stressors, causes, and actions determined per each stream section following the stream stressor guide and based on available watershed data and steering committee input. These causes were then used to determine solutions / action items to reduce and eliminate the identified stressors.

Table 9. Stressors, Causes, and Actions per Stream Section

	Stressors and Causes	Action Items
Above Baribeau Drive	• Low baseflow velocity due to undersized/misaligned culverts • Low DO at night, high DO swings due to missing riparian canopy with creation of wetlands due to undersized culvert and increased nutrients from urban runoff • Increased deposition of sediments due to ponding upstream of undersized culverts	• Increase culvert size • Reduce nutrients from urban runoff
Above Maine Street	• Increased catastrophic drift due to increased stormflows due to urbanization (stream straightened and not much floodplain due to development) and loss of floodplain and wetland storage • Increased frequent disturbance of substrate and loss of substrate downstream due to decreased gravel & sand habitat, increased bottom scoured to marine clay, urbanization and/or alteration of natural drainage patterns (including fill), loss of floodplain & wetland storage, and undersized and misaligned culverts • Increased alteration of substrate and loss of habitat diversity due to channelization • Increased deposition of sediments due to ponding upstream of undersized culverts • Possible potential acute toxicity in stormflow due to parking lot & school bus washing • Possible bacteria?	• Increase floodplain access • Increase culvert size • Restore stream channel • Reduce pollutants from bus parking lot • Install stormwater BMPs
Above Harpswell Road	• Possible increased temperature due to impoundment/dam • Increased frequent disturbance of substrate and loss of substrate downstream due to decreased gravel & sand habitat, increased bottom scoured to marine clay, urbanization and/or alteration of natural drainage patterns, and undersized and misaligned culverts • Increased deposition of sediments; Ponding upstream of undersized culverts • Decreased fish migration; Inadequate stream crossings and dams	• Increase culvert size • Restore stream channel • Explore impacts of dams • Install stormwater BMPs

	Stressors and Causes	Action Items
Below Harpswell Road	• Increased frequent disturbance of substrate and loss of substrate downstream due to decreased gravel & sand habitat, increased bottom scoured to marine clay, and undersized and misaligned culverts • Increased alteration of substrate and loss of habitat diversity due to decreased riparian buffer/canopy • Increased deposition of sediments due to ponding upstream of undersized culverts • Possible decreased oviposition of eggs in stream due to downstream culvert	• Increase culvert size (Harpswell Road, see above) • Increase riparian buffer/canopy • Explore opportunities to improve runway crossing impacts
Runway to Head of Tide	• Increased frequent disturbance of substrate and loss of substrate downstream due to decreased gravel & sand habitat, increased bottom scoured to marine clay, urbanization and/or alteration of natural drainage patterns, and loss of access to floodplain • Increased alteration of substrate and loss of habitat diversity due to channelization and decreased riparian buffer/canopy • Decreased available habitat due to stream underground for long distance • Decreased upstream fish migration due to inadequate stream crossings & dams • Potential toxicity in base flow due to soil & groundwater contamination sites	• Restore stream channel • Increase riparian buffer/canopy • Increase culvert size • Investigate possible impact of former BNAS groundwater contamination to the stream • Install stormwater BMPs
Merriconeag Stream	• Increased temp due to impoundment/dam • Increased frequent disturbance of substrate & loss of substrate downstream due to decreased gravel & sand habitat, increased bottom scoured to marine clay, and urbanization and/or alteration of natural drainage patterns • Decreased upstream fish migration due to inadequate stream crossings & dams • Potential toxicity in base flow due to soil & groundwater contamination sites	• Investigate modification to Picnic Pond outlet • Install stormwater BMPs • Increase culvert size • Investigate possible impact of former BNAS groundwater contamination to the stream

6 Remediation Action Items

Based on the data and assessments completed, a combined list of action items (both structural and non-structural) to address Mare Brook's water quality impairment was created. This list was broken into stream sections with a category for action items recommended watershed wide. Action items were prioritized by the Mare Brook Watershed Management Plan Development Steering Committee and Technical Advisory Committee based on the action's effectiveness of directly targeting the proximate stressor and on what the steering committee felt was needed to best achieve the overall goal of this plan. Solutions/action items and their priority rankings were presented to the public for additional information and feedback to consider.

Table 10 is a combined list of remediation action items based on the assessments conducted. While all items are of significance, some actions were ranked by the Steering Committee/Technical Advisory Committee as the highest and medium priorities based on actions that would most likely address specifically identified stream stressors. These rankings are reflected in the table.

Table 10. Remediation Action Items Based on Assessments

	Remediation Action Item	Highest Priority	Medium Priority
Above Baribeau Drive	Culverts	x	
	○ Hydrologic and hydraulic (H&H) Study to be done first watershed-wide	x	
	○ Thornton Oaks Trail Crossings – Replace with footbridges; Incorporate geomorphic concept Design 1		
	○ Replace culverts at main stem of Mare Brook crossing with Baribeau Drive with an open bottom culvert (H&H study first)	x	
	○ Remove obstruction at Baribeau Drive southern tributary crossing		
	○ Replace and upgrade inlet/outlet of Western Thornton Oakes Property's southern tributary		
	Chop and drop from Windorf Circle to backside of Senior Housing at end of Matthew Drive (Included in Design 1)	x	
	Detach impervious cover from stormwater / install stormwater BMPs		x
Above Maine Street	Follow-up bacteria monitoring: Is bacteria an issue around Barrows St?		
	Culverts:	x	
	○ Remove armor downstream of Baribeau Drive culvert		
	○ Upsize culvert at Barrows Street after H&H		
	○ Upsize culvert at Macmillian Drive after H&H		
	○ Upsize culvert at Maine Street after H&H (Geomorphic Concept Design 3)	x	
	○ Upsize culverts at Richards Drive tributary crossing		
	○ Add riprap to outlet of Colonial Drive tributary crossing		
	Remove fill and replace foot bridge just above Barrows Street (Geomorphic Concept Design 2)		
	Remove bed armoring just downstream of Barrows Street; Install wood additions or chop and drop	x	
	Install anchored wood additions upstream of MacMillan Drive; Bio stabilization (plantings, log jams, etc.) by homes	x	
	Chop and drop just upstream of Maine Street crossing (and downstream along with removing fill in floodplain – see Maine Street to Meadowbrook Road below)	x	
	Outreach to bus/transportation center		
	Replace Barrows and McMillan Street Outfalls/Down chutes at least two locations with deep sump catch basins with hooded outlets.		

	Remediation Action Item	Highest Priority	Medium Priority
Above Harpswell Road	Culverts	x	
	○ Subcommittee to be established to look at weir structure, sediment contaminants, sediment movement, community values		
	○ Upsize culvert at Meadowbrook Road after H&H		
	○ Upsize culvert at Sparwell Lane tributary crossing after H&H and rebuild road		
	○ Upsize culvert at Harpswell Road after H&H	x	
	Chop and drop from Maine Street to Coffin Ice Pond	x	
	Remove fill at Maine Street to Meadowbrook Rd	x	
	Explore removal, repair, or modification of Coffin Ice Pond Dam, involve community *(Town Rec manages dam)*	x	
	Address erosion at gravel access road to Coffin Ice Pond		
	Retrofit Bowdoin College Athletic Field deep water detention basin with gravel wetland		
	Outreach to landowners on lawn fertilizer use (YardScaping) – *watershed wide*		
Below Harpswell Road/Above Runway	Culverts		
	○ Resize culvert at Navy Base fence (*Check with C. Baldwin*)		
	○ Review culvert on Samuel Drive and stream between Samuel Drive and runway culvert		
	○ *Jeff: Consider caddisfly migration in culvert design (watershed wide)*		
	Perimeter Road culvert – not high priority, H&H would confirm		
	Remove armor downstream of culvert at Navy Base fence		
	Below Perimeter Road: Install wood additions to channel and on floodplain/plant forested buffer (test plot first) between Navy Base fence (owned by Bowdoin, "Perimeter Road"/extension of Allagash Road? = dirt extension of Allagash Drive – Samuel Adams is within base/West Road) and runway culvert	x	
	Explore opportunities to identify runway crossing impact and possible improvements (adaptation techniques to adapt stream to the culvert)		x
	○ Any stormwater outfalls into this culvert?		x
	○ Fish tagging		x
	○ Could some areas of the stream be opened without impacting air traffic needs/safety?		x

	Remediation Action Item	Highest Priority	Medium Priority
Runway to Head of Tide	Culverts	x	
	○ Resize Eagle Drive/Major Pope Ave culvert	x	
	Install wood additions to channel and on floodplain below the runway culvert		x
	Plant forested buffer downstream of runway culvert	x	
	Chop and drop to increase stream complexity downstream of Eagle Drive/Major Pope Ave		
	Investigate possible impact of former BNAS groundwater contamination to the stream		x
	○ Landfill seeps		
	○ Eastern plume		
	○ (3rd is in Merriconeag subwatershed)		
	Coordinate communication amongst partners and committees (*watershed-wide*)	x	
	Add wood (in stream and along shoreline) and remove berm to increase stream complexity and canopy cover and restore floodplain continuity	x	
Merriconeag Stream	Culverts:		
	○ Resize Purinton Road culvert		
	Participate in / partner with MRRA task force: What can be done at Picnic Pond and upstream ponds (Ponds A, B, C) – Add recommendations to the WMP when determined	x	
	Continue to investigate Picnic Pond's impact to Merriconeag Stream: What can be done to assist in meeting Class standards		
	Investigate possible impact of former BNAS groundwater contamination to the stream		
	Install stormwater BMPs		
Watershed-wide	Steering Committee to oversee implementation of final Mare Brook WMP and continue communication with various stakeholders	x	
	Create education and outreach plan to identify purpose, targeted audience, and method. Possible needs based on observations include covering topics on:	x	
	○ Benefit of fallen trees/wood left in the Brook (yet yard waste along stream bank is not beneficial)		
	○ Reducing lawn pesticide and fertilizer use (perhaps using existing CCSWCD YardScaping program)		
	○ Reduced winter salt use		
	Stream monitoring: Stream flow including above and below former BNAS	x	
	Hydrologic and hydraulic (H&H) study: Culvert replacements to be prioritized after H&H study entire watershed and in conjunction with other factors (town paving schedule, funding, collaboration with other improvement projects)	x	
	Address chloride in the future as this is a very sandy watershed – encourage Planning Department to review new development with a lens to minimize need for salt		

7 Preventing Stressor Increases

In addition to implementing on-the-ground actions for stream restoration, additional actions were considered to prevent future stressors on Mare Brook. Topics discussed through the Steering Committee overseeing the compilation of this management plan include:

- Reviewing existing Town **ordinances and design standards** for opportunities to protect Mare Brook from increased stream stressors. Topics to explore include:
    - Reducing impervious impacts
    - Establishing new culvert standards
    - Reducing chloride use particularly in crucial areas; Possibly developing a Town-wide winter salt management plan

  Design standards to review[26]:
    - Enhancing floodplain protection and restoration
    - Reviewing the Rural Protection Stormwater Management (RPSMO) Best Management Practices (BMP) Manual for small scale treatment opportunities
    - Reviewing landscaping standards for opportunities to integrate stormwater treatment in new and redeveloped areas

  Specific areas to review were suggested by the Town of Brunswick's Town Planner, Jared Woolston, in **Table 11.**
- Determining and providing **incentives** for practices that improve and protect stream water quality particularly to:
    1) Preserve and restore natural riparian woody vegetation, and to
    2) Treat and possibly reduce existing areas of pavement.
- Exploring **land purchasing and/or conservation easements** for stream protection
- Creating and implementing a watershed-wide **maintenance** plan to ensure installed stormwater BMPs are maintained properly to function as intended.
- Creating an **education and outreach** plan to support addressing known stressors and to prevent stressor increases. An Education and Outreach Plan establishes a focused and targeted message, audience, and timeline to gain support of the WMP's initiatives. It also avoids over saturation of multiple messages and thus allows limited time, funding, and resources to be spent most efficiently. Potential topics an education and outreach plan for Mare Brook could pursue include:
    - Increase education efforts on existing stream protection regulations (landowners and contractors)
    - Stormwater BMP's landowners can implement (i.e. rain gardens to retain and treat stormwater onsite)
    - Importance of BMP maintenance for town infrastructure and private BMPs
    - Importance of woody vegetation along and within the stream channel

[26] Recommended by Town of Brunswick's Town Planner, Jared Woolston

- Ways to reduce impervious cover
- Proper disposal of yard waste
- Reduced pesticides and fertilizer use (e.g. YardScaping program)

Table 11. Town Planner's Suggestions for Specific Ordinances to Review

Specific recommendations to explore in conducting a Town of Brunswick ordinance review to increase stream and aquifer protection and to encourage low impact development (LID) include:

- Review existing overlay zoning district standards in Brunswick for compliance opportunities that mitigate the effects of stormwater runoff from developed areas and protect vegetation in riparian corridors including: 1) the existing 75-foot Shoreland Protection Overlay Stream Protection subdistrict (SPO-SP) and 2) the Rural Protection Stormwater Management Overlay (RPSMO) zoning district and associated stormwater treatment best management practices (BMPs) developed by Cumberland County Soil and Water Conservation District. NOTE: *any amendment to the SPO-SP must be approved by the Town of Brunswick and the Maine DEP pursuant to shoreland zoning statute. An amendment to the RPSMO zoning map or applicable standards, if determined appropriate, may be considered solely by the Town of Brunswick.*
- Consider the adoption of urban impaired stormwater treatment standards and applicable treatment thresholds that mitigate known subwatershed stressors (see Brunswick Zoning Ordinance, Section 4.5.4 "Stormwater Management")
- Review the appropriateness of the existing single and two dwelling unit structure exemption from stormwater treatment in Brunswick (see Brunswick Zoning Ordinance, Section 4.1 "Applicability of Property Development Standards"). NOTE: *The engineered porous driveways approved at the Cottages on Upper Maine residential subdivision is an important LID case study in Brunswick. This subdivision received approval from the Planning Board for an increased impervious surface standard (percent cover) where porous driveways were designed by and inspected during construction by a Professional Engineer (PE) and a maintenance plan was prepared by the design engineer. This allowed the project to maximize residential density in its growth area zoning district where such development is encouraged.*
- Consider a point system or other straightforward incentives for encouraging LID stormwater treatment that maintain natural drainage patterns to the greatest extent practical (references include 'Urban Street Stormwater Guide' by National Association of City Transportation Officials).
- Consider impacts of stormwater infiltration that could increase groundwater contamination or seasonal mobility of known legacy pollutants at the former Naval Air Station.
- Review opportunities for new green infrastructure with the Brunswick Bicycle and Pedestrian Advisory Committee (BBPAC) that reduces impervious areas in transportation corridors and improves bicycle and pedestrian safety and access as described in the 2020 Bicycle and Pedestrian Improvement Plan, approved by the BBPAC on May 27, 2021, and adopted as a local policy by the Town of Brunswick on August 16, 2021.

8 Complete Action Plan and Timeline

As stated in this plan's Executive Summary, the **primary goal of this plan is for Mare Brook, including Merriconeag Brook, to meet its State-designated Class B standards.** An estimated time to achieve this goal is 2037 which allows for 10 years of restoration work to occur and an additional 5 years for improved macroinvertebrate assessment to occur. This goal is to be accomplished by directly addressing the identified proximate stressors impacting Mare Brook's impairment while incorporating a number of additional strategies to support directly addressing proximate stressors and preventing future stressors to macroinvertebrates and other key water quality parameters.

Working with recommendations and potential solutions provided by watershed specialists, the plan's steering committee, and the public, this plan combined restoration actions into 6 main objectives needed for Mare Brook to attain its Class B standards:

1. **Establish support for implementing the WMP**
2. **Address known stressors**
3. **Continue exploring additional stressors**
4. **Prevent stressor increases from future development**
5. **Create and implement targeted education and outreach (to assist in addressing known stressors and preventing future stressors)**
6. **Monitor WMP's effectiveness (investigating new stressors and updating actions as needed)**

Detailed action items (or Management Measures) for these six objectives are listed in **Table 12** and include an approximate schedule, involved parties, potential funding sources, and estimated costs. The action items are broken into three phases over the plan's 10-year duration and include plans for both structural and non-structural solutions. The structural solutions consist of stream crossing upgrades, in-stream and riparian zone restorations, and stormwater conveyance retrofits. Non-structural solutions include forming a leadership team and working groups to find and oversee solutions, conducting education and outreach, establishing residential incentive programs for stream protection efforts, increasing maintenance techniques, reviewing stormwater ordinances, and continuing and increasing water quality sampling and testing.

A broad overall timeline summary for accomplishments, including both structural and nonstructural action items, is as follows:

Phase I: Years 2022-2026

- Establish a Mare Brook Leadership Team and appoint representatives to working group committees (education and outreach, Coffin Ice Pond dam, MRRA)
- Pursue funding for Phase I initiatives specifically focusing on funding a Hydrologic and Hydraulic (H&H) study and applying for an EPA Section 319 Clean Water Act grant to jumpstart project implementation.
- Provide ongoing project updates

- Conduct a Hydrologic and Hydraulic (H&H) study and prioritize sequence of stream culvert replacements and adjacent geomorphic stream restoration projects
- Address at least one major stream crossing culvert, including implementation of adjacent geomorphic stream restoration recommendations
- Address culverts in the upper watershed not requiring an H&H study
- Determine and implement short-term plans to address failing Coffin Ice Pond dam and the gravel access road
- Determine long-term plans for Coffin Ice Pond and start to prepare implementing these plans
- Create a timeline for outfall upgrades and address at least 3 outfall remediation sites identified
- Determine where to install sediment hoods and start installation process
- Explore stormwater retrofit and site-specific BMP improvements and pursue improvements for at least one site
- Work with private properties to detach impervious cover from stormwater infrastructure particularly within the "Above Baribeau Drive" subwatershed
- Determine and implement long-term solution for bus washing at the Coffin School
- Explore maintenance needs of installed BMPs throughout the watershed and establish system to encourage education of and ongoing maintenance.
- Start exploring opportunities to identify the impact of the ¾-mile culvert under the Brunswick Executive Airport and possible improvements
- Continue to investigate impacts of groundwater contamination to the stream from the former Brunswick Naval Air Station
- Investigate upper Merriconeag watershed (including Brunswick Landing) and Picnic Pond's impact to Merriconeag Stream's water quality
- Explore impact of trails and recreational uses within Mare Brook's floodplain and work to minimize impacts
- Review ordinance for opportunities to protect Mare Brook from increased stream stressors (Topics to explore include reducing impervious impacts, establish new culvert standards, reducing chloride use / developing salt management plan)
- Determine and provide incentives to preserve and restore natural riparian woody vegetation
- Start to explore feasibility of land purchasing and/or conservation easements for stream protection
- Create a watershed-wide maintenance plan
- Establish a Mare Brook Education and Outreach Committee to create a Mare Brook water quality education and outreach plan
- Continue to collect and review water quality data and macroinvertebrate data pursuing opportunities to increase sampling efforts where needed
- Formally amend WMP's action items as new information is gathered

- Create and maintain a digital spreadsheet/GIS database (NPS Site Tracker) of remediation sites addressed and remaining

Phase II: Years 2027-2029

- Mare Brook Leadership Team to continue active oversight of WMP initiatives
- Pursue funding for Phase II initiatives
- Provide ongoing project updates
- Address at least two major stream crossing culverts implementing adjacent geomorphic stream restoration recommendations
- Address culverts along lower Mare Brook not requiring an H&H study
- Implement long-term improvements to improve or minimize water quality impacts of Coffin Ice Pond dam and the gravel access road
- Address at least 2 culvert outfall remediation sites including continuation of installing sediment hoods
- Explore stormwater retrofit and site-specific BMP improvements and pursue improvements for at least two sites
- Continue to work with private properties to detach impervious cover from stormwater infrastructure particularly within the "Above Baribeau Drive" subwatershed
- Continue to explore maintenance needs of installed BMPs throughout the watershed and establish system to encourage education of and ongoing maintenance.
- Continue to explore opportunities to identify the impact of the ¾-mile culvert under the Brunswick Executive Airport and possible improvements
- Continue to investigate impacts of groundwater contamination to the stream from the former Brunswick Naval Air Station
- Continue to investigate upper Merriconeag watershed (including Brunswick Landing) and Picnic Pond's impact to Merriconeag Stream's water quality
- Continue to provide incentives to preserve and restore natural riparian woody vegetation
- Determine and provide incentives to treat and possibly reduce existing pavement
- Continue to explore land purchasing and/or conservation easements for stream protection
- Determine watershed-wide maintenance and pursue funding
- Start implementing identified maintenance needs
- Continue implementation of a Mare Brook Education and Outreach Plan
- Continue to collect and review water quality data and macroinvertebrate data pursuing opportunities to increase sampling efforts where needed
- Formally amend WMP's action items as new information is gathered
- Create and maintain a digital spreadsheet/GIS database (NPS Site Tracker) of remediation sites addressed and remaining; Consider using GIS data as a storybook of sites completed for education and outreach purposes

Phase III: Years 2030-2032

- Mare Brook Leadership Team to continue active oversight of WMP initiatives

- Pursue funding for Phase III initiatives
- Provide ongoing project updates
- Address at least two major stream crossing culverts implementing adjacent geomorphic stream restoration recommendations
- Address culverts along Merriconeag Stream not requiring an H&H study
- Address at least 3 culvert outfall remediation sites including continuation of installing sediment hoods
- Explore stormwater retrofit and site-specific BMP improvements and pursue improvements for at least two sites
- Continue to investigate impacts of groundwater contamination to the stream from the former Brunswick Naval Air Station
- Continue to provide incentives to treat and possibly reduce existing pavement
- Continue to explore land purchasing and/or conservation easements for stream protection
- Continue to implement identified watershed-wide maintenance needs
- Continue implementation of a Mare Brook Education and Outreach Plan
- Continue to collect and review water quality data and macroinvertebrate data pursuing opportunities to increase sampling efforts where needed
- Formally amend WMP's action items as new information is gathered; Consider plan for next 10 years for watershed protection efforts
- Create and maintain a digital spreadsheet/GIS database (NPS Site Tracker) of remediation sites addressed and remaining; Consider using GIS data as a storybook of sites completed for education and outreach purposes

Table 12. Goal Objectives and Action Items/Management Measures

		Action Items / Management Measures	Schedule	Involved Parties	Potential Funding Sources	Estimated Cost (10 years)
1. Establish Support for Implementing the Watershed Management Plan						
1.a.	Create a 'Mare Brook Leadership Team' or other formal committee to oversee the implementation of the WMP					
	1.a.i.	Appoint membership and establish charge: Use representative membership to determine specific timing and logistics for overall watershed improvements and increased communication among watershed stakeholders/groups and the public.	Phase I (2022 and every 2 to 3 years depending on term limits established)	Brunswick Town Council with community stakeholder input	In-kind: Brunswick Town Council, Community Stakeholders	$5K (in-kind)
	1.a.ii.	Hold a minimum of four committee meetings per year (Mare Brook Leadership Team or affiliated ad-hoc meeting)	Phase I-III (2022-2032)	Mare Brook Leadership Team (Town of Brunswick and Community Stakeholders)	In-kind: Mare Brook Leadership Team (Town of Brunswick and Community Stakeholders)	$80K (in-kind)
	1.a.iii.	Establish a 'Coffin Ice Pond Stakeholder Working Group' with a definitive charge and timeline to weigh benefit of dam removal and/or restoration to stream health versus community and ecological benefits to provide a recommendation to the Mare Brook Leadership Team (If dam is removed, how do we mitigate stressors? / If dam is kept, how do we mitigate stressors?)	Phase I (2022)	Brunswick Town Council with Mare Brook Leadership Team recommendations	In-kind: Brunswick Town Council, Mare Brook Leadership Team	$1K (in-kind)

		Action Items / Management Measures	Schedule	Involved Parties	Potential Funding Sources	Estimated Cost (10 years)
	1.a.iv.	Designate Mare Brook Leadership Team member(s) to serve on ad-hoc committees whose actions may affect Mare Brook's water quality to keep communication between all parties open to best protect and remediate Mare Brook.	Phase I (2022 and every 2 to 3 years depending on term limits established)	Brunswick Town Council with Mare Brook Leadership Team recommendations	In-kind: Brunswick Town Council, Mare Brook Leadership Team	$5K (in-kind)
1.b.	Determine how to fund the WMP's action items					
	1.b.i.	Mare Brook Leadership Team to advise / work through Town of Brunswick's Capital Improvement Program (CIP) process working with Brunswick's Finance Committee	Phase I-III (2022-2032)	Mare Brook Leadership Team	In-kind: 1-3 Mare Brook Leadership Team Members, Town of Brunswick's Finance Committee	$8K (in-kind)
	1.b.ii.	Schedule at least one meeting per year to determine yearly funding objectives (Requests for Town of Brunswick versus grants and other funding sources to pursue)	Phase I-III (2022-2032)	Mare Brook Leadership Team	In-kind: Mare Brook Leadership Team	$20K (in-kind)
	1.b.iii.	Apply for EPA Clean Water Act Section 319 grant funds to assist with the start of implementation efforts in 2023 (Additional 319 grants likely to applied for based on review of needs and funding sources in 1.b.ii)	Phase I (Spring 2022)	Town of Brunswick with assistance from CCSWCD	In-kind: Town of Brunswick Cash: Town of Brunswick	$1K (in-kind) $5K (cash) $6K Total

		Action Items / Management Measures	Schedule	Involved Parties	Potential Funding Sources	Estimated Cost (10 years)
	1.b.iv.	Apply for funds/grants determined based on review of needs and funding sources in 1.b.ii (in addition to applying for 319 grant funds in 2022, 1.b.iii.).	Phase I-III (2022-2032)	Town of Brunswick, CCSWCD, Mare Brook Leadership Team members	In-kind: Town of Brunswick, CCSWCD, Mare Brook Leadership Team members Cash: Town of Brunswick	$30K (in-kind) $25K (cash) $55K Total
1.c.	Garner continued support for the WMP's actions					
	1.c.i.	Establish and maintain a website page within Town of Brunswick's website with up-to-date information on WMP's implementation efforts	Phase I-III (2022-2032)	Town of Brunswick	In-kind: Town of Brunswick	$5K (in-kind)
	1.c.ii.	Provide yearly public updates in the form of Town Council presentations, newspaper articles, social media outlets, etc. on the happening of the WMP's implementation and successes	Phase I-III (2022-2032)	Mare Brook Leadership Team	In-kind: Mare Brook Leadership Team	$5K (in-kind)
	1.c.iii.	Create and maintain a digital spreadsheet/GIS database (NPS Site Tracker) of remediation sites addressed and remaining; Consider using GIS data as a storybook of sites completed for education and outreach purposes	Phase I-III (2022-2032)	Mare Brook Leadership Team, Town of Brunswick, CCSWCD	In-kind: Town of Brunswick	$15K (in-kind)
2. Address Known Stressors						
2.a.	Address stream culverts impacting Mare Brook					

		Action Items / Management Measures	Schedule	Involved Parties	Potential Funding Sources	Estimated Cost (10 years)
	2.a.i.	Conduct a Hydrologic and Hydraulic (H&H) study to assist in prioritizing stream culverts recommended for upsizing	Phase I (2022)	Town of Brunswick	Cash and in-kind: Town of Brunswick Grant funds (e.g. American Rescue Plan Act, Community Action Grant, Maine Coastal Community Planning Grant, see **Table 18**)	$5K (in-kind) $115K (cash/grant funds) $120K Total
	2.a.ii.	Determine sequence, timing, and logistics of recommended culvert upgrades listed in **Table 3** based on H&H study along with town paving schedule, available funding, collaboration with other adjacent improvement projects, etc.	Phase I (2022 and 2023, revisiting Years 3-9)	Town of Brunswick Planning, Engineering and Public Works, CCSWCD	In-kind: Town of Brunswick and CCSWCD	$1,200 (in-kind)
	2.a.iii.	Address culverts not requiring an H&H study based on water quality improvement priorities listed in **Table 3**, town paving schedule, available funding, collaboration with other adjacent improvement projects, etc.	Phase I-III (2022-2032)	Town of Brunswick Planning, Engineering, and Public Works, CCSWCD Engineer	Cash and in-kind: Town of Brunswick Grant funds (e.g. EPA Clean Water Act Section 319 grant funds, see **Table 18**)	$12,750 (in-kind) $51K (cash/grant funds) $63,750 Total

		Action Items / Management Measures	Schedule	Involved Parties	Potential Funding Sources	Estimated Cost (10 years)
	2.a.iv.	Upgrade culverts based on determined schedule after H&H study completed	Phase I-III (2023-2032)	Town of Brunswick Planning, Engineering, and Public Works, CCSWCD Engineer	Cash and in-kind: Town of Brunswick Grant funds (e.g. Municipal Stream Crossing Upgrade Grant Program, EPA Clean Water Act Section 319 grant funds, see **Table 18**)	$320K (in-kind) $1.3 million (cash/grant funds) $1.6 million Total
2.b.	Implement geomorphological recommendations					
	2.b.i.	Determine timing and logistics of installing geomorphic recommendations based on water quality improvement priorities listed in **Table 2**, collaboration with other adjacent improvement projects (such as culvert replacements), feasibility/landowner cooperation, and funding	Phase I (2023 and revisiting Years 3-9)	Town of Brunswick Planning, Engineering, and Public Works, CCSWCD	In-kind: Town of Brunswick and CCSWCD	$1,200 (in-kind)

		Action Items / Management Measures	Schedule	Involved Parties	Potential Funding Sources	Estimated Cost (10 years)
	2.b.ii.	Install geomorphological recommendations listed in **Table 2** (apart from removing Coffin Ice Pond Dam) according to the to-be-determined timeline with a fluvial geomorphologist's oversight	Phase I-III (2023-2032)	Town of Brunswick Planning, Engineering, and Public Works, CCSWCD Engineer, Professional Geomorphologist, Possibly Hired Contractors	Cash and in-kind: Town of Brunswick Cash: Town of Brunswick Grant funds (e.g. EPA Clean Water Act Section 319 grant funds, Building Federal Emergency Management Agency, Maine DOT, Eastern Brook Trout Joint Venture grants, see **Table 18**)	$304,000 (in-kind) $1.2 million (cash/grant funds) $1.5 million
	2.b.iii.	Determine and implement short-term plans to address failing Coffin Ice Pond dam to prevent water quality impacts	Phase I (2022 and 2023)	Mare Brook Leadership Team, Town of Brunswick Planning, Engineering, Public Works, and Town Council	Cash and in-kind: Town of Brunswick	$6,250 (in-kind) $18,750 (cash) $25K

		Action Items / Management Measures	Schedule	Involved Parties	Potential Funding Sources	Estimated Cost (10 years)
	2.b.iv.	Determine and implement long-term improvements to improve or minimize water quality impacts of Coffin Ice Pond dam and the gravel access road (following Coffin Ice Pond Stakeholder Working Group recommendations to MBLT)	Phase I and II (2023-2028)	Mare Brook Leadership Team, Town of Brunswick Planning, Engineering, Public Works, and Town Council	Cash and in-kind: Town of Brunswick Grant funds (e.g. Eastern Brook Trout Joint Venture, Trout Unlimited, National Fish and Wildlife Foundation, see **Table 18**)	$30K (in-kind) $10K (cash/grant funds) $40K Total
	2.b.v.	Address erosion at Coffin Ice Pond's gravel access road during short-term and long-term fixes	Phase I and II (2022 and 2024)	Mare Brook Leadership Team, Town of Brunswick Planning, Engineering, Public Works, and Town Council	Cash and in-kind: Town of Brunswick	$2K (in-kind) $2K (cash) $4K Total
2.c.	Address public stormwater outfall upgrade recommendations					
	2.c.i.	Review public outfall upgrade recommendations in **Table 4** and determine schedule and funding to address	Phase I (2022 and 2032)	Mare Brook Leadership Team, Town of Brunswick Planning, Engineering, Public Works, and Town Council	In-kind: Town of Brunswick and CCSWCD	$1,200 (in-kind)

		Action Items / Management Measures	Schedule	Involved Parties	Potential Funding Sources	Estimated Cost (10 years)
	2.c.ii.	Implement public outfall upgrade recommendations in **Table 4**	Phase I-III (2022-2032)	Mare Brook Leadership Team, Town of Brunswick Planning, Engineering, Public Works, and Town Council	In-kind and cash: Town of Brunswick Grant funds (e.g. EPA Clean Water Act Section 319 grant funds, Community Action Grants, Maine DOT, see **Table 18**)	$16,600 (in-kind) $66,500 (cash/grant funds) $83,100 Total
	2.c.iii.	Review the existing closed drainage system to determine where to install sediment hoods such as Snouts™ to prevent sediment and debris from entering Mare Brook.	Phase I (2022-2023)	Town of Brunswick	In-kind: Town of Brunswick	$600 (in-kind)
	2.c.iv.	Install sediment hoods where appropriate based on review findings	Phase I and II (2023-2026)	Town of Brunswick	Cash and in-kind: Town of Brunswick	$5K (in-kind) $6K (cash) $11K Total
2.d.	Implement stormwater retrofits and site-specific BMP improvements					
	2.d.i.	Explore additional stormwater retrofits and site-specific BMP improvements in relationship to identified stream stressors and add information to **Table 5**	Phase I-III (2022-2032)	Town of Brunswick, CCSWCD, Maine DEP	Cash and in-kind: Town of Brunswick In-kind: Maine DEP	$9K (in-kind) $3K (cash) $12K Total

		Action Items / Management Measures	Schedule	Involved Parties	Potential Funding Sources	Estimated Cost (10 years)
	2.d.ii.	Determine sequencing, timing, and logistics of installing stormwater retrofit recommendations based on water quality improvement priorities in **Table 5**, collaboration with other adjacent improvement projects, feasibility/landowner cooperation, and funding	Phase I-III (2022 – 2032)	Town of Brunswick, CCSWCD, Maine DEP	Cash and in-kind: Town of Brunswick In-kind: Maine DEP	$6K (in-kind) $3K (cash) $9K Total
	2.d.iii.	Install stormwater retrofit recommendations in **Table 5** according to the to-be-determined timeline with engineering oversight	Phase I-III (2023-2032)	Town of Brunswick, Private Property Owners, CCSWCD	Cash and in-kind: Town of Brunswick, Private Property Owners Grant funds (e.g. EPA Clean Water Act Section 319 grant funds, Community Action Grants, Maine DOT, see **Table 18)**	$590K (in-kind) $305K (cash/grant funds) $895K Total
	2.d.iv.	Work with private properties to detach impervious cover from stormwater infrastructure/reduce impact of impervious cover to water quality, with particular focus on "Above Baribeau Drive" subwatershed	Phase I and II (2023-2028)	Town of Brunswick, Private Property Owners, CCSWCD	Cash and in-kind: Town of Brunswick, Private Property Owners	$10K (in-kind) $20K (cash) $30K Total

		Action Items / Management Measures	Schedule	Involved Parties	Potential Funding Sources	Estimated Cost (10 years)
	2.d.v.	Determine and implement long-term solution for bus washing at the Coffin School *(School Department has obtained a cost estimate of $220K for a bus washing garage as an alternative.)*	Phase I (2022-2025)	Town of Brunswick, Brunswick School Department	Cash: Town of Brunswick/Brunswick School Department Grant funds (e.g. EPA Clean Water Act Section 319 grant funds, see **Table 18**)	$220K (cash/grant funds)
	2.d.vi.	Explore maintenance needs of installed BMPs throughout the watershed and establish system to encourage education of and ongoing maintenance.	Phase I and II (2023-2027)	Town of Brunswick Planning, Engineering, Public Works, CCSWCD	Cash and in-kind: Town of Brunswick Grant funds (e.g. EPA Clean Water Act 319 grant funds, see **Table 18**)	$3K (in-kind) $3K (cash/grant funds) $6K Total
3. Continue Exploring Additional Stressors						
3.a.	Explore opportunities to identify the impact of the ¾-mile culvert under the Brunswick Executive Airport and possible improvements		Phase I and II (2023-2028)	Mare Brook Leadership Team, MRRA, U.S. Navy, Maine Fish and Wildlife, Maine DEP, Consultants	Cash and in-kind: MRRA, U.S. Navy, Maine Fish and Wildlife, Maine DEP	$5K (in-kind) $5K (cash) $10K Total
3.b.	Continue to investigate impacts of groundwater contamination to the stream from the former Brunswick Naval Air Station		Phase I-III (2022-2032)	MRRA, U.S. Navy	Cash and in-kind: MRRA, U.S. Navy	Unknown

		Action Items / Management Measures	Schedule	Involved Parties	Potential Funding Sources	Estimated Cost (10 years)
3.c.	Investigate upper Merriconeag watershed (including Brunswick Landing) and Picnic Pond's impact to Merriconeag Stream's water quality		Phase I and II (2022-2029)	MRRA, U.S. Navy, Town of Brunswick, Mare Brook Leadership Team	Cash and in-kind: MRRA, U.S. Navy, Town of Brunswick	$20K (in-kind) $20K (cash) $40K Total
3.d.	Explore impact of trails and recreational uses within Mare Brook's floodplain and work to minimize impacts		Phase I (2022-2025)	Mare Brook Leadership Team, CCSWCD, Maine DEP	Cash and in-kind: Town of Brunswick	$6K (in-kind) $8K (cash) $14K Total
4. Prevent Stressor Increases						
4.a.	Review ordinance for opportunities to protect Mare Brook from increased stream stressors (Topics to explore include reducing impervious impacts, establish new culvert standards, reducing chloride use / developing salt management plan)		Phase I (2023-2025)	Mare Brook Leadership Team, Town of Brunswick, CCSWCD	Cash and in-kind: Town of Brunswick	$4K (in-kind) $8K (cash) $12K Total
4.b.	Determine and provide incentives for practices that improve and protect stream water quality					
	4.b.i.	Determine and provide incentives to preserve and restore natural riparian woody vegetation	Phase I and II (2023-2028)	Mare Brook Leadership Team, Town of Brunswick, CCSWCD, Maine DEP	In-kind: Town of Brunswick Grant funds (e.g. EPA Clean Water Act 319 grant funds, see **Table 18**)	$5K (in-kind) $15K (cash/grant funds) $20K Total

		Action Items / Management Measures	Schedule	Involved Parties	Potential Funding Sources	Estimated Cost (10 years)
	4.b.ii.	Determine and provide incentives to treat and possibly reduce existing pavement	Phase II and III (2026-2031)	Mare Brook Leadership Team, Town of Brunswick, CCSWCD, Maine DEP	In-kind: Town of Brunswick Grant funds (e.g. EPA Clean Water Act 319 grant funds, see **Table 18**)	$5K (in-kind) $20K (cash/grant funds) $25K Total
4.c.	Explore land purchasing and/or conservation easements for stream protection		Phase I-III (2022-2032)	Town of Brunswick, Brunswick-Topsham Land Trust, Mare Brook Leadership Team	In-kind: Town of Brunswick, Brunswick-Topsham Land Trust, Mare Brook Leadership Team	$5K (in-kind)
4.d.	Create and implement a watershed-wide maintenance plan					
	4.d.i.	Compile stormwater protection maintenance needs of entire watershed and develop plan for conducting ongoing maintenance for both structural (installed BMPs) and non-structural (i.e. winter sand sweeping) applications	Phase I (2024-2025)	Town of Brunswick, CCSWCD, Maine DEP	Cash and in-kind: Town of Brunswick Grant funds (e.g. EPA Clean Water Act 319 grant funds, see **Table 18**)	$10K (in-kind) $10K (cash/grant funds) $20K Total
	4.d.ii.	Determine maintenance needs budget and work through Town of Brunswick's Capital Improvement Program (CIP) process working with Brunswick's Finance Committee to assist in funding	Phase II (2026)	Mare Brook Leadership Team, Town of Brunswick	In-kind: Mare Brook Leadership Team, Town of Brunswick	$8K (in-kind)

		Action Items / Management Measures	Schedule	Involved Parties	Potential Funding Sources	Estimated Cost (10 years)
	4.d.iii.	Implement identified maintenance needs	Phase II and III (2027-2032)	Town of Brunswick, Stormwater Maintenance Contractors	Cash and in-kind: Town of Brunswick	$2K (in-kind) $30K (cash) $32K Total
5. Create an Education and Outreach Plan (to assist in addressing known stressors and preventing future stressors)						
5.a.	Create a Mare Brook Education and Outreach Committee under the Mare Brook Leadership Team to develop and implement a Mare Brook Education and Outreach Plan					
	5.a.i.	Appoint membership and establish charge: Use membership to determine specific topics, timing, and logistics of conducting education throughout the watershed. Potential topics to include: • Increase education efforts on existing stream protection regulations (landowners and contractors) • Stormwater BMP's landowners can implement (i.e. rain gardens to retain and treat stormwater onsite) • Importance of BMP maintenance for town infrastructure and private BMPs • Importance of woody vegetation along and within the stream channel (Relate to 4.b.i) • Ways to reduce impervious cover (Relate to 4.b.ii.)	Phase I (2022/2023)	Mare Brook Leadership Team, Town of Brunswick, Brunswick Conservation Commission, CCSWCD, Maine DEP	Cash and in-kind: Town of Brunswick	$600 (in-kind)

		Action Items / Management Measures	Schedule	Involved Parties	Potential Funding Sources	Estimated Cost (10 years)
	5.a.ii.	Start implementation of the Mare Brook Education and Outreach Plan	Phase I-III (2023-2032)	Mare Brook Education and Outreach Committee, Town of Brunswick, CCSWCD, Maine DEP	Cash: Town of Brunswick In-kind: Mare Brook Education and Outreach Committee Grant funds (e.g. EPA Section 319 Clean Water Act, see **Table 18**)	$30K (in-kind) $30K (cash/grant funds) $60K Total
	5.a.iii.	Hold a minimum of two committee meetings per year	Phase I-III (2022-2032)	Mare Brook Education and Outreach Committee, Town of Brunswick, CCSWCD, Maine DEP	Cash: Town of Brunswick In-kind: Mare Brook Education and Outreach Committee Grant funds (e.g. EPA Section 319 Clean Water Act, see **Table 18**)	$12,000 (in-kind) $12,000 (cash/grant funds) $24,000 Total
6. Monitor WMP's Effectiveness and Update Plan as Needed						
6.a.	Continue to collect and review water quality data and macroinvertebrate data					
	6.a.i.	Maine DEP schedule for collecting water quality data (every 5 years for macroinvertebrate data)	Phase I-III (2022-2032)	Maine DEP	State funded	Unknown
6.b.	Based on collected data, determine if additional water quality sampling is needed					

		Action Items / Management Measures	Schedule	Involved Parties	Potential Funding Sources	Estimated Cost (10 years)
	6.b.i.	Determine additional sampling needs and yearly sampling plans (Consider implementing bacteria testing in "Above Baribeau Drive" and "Above Maine Street" subwatersheds)	Phase I-III (2022-2032)	Mare Brook Leadership Team, Maine DEP	In-kind: Mare Brook Leadership Team, Maine DEP	$6,000 (in-kind)
	6.b.ii.	Work with Bowdoin College to set up additional water quality and macroinvertebrate testing sites and frequency	Phase I-III (2023-2032)	Mare Brook Leadership Team, Bowdoin College, Maine DEP	Cash: Town of Brunswick In-kind : Mare Brook Leadership Team, Bowdoin College, Maine DEP	$15,000 (in-kind) $5,000 (cash – testing costs) $20K Total
6.c.	Formally amend WMP's action items as new information is gathered					
	6.c.i.	Review WMP's action items at least once per year	Phase I-III (2022-2032)	Mare Brook Leadership Team	In-kind: Mare Brook Leadership Team	$1,200 (in-kind)
	6.c.ii.	Establish method for formally updating the WMP	Phase I (2022)	Mare Brook Leadership Team	In-kind: Mare Brook Leadership Team	$1,200 (in-kind)
	6.c.iii.	Notify public of WMP updates	Phase I-III (2022-2032)	Mare Brook Leadership Team	In-kind: Town of Brunswick	$12,000 (in-kind)

Total 10-year Estimated Cost: $5.2 million ($1.9 million in-kind, $3.3 million cash/grant funded)

Total Estimated Structural Costs: $4.5 million

Total Estimated Non-Structural Costs: $700K

9 Evaluating Project Success

9.1 Pollutant Load Reduction Targets

The goal of this watershed management plan is to restore the brook's water quality and habitat to attain Class B standards. As has been detailed in **Section 5** a primary concern, or stressor, for all sections of the watershed is the **alteration of physical habitat,** resulting in excessive sediment movement.

Sediment and nutrient loading in the Mare Brook watershed were estimated using *Model My Watershed* (Version 1.32.2, available at https://modelmywatershed.org/). *Model My Watershed* is a regionally calibrated land-use model which estimates stormwater runoff, sediment and nutrient (nitrogen and phosphorus) loads on a watershed scale using land use, soil and climate data. *Model My Watershed* can also be used to estimate the impact of conservation practices on the estimated loadings.

Parameters included in the model are stream length (Continental US Medium Resolution Stream Network, NHDplusV2), land cover distribution (National Land Cover Database 2011, **Table 13**), hydrologic soil groups from USDA (gSSURGO 2016), monthly mean precipitation and temperature (USEPA National Climate Data), elevation and slope (NHDplusV2) and estimated number of farm animals (USDA Cumberland County). The default number of farm animals was based on the USDA County numbers, divided by acres of agricultural land in the watershed. Given local knowledge of current use of agricultural land in the watershed, all farm animal estimates were changed to zero.

Currently, an estimated 320,680 kg (353.5 tons) of sediment, 8,820 kg (9.7 tons) total nitrogen and 275 kg (606.3 pounds) total phosphorus make up the annual pollutant loads exported to the brook (**Table 14**). These estimates are broken down into land use sources in **Table 15**.

Table 13. Land Cover Distribution for Mare Brook Watershed (National Land Cover Database 2011)

Type	Area (km²)	Coverage (%)	Active River Area (km²)
Open Water	**0.03**	**0.2**	**0.02**
Perennial Ice/Snow	**0**	**0**	**0**
Developed, Open Space	**3.25**	**25.76**	**2.93**
Developed, Low Intensity	**2.14**	**16.95**	**1.93**
Developed, Medium Intensity	**1.57**	**12.48**	**1.52**
Developed, High Intensity	**1.3**	**10.31**	**1.29**
Barren Land (Rock/Sand/Clay)	**0.01**	**0.09**	**0.01**

Deciduous Forest	**0.48**	**3.78**	**0.22**
Evergreen Forest	**1.29**	**10.21**	**0.82**
Mixed Forest	**1.42**	**11.27**	**0.88**
Shrub/Scrub	**0.23**	**1.84**	**0.16**
Grassland/Herbaceous	**0.2**	**1.57**	**0.12**
Pasture/Hay	**0.11**	**0.85**	**0.09**
Cultivated Crops	**0**	**0**	**0**
Woody Wetlands	**0.55**	**4.34**	**0.48**
Emergent Herbaceous Wetlands	**0.04**	**0.35**	**0.04**
Total	**12.61**	**100**	**10.5**
Mare Brook Watershed area = **12.6** km^2 **(3,110 acre)**			

Table 14. Average Annual Pollutant Loads in the Mare Brook Watershed

Sources	**Sediment**	**Total Nitrogen**	**Total Phosphorus**
Total Loads (kg)	320,683.50	8,619.40	274.8
Loading Rates (kg/ha)	341.99	9.19	0.29
Mean Annual Concentration (mg/L)	65.39	1.76	0.06
Mean Low-Flow Concentration (mg/L)	120.59	3.26	0.21

Table 15. Average Annual Loads in the Mare Brook Watershed by Source

Sources	Sediment (kg)	Total Nitrogen (kg)	Total Phosphorus (kg)
Hay/Pasture	**758.3**	**6.7**	**3.4**
Cropland	**0**	**0**	**0**
Wooded Areas	**113.3**	**32.4**	**1.8**

Wetlands	47.3	17.2	1
Open Land	75.9	24.7	0.6
Barren Areas	0.9	0.9	0
Low-Density Mixed	3,961.50	98.2	10.6
Medium-Density Mixed	12,661.90	308.8	31.9
High-Density Mixed	10,459.50	255.1	26.3
Low-Density Open Space	6,020.60	149.3	16.1
Farm Animals	0	0	0
Stream Bank Erosion	292,605.00	179	100
Subsurface Flow	0	7,122.40	99.1
Point Sources	0	0	0
Septic Systems	0	574	0

According to the Maine Impervious Cover TMDL (MDEP, 2012), in order to support Class B aquatic life use, the Mare Brook watershed may require the characteristics of a watershed with 8% impervious cover. This would require an effective impervious cover reduction of 62% from the current 21% impervious cover. *Model My Watershed* allows for modeling of future loading amounts with the installation of various conservation practices. The load reduction from the installation of conservation practices can be used as a proxy for the effective disconnection of impervious cover.

With the installation of the instream conservation practices in the Action Items, pollutant load reduction is estimated to be 45% for sediment, total nitrogen by 2% and total phosphorus by 21% (**Table 16**). An estimate of loading if the impervious cover was reduced by the IC TMDL recommendation of 62% was modeled by reducing the impervious cover land uses (high, medium and low-density mixed development) by 62% and converting those acres into wooded areas. This modeled land use change resulted in load reductions of 62% of sediment and 26% of total phosphorus. Total nitrogen was estimated to increase by 8%, likely due to increases in nitrogen from leaf fall. While the estimates of pollutant load reductions from the planned conservation practices in this 10-year plan do not quite equal those if the effective impervious cover was reduced by the IC TMDL recommendation, the implementation of all recommendations of the plan was modeled to result in a 71% reduction in sediment, 3% reduction of nitrogen, and 32% reduction of phosphorus.

The stream stressor analysis indicated movement of sediment as a major stressor to the stream. Instream culverts and geomorphic issues are a large part of this sediment movement, along with

stormwater runoff and hydrologic modifications in the watershed. The estimated reduction of sediment input from the watershed and land use-associated bank erosion from the model can be used as a proxy for the reduction of sediment transport and instream geomorphic improvements. This reduction in excessive sediment movement is vital to improving the habitat for macroinvertebrates in the brook, and the stream meeting its classification standards.

Table 16. Pollutant Load Reduction Estimates

Total Loads	Current Conditions	Stream restoration BMPs in Action Plan	Percent Reduction
Sediment (kg)	320,683.50	177,409.80	45%
Total Nitrogen (kg)	8,619.40	8,443.30	2%
Total Phosphorus (kg)	274.8	217.30	21%

9.2 Measurable Milestones

Since it may take longer than 10 years for Mare Brook to meet its State-designated water quality standards, interim targets are recommended to determine if restoration actions are helping to meet the overall water quality goals. **Table 17** lists measurable milestones to be used when assessing the effectiveness of implementing this plan's action items. Through Objective 6, the plan's effectiveness with be monitored and actions will be updated as needed. The Mare Brook Leadership Team will use **Table 15** to determine if key targets and benchmarks are being made thus leading to the waterbody's predicted attainment of its Class B water quality listing. Official delisting of the waterbody from impaired to non-impaired will follow Maine DEP's evaluation protocol.

Table 17. Measurable Milestones

	Indicator	Cumulative Interim Targets and Benchmarks		
		End of Phase I - 2026	**End of Phase II - 2029**	**End of Phase III - 2032**
Water Quality Benchmarks	Enhance macroinvertebrate type, abundance, and distribution. **GOAL:** Meet Class B standards (based on probabilities of meeting).	25%	50%	75% *(100% target is 2037)*

	Indicator	Cumulative Interim Targets and Benchmarks		
		End of Phase I - 2026	**End of Phase II - 2029**	**End of Phase III - 2032**
	Reduction of estimated sediment load. **GOAL:** Meet estimated sediment reduction modeled for IC TMDL-recommended reduction of impervious cover (62%).	15%	30%	45% *(62% target is 2037)*
Structural Benchmarks	Implement culvert recommendations using the results of the H&H study and stream restoration prioritization **GOAL:** Improve stream geomorphology and flow by addressing 5 culverts	1 stream culvert addressed	3 stream culverts addressed	5 stream culverts addressed
	Reduce and eliminate stream habitat degradation problems as a result of, and in conjunction with, stream culvert remediation projects. **GOAL:** Improve stream habitat at 5 sites.	Geomorphic recommendations implemented in association with 1 stream culvert addressed	Geomorphic recommendations implemented in association with 3 stream culverts addressed	Geomorphic recommendations implemented in association with 5 stream culverts addressed
	Address tributary and stream culverts not requiring a prior H&H study **GOAL:** Address culverts not requiring a prior H&H study at 6 sites.	2 culverts in the upper watershed not requiring an H&H study addressed	4 culvert sites along upper Mare Brook not requiring an H&H study addressed	Total of 6 culvert sites not requiring an H&H study addressed

	Indicator	Cumulative Interim Targets and Benchmarks		
		End of Phase I - 2026	**End of Phase II - 2029**	**End of Phase III - 2032**
	Implement outfall remediation recommendations to reduce impact on brook. Recommendations include clearing sediment, replacing outfall pipes, and providing outlet protection. **GOAL:** Implement recommendations at 7 outfall sites.	Outfalls to address prioritized 3 outfall sites addressed Sediment hoods considered	5 outfall sites addressed	7 outfall sites addressed
	Install stormwater retrofits at key areas where the largest impact is to be had and landowner participation is willing. **GOAL:** 5 stormwater retrofit sites implemented	Explore stormwater retrofit and site-specific BMP improvements Pursue improvements for at least one site	3 stormwater retrofit sites pursued	5 stormwater retrofit sites pursued
Non-Structural Benchmarks	Create a 'Mare Brook Leadership Team' or other formal committee **GOAL:** Oversee the implementation of this WMP in providing guidance on specific timing and logistics for overall watershed improvements and increasing communication among watershed stakeholders and the public.	Team/ Committee appointed/ established; 16 Committee-related meetings held Coffin Ice Pond Stakeholder Working Group established Mare Brook Education and Outreach Committee formed	32 Committee-related meetings held	44 Committee-related meetings held

	Indicator	Cumulative Interim Targets and Benchmarks		
		End of Phase I - 2026	**End of Phase II - 2029**	**End of Phase III - 2032**
	Fund and complete a Hydrologic and Hydraulic (H&H) Study for the entire watershed. **GOAL:** Prioritize sequence of major stream crossing upgrades and replacements to avoid unintended problems	Completed H&H Study with major stream crossings prioritized based on result	N/A	N/A
	Secure funding for structural plan implementation **GOAL:** Mare Brook Leadership Team/Advisory Committee to seek and obtain grant funds and town funding working with Town of Brunswick's Capital Improvement Program for structural plan implementation.	Structural BMP design and installation costs pursued and obtained for 1 stream crossing site (approximately $1.5 million)	Structural BMP design and installation costs pursued and obtained for an additional 2 stream crossing sites (approximately $3 million)	Structural BMP design and installation costs pursued and obtained for an additional 2 stream crossing sites (approximately $4.5 million)
	Secure funding for non-structural plan implementation. **GOAL:** Mare Brook Leadership Team/Advisory Committee to seek and obtain grant funds and town funding working with Town of Brunswick's Capital Improvement Program to seek funding for non-structural plan implementation.	1/3 of non-structural BMP costs pursued and obtained (approximately $192K)	2/3 of non-structural BMP costs pursued and obtained (approximately $384K)	All non-structural BMP costs pursued and obtained (approximately $582K)

	Indicator	Cumulative Interim Targets and Benchmarks		
		End of Phase I - 2026	**End of Phase II - 2029**	**End of Phase III - 2032**
	Create and implement a Mare Brook Watershed Education and Outreach Plan to reduce water quality impacts and obtain buy-in of proposed projects **GOAL:** Education and Outreach Plan created and implemented	Created Education and Outreach Plan Implement Phase I of Education and Outreach Plans	Implement Phase II goals of Education and Outreach Plan	Implement Phase III goals of Education and Outreach Plan
	Create watershed-wide maintenance plan to ensure current BMPs are performing as intended **GOAL:** Watershed-wide maintenance plan established and implemented	Create watershed-wide maintenance plan Implement Phase I of maintenance plan	Implement Phase II of maintenance plan	Implement Phase III of maintenance plan

10 Implementing the Plan

10.1 Ownership and Community Involvement

The Town of Brunswick and other Mare Brook watershed stakeholders provided invaluable guidance and input into determining this plan's objectives and action items. While the Town of Brunswick is the primary owner of this plan, continued community involvement will be crucial to successfully implementing the plan as is anticipated and demonstrated in the Action Plan's list of Involved Parties.

Through a series of three Town of Brunswick public meetings held in the fall of 2021, proposed stressors and recommended actions were presented. Feedback from the public was then reviewed and included where feasible into this final plan with the project's Steering Committee acceptance. Public involvement in the planning stage is imperative to a successful implementation. Those living and working within the watershed are likely to have the best insight into ongoing problems and realistic solutions that they may even be willing to help implement. Several neighborhood groups have already reached out with interest on how they

can help with Mare Brook's remediation actions. The Mare Brook Watershed has been fortunate to have many stakeholders from a variety of organizations, who are very eager and willing to help restore and protect Mare Brook's water quality. It is hoped that many of these stakeholders will continue and serve as Brunswick Town Council appointed Mare Brook Leadership Team members and/or involved volunteers.

10.2 Funding

Table 18 is a list of potential funding sources to consider pursuing for implementing the WMP's action items. This table includes federal, state, and local funding sources. The table is not a complete list of all opportunities that may exist, but rather a starting point to consider when all options are discussed as specific action items are pursued.

Table 18. Potential Action Item Funding Sources

Potential Funding Source	**Description**
5 Star Wetland and Urban Waters Restoration Grants, US Environmental Protection Agency and National Fish and Wildlife Foundation	Grant intended for community-based education and community capacity building to restore coastal, wetland, and riparian ecosystems nation-wide. Goal is to meet conservation needs of important species and habitats providing meaningful conservation and educational outcomes. Project funds are $10k-$40K with $20K the average project amount. Funding priorities include: • Wetland, riparian, in-stream and/or coastal habitat restoration projects • Important education and training activities (community outreach, participation and/or integration with K-12 environmental curriculum) • Measurable community, ecological, and educational benefits • Projects that engage diverse community partners to achieve ecological and educational outcomes More information: 5 Star Wetland and Urban Waters Restoration Grants | US EPA *Consider for community education and outreach goals particularly on in-stream and riparian zone protection incentives.*
American Rescue Plan Act, Cumberland County	Recovery funds available to replace lost revenues and respond to the Covid-19 pandemic. Funding can be used for initiatives that align with the State's "Maine Won't Wait" climate action plan including protecting the environment and promoting natural climate solutions, and building healthy and resilient communities, see Community Action Grants. More information: American Rescue Plan Act | Cumberland County, ME - Official Website *Town of Brunswick has submitted a proposal to conduct the Mare Brook Watershed H&H study.*

Potential Funding Source	Description
Building Resilient Infrastructure and Communities, Federal Emergency Management Agency	Mitigation grant funds to prepare for major disasters through preparedness and investment in infrastructure resiliency. More information: Federal Register :: Hazard Mitigation Assistance: Building Resilient Infrastructure and Communities *Consider for recommended large stream crossing upgrades and adjacent geomorphic restoration sites.*
Casco Bay Community Grants, Casco Bay Estuary Partnership	Grant funds available that meet CBEP's Casco Bay Plan priorities, some of which include: • Citizen science and stewardship initiatives • Storytelling and art projects • Environmental restoration and habitat enhancement • Assistance in addressing complex challenges and activities or public awareness that benefit Casco Bay including stormwater and stream connectivity $11K was available in 2020 with proposal between $500 and $5K More information: Grant Opportunities - Casco Bay Estuary Partnership *Consider for non-structural action items of the WMP.*
Casco Bay Habitat Protection Funds, Casco Bay Estuary Partnership	Funding available for land acquisition of high value habitat to meet CBEP's goal in "Conserving significant habitat and areas that protect water quality, such as river corridors, wetlands, and headwater forests." Grants considered seed funding for larger projects, early project risk money, and assessment and transaction costs. In 2021, $30K total was awarded to four entities ($5-$10K projects). More information: Habitat Protection & Restoration - Casco Bay Estuary Partnership *Consider in conjunction and as an enhancement to larger culvert upgrades and geomorphic restoration grant project efforts.*

Potential Funding Source	Description
Clean Water State Revolving Loan Fund, Maine DEP	Loan that provides low interest rate or principal forgiveness to borrowers to implement water quality protection projects. SRF Loan Fund, Maine Department of Environmental Protection *Consider for municipal stormwater retrofits.*
Community Action Grants, Maine Community Resilience Partnership	Grant funds that support spelled out activities (List of Community Actions_2021-12-01_4.xlsx (live.com)) that align with the State of Maine's "Maine Won't Wait" climate action plan including protecting the environment and promoting natural climate solutions, and building healthy and resilient communities. Minimum of $5K and maximum of $50K with collaborative proposals allowing up to $100K requests. No local matching funds required. More information: Grant Opportunities | Office of Policy Innovation & Future (maine.gov) *Consider for river riparian zone and shoreline protection projects, flood resiliency projects, possibly an H&H study, and utilizing climate-ready standards, designs, and practices to improve infrastructure (low-impact designs (LID), Stream Smart Crossing Guidelines, etc.).*
Eastern Brook Trout Joint Venture, Natural Fish Habitat Partnership	Up to $50K for an individual project for on-the-ground brook trout habitat conservation and restoration projects in the native eastern range. Requires one-to-one non-federal match. More information: 2023 EBTJV Funding Opportunity – EBTJV (easternbrooktrout.org) *Consider for geomorphic "chop and drop" recommendations.*
Embrace a Stream, Trout Unlimited	Internal grant program for local Trout Unlimited chapters and councils awarding grants ranging from $1K-$10K. More information: Applying for Grants | Trout Unlimited, Maine Council of Trout Unlimited (tumaine.org), What We Do – Trout Unlimited - Sebago Chapter (sebagotu.org) *Local Trout Unlimited services may be able to help with future survey work, education, and enhancements to larger stream crossing upgrades and adjacent geomorphic restoration sites.*

Potential Funding Source	Description
Flood Mitigation Assistance Program, Federal Emergency Management Act	Funding for planning and projects to reduce or eliminate risk of flood damage to buildings insured under the National Flood Insurance Program. More information: Flood Mitigation Assistance (FMA) Grant | FEMA.gov
Local Road Assistance Program, Maine Department of Transportation	Training and technical assistance for Maine's towns, cities, and counties distributing over $20 million of highway fund money each year for municipal road work. Local Road Assistance Program - Community Services Division (maine.gov) *Consider for road improvement projects associated with culvert upgrade and stream crossing remediation projects.*
Maine Coastal Community Planning Grants, Maine Department of Agriculture, Conservation, and Forestry	Grants for municipal and regional projects in Maine's coastal zone that focus on building community resiliency and adapting to climate change. Eligible project categories include: • Ensuring sustainable, vibrant coastal communities • Restoring coastal habitats • Preparing for coastal storms, erosion and flooding, and coastal hazards In fiscal year 2022, minimum awarded funding was $20K and maximum was $50K with a total of $175K available. More information: Municipal Planning Assistance Program: Maine Department of Agriculture, Conservation and Forestry *Consider for partial funding for watershed-wide H&H study and project-specific geomorphic and/or culvert site restoration.*

Potential Funding Source	Description
Municipal Partnership Initiative, Maine DOT	Incorporates municipal interests on state and state-aid highways to make road improvements with greater results due to combined interests and resources. Approximately $7 million available yearly for the program with municipalities providing a share of remediation costs based on a three-tiered system of municipal valuation of the project. Work pursued must improve state transportation system. No minimum for amount requested. More information: MPI2020.pdf (maine.gov) *Consider for culvert replacement recommendations.*
Municipal Stream Crossing Upgrade Grant Program, Maine DEP	Competitive grant funds to upgrade culverts at stream crossings on municipal roads to improve fish and wildlife habitat, improve public safety and minimize flooding, and represent a cost effective and efficient investment. $125K per project, maximum of 2 awards per municipality. No minimum amount of match required yet grants cannot fund 100% of project and match is factored into the scoring of cost-effectiveness. More information: Stream Crossing Upgrade Grant, Bureau of Land Resources (Maine DEP) *Consider for recommended large stream crossing upgrades.*
New England Forests and Rivers, National Fish and Wildlife Foundation	Competitive grant funds to restore and sustain healthy forests and rivers that provide habitat for freshwater fish or diverse native bird populations in New England. Requires a one-to-one non-federal match. Awarded grants are from $50 to $200K. More information: New England Forests and Rivers Fund | NFWF *Consider for recommended large stream crossing upgrades and adjacent geomorphic restoration sites.*

Potential Funding Source	Description
Nonpoint Source Pollution Control Projects – Watershed-Based Plan Implementation, Maine DEP with funding from US EPA Section 319 Clean Water Act	Yearly competitive funding to help communities implement watershed-based management plans addressing nonpoint sources pollution. Up to $800K in grant funds available with 8 to 12 projects awarded each year. Funding requires 40% non-federal match for 319 Projects. More information: 319 Grant Program, Maine Department of Environmental Protection *Consider for site-specific remediation projects and some education and outreach in conjunction with remediation efforts.*
Regional Coastal Resilience Fund, National Fish and Wildlife Foundation	Invests in projects that restore, increase, and strengthen natural infrastructure to protect coastal communities and enhance habitat for fish and wildlife. More information: National Coastal Resilience Fund | NFWF And National Coastal Resilience Fund 2021 Request for Proposals | NFWF *Consider for recommended large stream crossing upgrades and adjacent geomorphic restoration sites.*

10.3 Monitoring and Adaptive Management

Using an adaptive management approach, monitoring and updating the plan as necessary will occur during plan implementation. As new information or technology becomes available, this information will be reviewed and determined if adjustments to the plan are needed. This plan calls for yearly reviews of the action items and measurable milestones under the direction of the Mare Brook Leadership Team. If measurable milestones are not being met, then action items will be further investigated to determine if they are working. Additional investigation and an updated directive to meet the measurable milestone benchmark goals may be determined by the Leadership Team. Possible updates will be attached to the Plan as an addendum with a majority vote from the Leadership Team. Through this process, Maine DEP will be consulted for their opinion and their approval of the addendum will be sought. Maine DEP approval of addendums is only necessary if future EPA Section 319 grant funds are to be pursued to continue to implement the Plan, yet their input should be of valuable consideration.

Maine DEP monitors stream macroinvertebrates statewide on a rotating 5-year river basin cycle. DEP plans to continue to include Mare Brook macroinvertebrate monitoring in this rotation. Additional inter-cycle monitoring may occur as deemed useful with the support of the Maine DEP Watershed Unit. Results from all Maine DEP biomonitoring will be considered in removal of the brook from the impaired category in the Maine Integrated Report. This delisting likely will take time given the lag between watershed and stream improvements and impacts to sensitive macroinvertebrates with long-life stages, annual weather variations and the monitoring cycle. Listing and delisting a stream due to aquatic life requires several years of consistent results to account for interannual variability. Since officially removing the brook from the Integrated Report impaired list will take time, results of biomonitoring macroinvertebrate sampling can be used as guidance on if the brook is showing improvement, knowing signs of improvement take time. If plan action items are being implemented and several years of macroinvertebrate sampling show no improvements, the plan and action items should be reassessed and modified appropriately by the Mare Brook Leadership Team as indicated above.

10.4 Next Steps

With the completion of this plan, it is imperative that immediate next steps are taken to start implementing the plan according to its intended timeline to fully meet intended goals and to continue the current momentum of stakeholder interest and community involvement. Key action items to timely pursue include:

1) Establishing a Mare Brook Leadership Team to be appointed by Brunswick's Town Council to oversee the implementation of this plan; and

2) Starting the implementation of this plan in early 2022 by seeking funds to implement priority tasks (Particularly seeking funds for an H&H study and submitting a Clean Water Act 319 grant proposal).

Not listed in this Plan's Action Items is exploring the needs of the lower, tidal portion of the watershed and developing an action plan for this region. The Town of Brunswick will take the lead on pursuing this endeavor yet will highly rely on the Mare Brook Leadership Team for input and possible oversight.

10.5 Appendices

Appendix A: Geomorphic Assessment and Restoration Recommendations for Mare Brook in Brunswick, ME

Appendix B: Culvert and Outfall Inspections on Mare Brook

Appendix A
Geomorphic Assessment and Restoration Recommendations

Geomorphic Assessment and Restoration Recommendations for Mare Brook in Brunswick, Maine

Prepared for

Town of Brunswick
Brunswick, ME

Prepared by

John Field
Field Geology Services
Portland, ME

November 2021

Table of Contents

EXECUTIVE SUMMARY 3
1.0 INTRODUCTION 4
2.0 BACKGROUND REVIEW AND HISTORIC ASSESSMENT 5
3.0 RAPID GEOMORPHIC ASSESSMENT 6
4.0 TOPOGRAPHIC SURVEYING AND CONCEPTUAL RESTORATION PLANS. 21
4.1 Site 1 – Reach 1: Wood additions and culvert replacement 22
4.2 Site 2 – Reach 5: Fill removal and bridge replacement 23
4.3 Site 3 – Reach 9: Floodplain restoration, bank stabilization, and culvert replacement 24
5.0 DEVELOPMENT OF A MONITORING PROTOCOL 25
6.0 CONCLUSIONS 26
8.0 REFERENCES 27
TABLES 28
APPENDIX 1 32
APPENDIX 2 50
APPENDIX 3 63

EXECUTIVE SUMMARY

A fluvial geomorphic assessment was completed of Mare Brook in Brunswick, Maine, an urban-impaired stream that fails to meet Maine's aquatic life standards. The assessment was used to identify the impacts of urbanization on channel morphology and physical aquatic habitat in order to develop conceptual restoration options that will address the identified underlying causes for stream impairment. Seventeen distinct geomorphic reaches of uneven lengths were delineated on Mare Brook with breaks between reaches occurring where the character of the valley or channel changes abruptly. Many of the reach breaks are at stream crossings where undersized culverts have disrupted the continuity of geomorphic, hydraulic, and ecological processes. The morphology of the channel from the outlet of one culvert to the inlet of the next crossing downstream typically transitions from a slightly incised channel starved of sediment at the culvert outlet, through a nearly undisturbed meandering channel with good access to an often well-forested floodplain, and finally to a poorly defined channel or wetland formed from sediment deposition in the impounded area upstream of the next culvert inlet. The extent of the upstream impounded area where habitat conditions are poorest varies with each crossing but impacts more than half of some reaches.

The middle of most reaches, where flow is least affected by the culverts, is characterized by excellent morphological and habitat conditions, especially where wood is abundant in the channel. The wood creates excellent cover habitat and provides a hard substrate for macroinvertebrate colonization along a stream dominated by mobile sandy bed sediments. Wood also increases the dynamic nature of the channel (e.g., meander and side channel formation) that creates closely spaced heterogeneous habitats and flow complexity absent from simplified channels where wood has been removed (as likely occurred on portions of Mare Brook in the past). These areas of excellent habitat are isolated from each other by undersized culverts and one dam (at Coffin Pond) where the long length of some culverts (e.g., the culvert passing under the Naval Air Station runway) and the significant fine sediment deposition that occurs upstream of others hinders the movement of macroinvertebrates and other aquatic organisms throughout the stream that are the primary indicators of healthy or unimpaired streams.

Three conceptual restoration plans were developed for Mare Brook that will restore fluvial processes in reaches constrained by undersized culverts and floodplain fill and lack sufficient structure (i.e., wood) to create the diversity of habitats and flow complexity common to natural unaltered stream channels. While these project concepts cover only a short length of stream, their implementation will demonstrate the restoration techniques (e.g., resizing of stream crossings, fill removal, and wood additions) that will need to be applied along greater lengths of the stream to ultimately create the conditions necessary to move Mare Brook off of Maine's list of urban impaired streams. To ensure that the resizing of individual culverts do not cause unexpected problems (e.g., flooding) at other culverts not yet upsized, a hydraulic model should be developed to assist in prioritizing and sequencing of recommended restoration projects identified along the full length of Mare Brook as part of the geomorphic assessment.

1.0 INTRODUCTION

The following report presents the findings and recommendations resulting from a fluvial geomorphic assessment of Mare Brook in Brunswick, Maine (Figure 1). Mare Brook has a total watershed area of only 5.8 mi^2 and a mainstem approximately 4.0 mi long from upstream of Baribeau Drive downstream to Liberty Crossing where the brook becomes tidally influenced before emptying into Harpswell Cove. The brook's primary tributary, Merriconeag Stream, is 1.3 mi long and drains south from the Cooks Corner area but was not included in the assessment presented herein. The watershed as a whole is estimated to have 21 percent impervious cover (MDEP, 2012) and is likely the largest contributing factor for why Mare Brook is listed on the 303(d) list of impaired waters for not providing for aquatic life use due to benthic macroinvertebrate non-attainment (MDEP, 2016, p. 93).

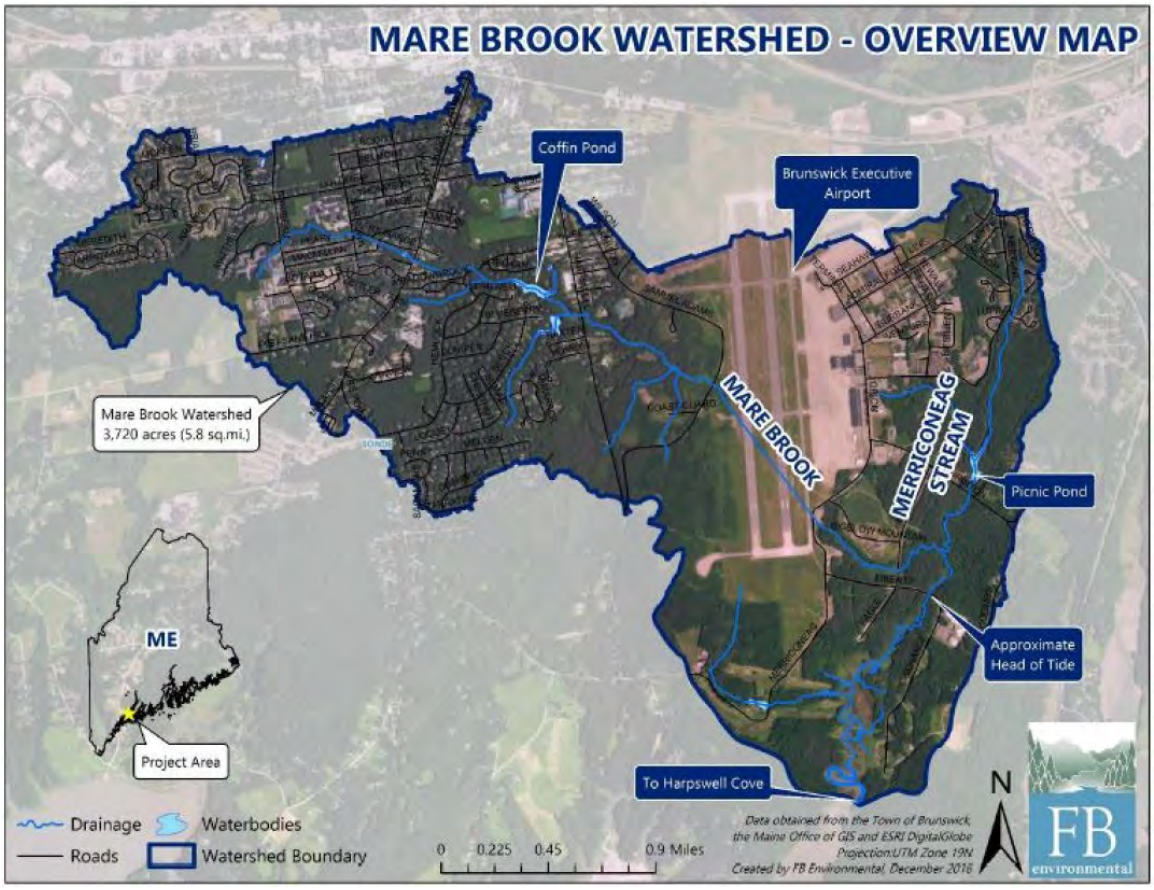

Figure 1. Map of Mare Brook and its surrounding watershed. From FB Environmental.

The geomorphic assessment of Mare Brook was conducted to identify potential physical impacts to the stream that might be contributing to the impairment and what restoration measures might be undertaken to improve conditions on Mare Brook, so the stream can be removed from the State's list of impaired waters. The geomorphic assessment consisted of: 1) a background review and historic assessment of existing materials; 2) a

rapid geomorphic assessment including reach delineation and identification of possible restoration options; 3) topographic surveying of three high priority sites to complete a more detailed geomorphic assessment and develop conceptual restoration plans; and 4) development of a monitoring protocol and collection of baseline monitoring data to document future changes along portions of Mare Brook and the progress of restoration efforts. The results for each of these assessment components are discussed in order below.

2.0 BACKGROUND REVIEW AND HISTORIC ASSESSMENT

The background and historic assessment of existing materials consisted of a review of: 1) online historical aerial photographs and topographic maps, 2) archival information at the Pejepscot History Center in Brunswick, and 3) relevant previously completed studies of Mare Brook. Comparisons of topographic maps from 1894 (based on an 1890 survey) and 1945 (surveyed in 1941 survey) with conditions present today document changes (and lack thereof) on Mare Brook over 130+ years (Web citation 1). The most significant observations resulting from the comparisons include:

- Coffin Pond (and associated dam) were not present in 1890 but had been created by 1941;
- A pond (and associated dam) were present just upstream of Eagle Drive on both the 1894 and 1945 topographic maps but no longer exists today, although evidence of the previous impoundment is seen today (see Section 3.0 below);
- The Brunswick Naval Air Station was built after 1941;
- Much of Mare Brook has a straight configuration on the 1894 and 1945 maps and is suggestive of artificial straightening of the channel prior to 1890, although this cannot be definitively established given the narrow floodplain and limited resolution of the historic topographic maps;
- Artificial fill may have narrowed the natural floodplain between Barrows Street to Maine Street, but this cannot be definitively established given the limited resolution of the historic topographic maps.

Historical information further refines the comparison of historical topographic maps. Online information documents that the Brunswick Naval Air Station was developed and opened in 1943 (Web citation 2) – shortly after the 1941 survey for the 1945 topographic map. At that point an approximately 4,000-foot section of Mare Brook would have been placed in culverts passing under the airfield's runway.

Additional information on Mare Brook was gleaned from previous studies completed on or around Mare Brook. A study of groundwater contamination from landfills associated with the Brunswick Naval Air Station, some of which are adjacent to Mare Brook just downstream of Orion Road, repeatedly refers to Mare Brook, or at least that portion near the landfills, as "Mere Brook beaver marsh" (Jordan, 1990). While no beaver dams were observed on Mare Brook during the rapid geomorphic assessment, the morphology of the

reach adjacent to the landfills is consistent with a former beaver marsh being present (see Section 3.0 below).

Upon request, the Pejepscot History Center conducted a search of their collections for any information on Mare Brook (and previous spellings and names for such) with a particular focus on three locations on Mare Brook where the rapid geomorphic assessment identified one existing dam (i.e., Coffin Pond) and two locations where evidence suggests dams were once present. Other than one reference to a plan for a canal linking Mare Brook with the Androscoggin River (that was never built), no relevant information for this study was found regarding Mare Brook as a result of this research. The absence of information is perhaps not surprising given that the Town's center of focus has been on the much larger Androscoggin River over the centuries, but might also suggest that no event or activity on Mare Brook has occurred significant enough to divert the Town's attention from the larger water body.

3.0 RAPID GEOMORPHIC ASSESSMENT

As part of the Rapid Geomorphic Assessment, Mare Brook was subdivided into 17 reaches of uneven length from the culvert outlet behind Jade Integrated Health on Windorf Circle downstream to Liberty Crossing near the head of tide, a total distance of approximately 4.2 mi. No tributaries were assessed. Each identified reach represents a relatively homogeneous stretch of stream channel that has a character distinct from adjacent reaches or is separated from an adjacent reach by a structure (e.g., culvert) or land feature (e.g., tributary confluence) that is causing or could cause alterations in channel morphology. The reaches on Mare Brook are numbered sequentially from the upstream end such that Reach 1 is the most upstream reach and Reach 17 ends at Liberty Crossing. Delineating the reaches and characterizing the morphological conditions present in each reach are critical for identifying the natural and human factors potentially responsible for observed channel instabilities and degraded aquatic habitat.

Reaches that share similar traits are referred to as "like-reaches" and an understanding of channel response or effective restoration techniques gained in one reach may apply to other "like-reaches". The breaks between reaches occur where there are observable changes resulting from various natural and human conditions such as a change in channel confinement, channel gradient, or human alteration of the channel such as a culvert. Typically, these reach breaks, whether associated with natural or human features, represent grade controls whereby channel adjustments in adjacent reaches cannot migrate upstream or downstream due to constraints at the reach breaks themselves. Consequently, the most dramatic channel adjustments often occur immediately adjacent to the reach breaks. Details on the location, length, and characteristics of each reach are presented in Table 1 (placed at end of report) and Figure 2.

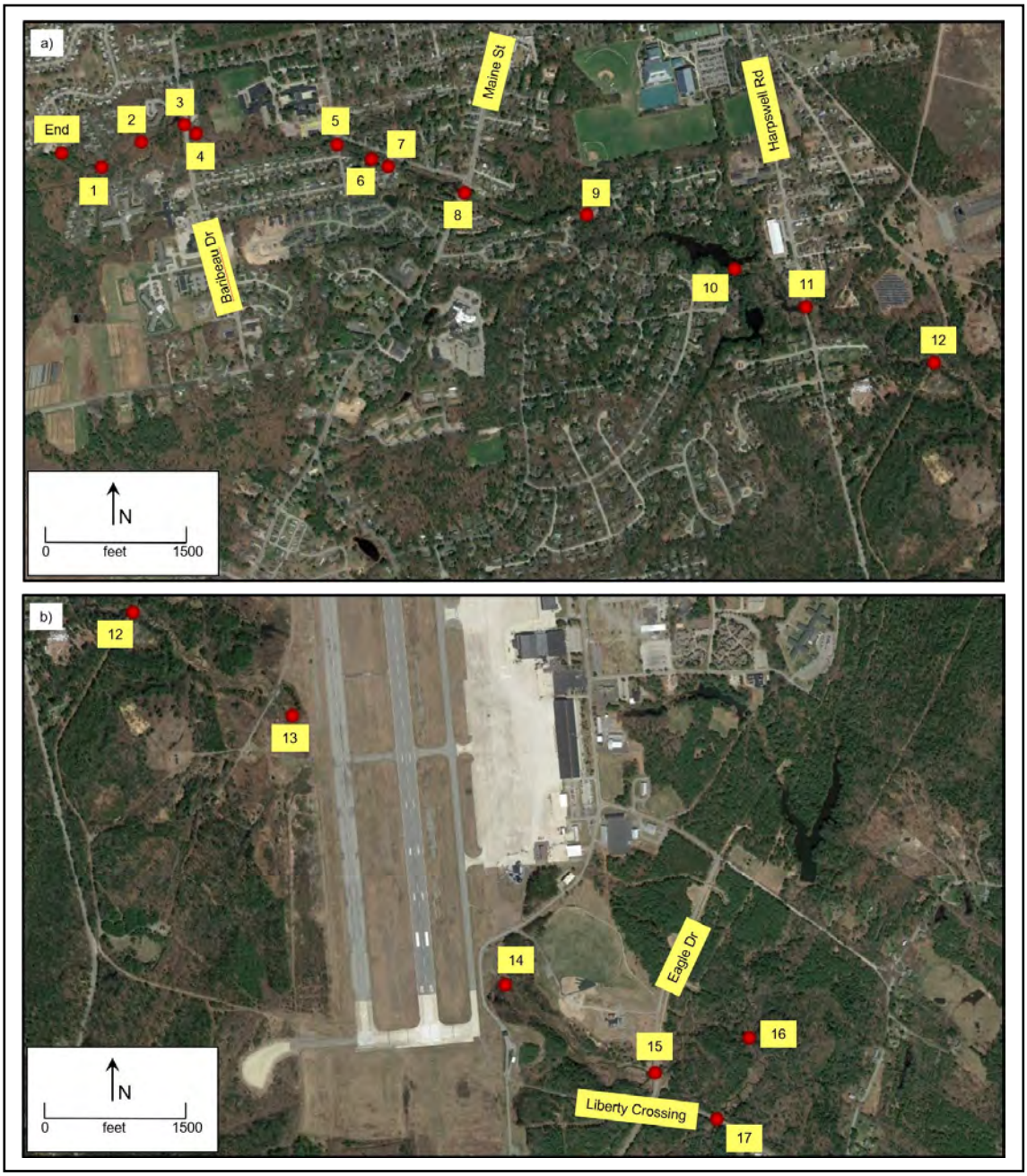

Figure 2. Location of reach breaks on Mare Brook shown as red dots a) upstream and b) downstream of the perimeter road. Reach number placed at downstream end of reach.

The rapid geomorphic assessment was conducted on the 17 reaches using an adaptation of EPA's *Streamwalk* protocol developed by Maine Inland Fisheries and Wildlife (Appendix 1). The rapid geomorphic assessment uses visible physical characteristics of the stream to identify whether the stream is undergoing morphological adjustments associated with aggradation (e.g., presence of bars, siltation in pools), degradation (e.g., headcuts, elevated tree roots), widening (e.g., leaning trees, erosion on both sides of channel), or planform changes (e.g., cut-off channels, formation of islands). Depending on the total number of features observed that are indicative of these adjustments, the stream is characterized as either "in adjustment" (i.e., numerous observed features),

"transitional/stressed" (i.e., some observed features), or "in regime" (i.e., very few or no observed features) (Appendix 1). Reaches "in regime" are considered geomorphically stable (i.e., in equilibrium) and are taken to represent the natural state of the channel that would emerge in the absence of human impacts. In contrast, reaches categorized as "stressed" or "in adjustment" are considered to be responding to varying degrees to human influences (e.g., channel straightening) or natural events (e.g., floods). However, the scores are based on the number of features present and not how well developed those features are such that a clearly degrading reach evidenced by dramatic increases in bank height may still classify as "in regime" if none of the other characteristic features of degradation are present. Consequently, the results of the rapid geomorphic assessment are best corroborated by a qualified professional (i.e., fluvial geomorphologist) and/or more detailed assessments.

Of the 17 assessed reaches on Mare Brook, none are "in adjustment", 13 are classified as "transitional/stressed", and 3 are considered "in regime" (Appendix 1). One reach was not assessed as it represents the long culvert under the Brunswick Naval Air Station and could be viewed only at its upstream and downstream ends. These results suggest that none of the assessed reaches, even if severely impacted by human alterations, exhibit conditions that represent an extreme departure from what might be expected naturally. Consequently, stream restoration efforts on Mare Brook may have a greater chance of success since no significant channel adjustments are ongoing.

The overall reach conditions may obscure localized channel adjustments, so a brief description of each reach from upstream to downstream along Mare Brook is provided below with potential restoration options also presented that could address both reach-wide conditions as well as more localized issues. Table 1 provides a summary of the conditions and potential restoration options in each reach. More detailed restoration options in three reaches are presented in Section 4.0 below.

Reach 1 – Windorf Circle to Matthew Drive

Mare Brook essentially begins at a culvert outlet with rock armor placed on the bed of the channel at the outlet. The reach is well forested with some smaller wood in what appears to be an overwidened channel (perhaps the result of some historic channelization) (Figure 3a). The channel is slowly infilling with soft fine-grained muddy sediments, particularly at the margins of the channel such that the channel is narrowing over time. The deposition is enhanced where wood is present and also upstream of an undersized culvert (i.e., narrower than the width of the channel) passing under a recreational path (Figure 3b).

Restoration of the reach could include the addition of wood through the "chop and drop" method (i.e., directional felling of live standing trees into the channel) that would accelerate the process of channel narrowing, lead to higher flow velocities at low flow conditions, improve flow complexity, provide cover habitat for aquatic organisms and a wood substrate for macroinvertebrate colonization. Restoration could also include replacing the undersized culvert with a channel-spanning bridge that will eliminate

backwatering and the resulting focused deposition of fine-grained sediment across the entire channel bottom rather than just along the margins as is typical elsewhere in the reach.

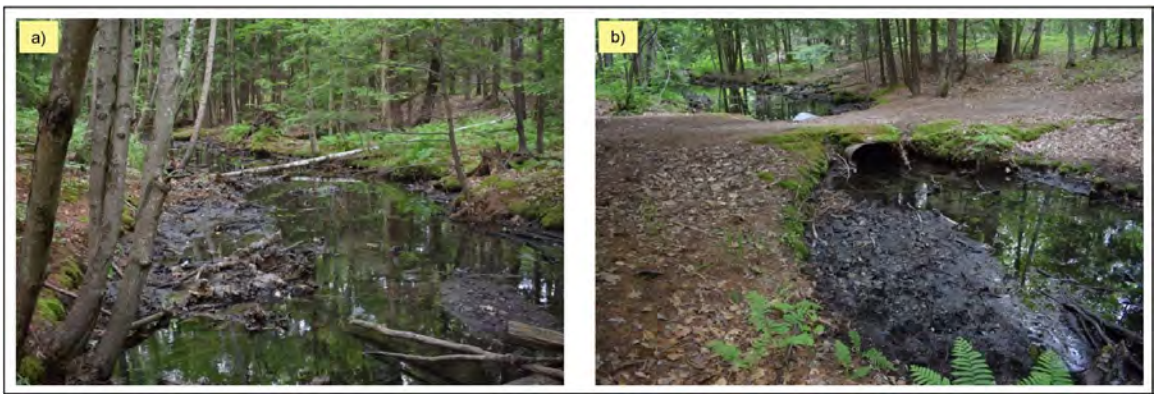

Figure 3. Reach 1 is a) overwidened with fine sediment accumulating along the margins and around wood and b) constricted by an undersized culvert causing further deposition.

Reach 2 – Downstream of Matthew Drive to backside of senior housing center

The channel in Reach 2 is narrow, sinuous, and may be slightly incised but still able to access its floodplain (Figure 4a). The channel is narrowest and most incised immediately downstream of the Matthew Drive culvert, likely due to sediment starvation downstream of the double culvert that is slightly narrower than the channel's width. Some wood is present in the channel but long stretches are largely devoid of wood despite the adjacent forested floodplain (Figure 4b). The channel substrate is primarily a soft fine-grained mud.

Other than the slight incision and absence of wood, the morphological and habitat conditions of the channel are very good, so extensive restoration is unnecessary. The addition of wood through the "chop and drop" method could help to reduce the incision by encouraging sediment deposition while providing additional substrate for macroinvertebrate colonization that is now limited by the soft fine-grained substrate.

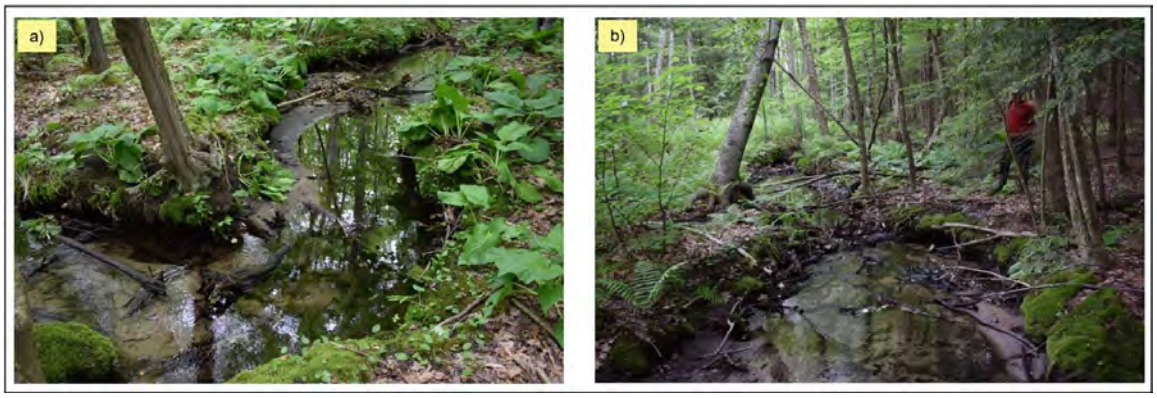

Figure 4. Reach 2 is a) sinuous and slightly incised with b) limited wood in the channel despite the forested floodplain.

Reach 3 – Backside of senior housing center to Baribeau Drive

Much of Reach 3 may be backwatered due to the undersized culverts passing under Baribeau Drive. The channel is wide (more similar to Reach 1 than Reach 2 just upstream) with abundant silt/sand bars around which the flow is diverted, leading to the undermining and collapse of trees into the channel (Figure 5a). The channel banks are very low and become increasingly ill-defined approaching Baribeau Drive where flow becomes more obviously ponded (Figure 5b). Due to the ponding at the upstream side of the Baribeau Drive, the channel, if it can even be so characterized, is spread out over a wide area with at least 4 widely spaced small culverts (2 are side by side) passing under the road.

Flow velocities are likely reduced throughout the reach due to the undersized culverts at Baribeau Drive, thus severely altering the morphological character and stream habitat with an increasing impact further downstream in the reach. Restoration of fluvial processes throughout the reach can only be achieved by replacing and consolidating the culverts into a single properly sized crossing at a well-defined channel that would naturally be present in the absence of the road-induced ponding.

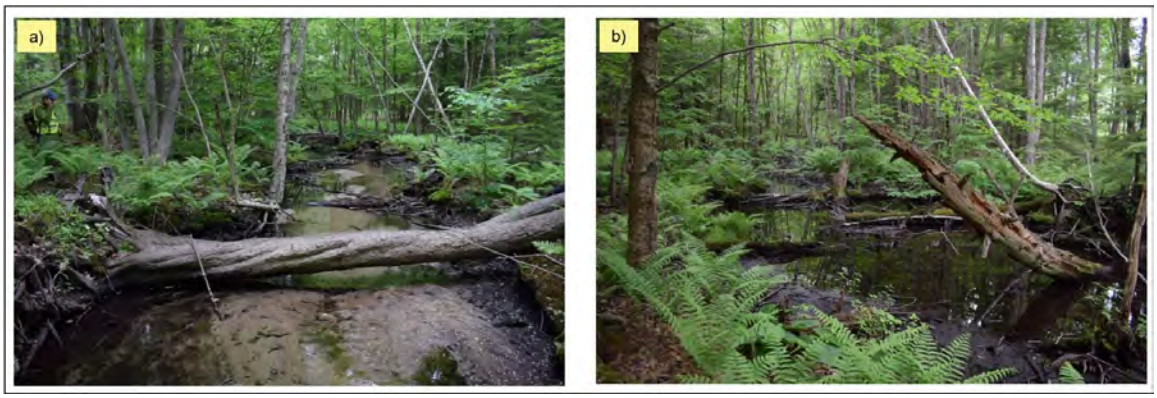

Figure 5. Reach 3 is influenced by the downstream culvert at Baribeau Dr. with a) trees undermined by flow diversion around deposited sediment and b) low banks and ponding further downstream.

Reach 4 – Downstream of Baribeau Drive to the area of no access

Reach 4 is only 300 ft long as access to the area further downstream was not granted by the landowner. The multiple widespread culverts passing under Baribeau Drive all converge into a narrow well-defined channel at their downstream end with the bed of the channel armored with rock at the culvert exit (Figure 6a). Further downstream, the narrow channel contains wood, has a fine-grained substrate, and flows adjacent to a well-forested floodplain (Figure 6b). These conditions extend into the short length of no access and likely remain unchanged into Reach 5 downstream.

Other than the rock armor on the bed of the channel, the morphological and habitat conditions of the stream channel are likely near their natural state, so extensive restoration is not warranted. As part of the Baribeau Drive culvert replacement discussed

above for Reach 3, the rock armor on the bed of the channel at the upstream end of Reach 4 could be removed to reestablish a more natural substrate.

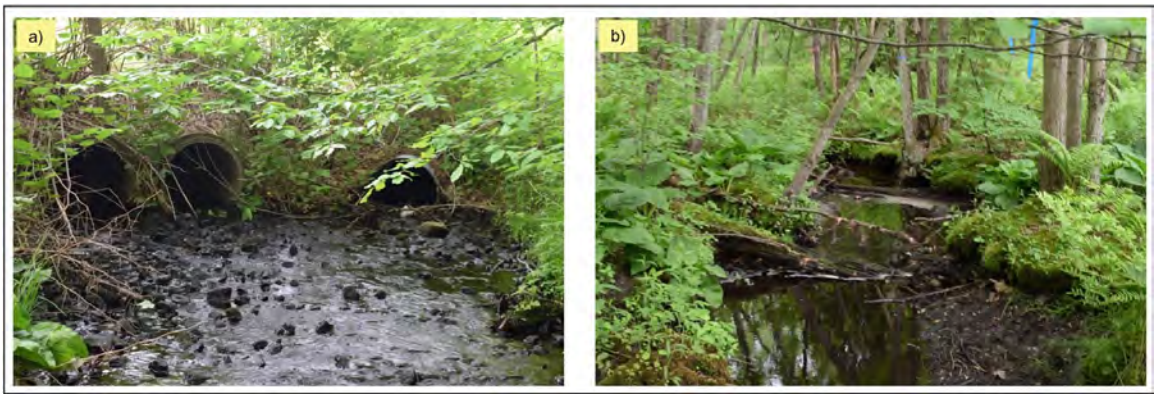

Figure 6. Reach 6 has a) an artificially armored bed at the outlet of the Baribeau Dr. culverts but b) further downstream appears in a near natural state.

Reach 5 – Area of no access to Barrows Street

Reach 5 is a meandering section of Mare Brook with considerable sand deposition and wood in the channel as well as good access in the upper half of the reach to its well-forested floodplain (Figure 7a). In the downstream half, considerable artificial fill was added in the past, for reasons unknown, that has elevated floodplain in places and prevents the channel from spreading over a wide area during floods. Where a pedestrian bridge crosses the channel at the Coffin School, additional fill was added to shorten the needed length for the bridge, thus further constricting the floodplain and the channel itself (Figure 7b). Much like an undersized culvert, flood flows are backwatered upstream of this constriction and excess sediment deposition is occurring. As a result, the channel upstream is less well defined and the adjacent floodplain remains persistently wet. Downstream of the pedestrian bridge, the channel remains confined by fill with minor bank erosion and a sandier substrate, perhaps derived from the application of sand on the adjacent school parking areas during the winter. Approaching Barrows Street culvert at the downstream end of the reach, backwatering conditions are again observed upstream of the undersized culvert.

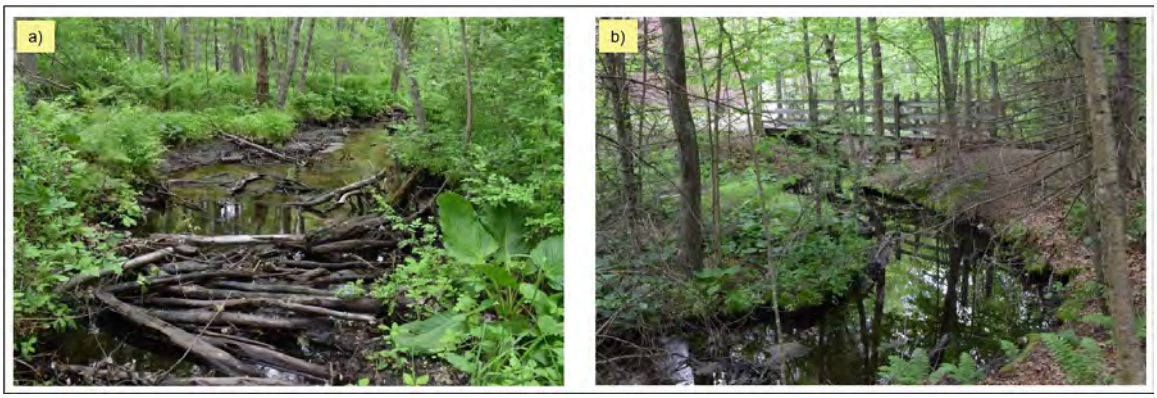

Figure 7. Reach 5 is a) a sinuous channel with lots of wood and sand deposition that b) is narrowed by fill at a pedestrian bridge.

The upstream half of the reach is in a relatively undisturbed natural condition with little need for restoration and largely reflects the same conditions in Reach 4 that likely extend through the short unassessed section where access was not granted. More natural fluvial processes could be restored to the two backwatered areas through 1) fill removal at the pedestrian bridge that would need to be replaced with a larger span and 2) replacement of the exiting culvert at Barrows Street with a properly sized crossing that also includes floodplain relief culverts.

Reach 6 – Barrows Street to a point even with Colonial Drive

Reach 6 is characterized by a wide channel with numerous sand/silt bars and considerable smaller pieces of wood sometimes forming log jams crossing the channel (Figure 8a). Flow diversion around these features has split the channel into multiple flow paths in places. The channel has access to the forested floodplain that narrows considerably at the downstream end as higher terrain on both sides of the channel converge. This convergence is likely a natural physiographic feature but could be the result of artificial fill given the presence of Richards Drive along one bank and residential homes on the other. The only definitive unnatural feature in the reach is the large rock armoring the channel bed at the exit of the Barrows Street culvert at the upstream end of the reach (Figure 8b).

Removing the rock armor at the upstream end of the reach would restore natural conditions in the reach. Large wood could be added to enhance the already natural processes present in the reach, but given the nearby homes and culverts further downstream the wood would need to be anchored to prevent movement.

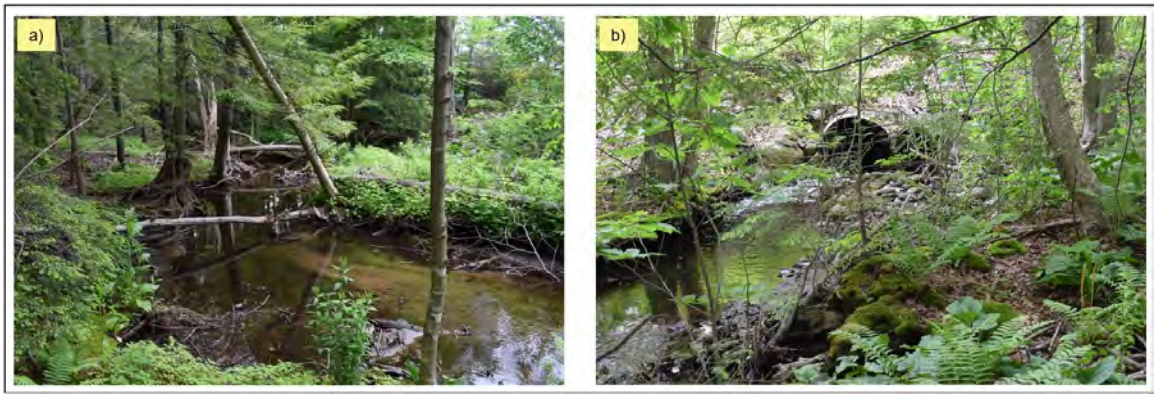

Figure 8. Reach 6 is a) wide with abundant sand/silt deposition and smaller pieces of wood in the channel with b) rock armor at the outlet of the Barrows St. culvert being the only unnatural feature in the reach.

Reach 7 – From the point even with Colonial Drive to MacMillan Drive

The channel in Reach 7 is meandering with good connection to its narrow partially forested floodplain (Figure 9a). The absence of a fully forested floodplain is likely related to the presence of homes adjacent to the channel with the property of one home experiencing minor bank erosion at the apex of a meander bend (Figure 9a). While some wood is present in the channel, the absence of wood through much of the reach may also

be related to the lack of a fully forested floodplain (Figure 9b). Much of the channel bed is composed of firm sand, although large cobbles occur in one area where the channel flows along the higher banks below Richards Drive. The morphology of the channel is not greatly altered by the presence of the culvert passing under MacMillan Drive.

The good channel morphology in Reach 7 (e.g., meandering planform, access to floodplain) indicates significant restoration is unnecessary. However, the limited amount of wood in the channel could be addressed with instream wood additions that would need to be anchored in place given the adjacent homes, roads, and MacMillan Drive culvert. The wood could be used to form habitat structures and for a bioengineering project to stabilize the erosion along one residential property (Figure 9a). Long-term sustainability of instream wood could be enhanced by riparian plantings to restore the forested floodplain.

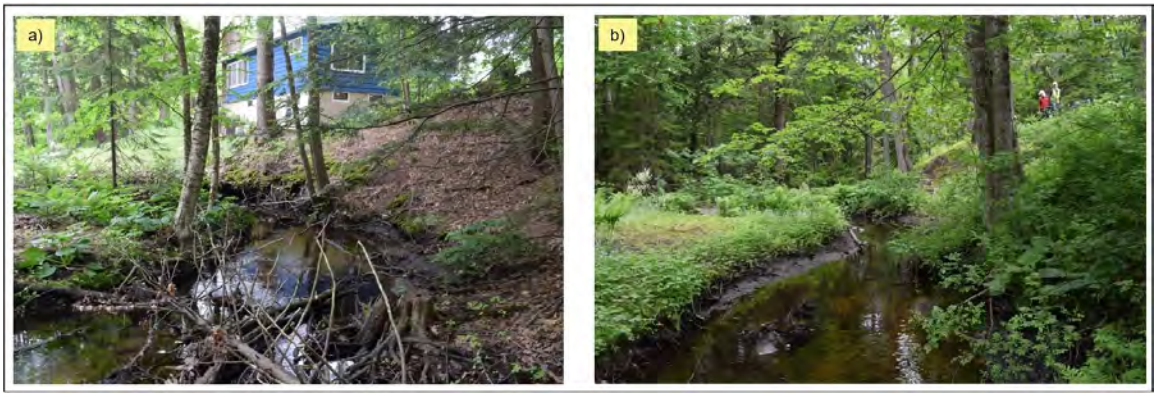

Figure 9. Reach 7 has a meandering channel causing erosion on the outside bends with b) the limited wood in the channel likely related to the absence of a well-forested floodplain.

Reach 8 – MacMillan Drive to Maine Street

Scour has occurred at the outlet of the MacMillan Drive culvert, but downstream of this localized impact, the narrow meandering channel has good access to its well-forested floodplain with considerable wood along parts of the channel and a firm sandy bottom (Figure 10a). For approximately half of the reach's length, an abandoned channel infilled with mud is adjacent to the active channel (Figure 10b). Such channels might form naturally as flow is diverted onto the floodplain to carve a new channel, especially given the low banks and abundance of instream wood. The infilling with mud suggests some time has passed since abandonment of the channel, but the absence of vegetation suggests flows still pass through this abandoned channel during floods. Approaching the undersized Maine Street culvert at the downstream end of the reach, the floodplain narrows, likely due to artificial filling in the past, and the channel becomes ponded with a soft muddy bottom. Mud may be contributed by an unnamed tributary that enters Mare Brook just upstream of Maine Street.

The abandoned channel through much of the reach may reflect the dynamic nature of Mare Brook through this reach but should be considered a natural process and does not reflect widespread channel instability caused by human impacts. Good habitat

complexity arises when the channel position is able to shift across its floodplain and this process could be enhanced by selectively adding wood through the "chop and drop" approach along those portions of the reach where wood is only minimally present. Natural fluvial processes could be restored to the lower end of the reach by replacing the undersized culvert and the removal of fill, where possible, to increase the floodplain's width.

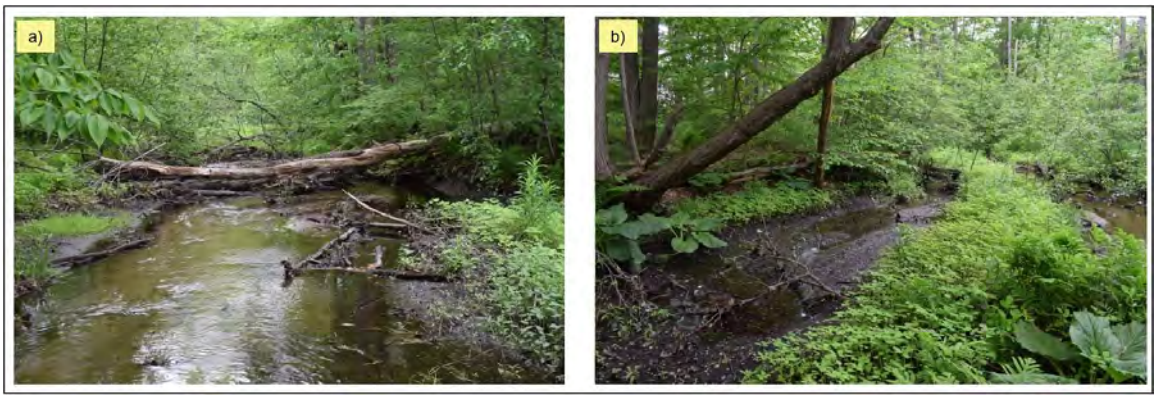

Figure 10. Reach 8 has a) plenty of wood in the channel and good floodplain access with b) a mud-filled side channel adjacent to the active channel for half the reach.

Reach 9 – Maine Street to Meadowbrook Road

Immediately downstream of Maine Street, the channel is very narrow and confined on both sides by long granite blocks that are being undermined and collapsing into the channel (Figure 11a). At the terminus of the wall a 2.5-foot deep pool (at low flow) is present, the deepest observed upstream of the Brunswick Naval Air Station, and is likely the result of scour associated with the granite blocks and associated channel confinement. The banks are high through the confined area and is likely the result of artificial fill on the left bank (looking downstream) but may be naturally high along the right bank. Immediately downstream of the granite blocks, a grassy floodplain is present on the left bank and is part of the lawn of an adjacent house. A low wooden structure crosses the channel at this location and suggests a dam may have once been present (see Section 4.0 below) but no archival information has been found to confirm this supposition (see Section 2.0 above).

Downstream of the yard, Reach 9 flows across a wide well-forested floodplain, has a well-developed meandering planform, abundant wood is found in the channel along much of its length, and numerous side channels are found on the floodplain (Figure 11b). Shifting of the channel's position may be more frequent than in Reach 8 as a rooted stump was observed in the middle of the channel at one point, indicating the current channel's position was established relatively recently. The channel substrate is firm and consists of sand and fine gravel. Given the extended length of the reach, this section of Mare Brook is in excellent condition and represents a largely natural undisturbed condition, although the channel flows through an old earthen berm or dam in one location. Despite the wide floodplain and narrowness of the culvert under Meadowbrook

Road, no significant evidence of backwatering (e.g., ponding, fine sediment deposition) was observed at the downstream end of the reach as might be expected.

Given the natural condition through much of the reach, restoration is not warranted in the forested areas other than perhaps selective "chop and drop" wood additions where the amount of wood in the channel is minimal. Immediately downstream of Maine Street, however, the artificial fill on the left bank could be removed to restore the floodplain and the collapsing granite blocks replaced with a bioengineered solution to stabilize the right bank and the back end of the restore floodplain, while the channel should be allowed to freely migrate across the restored floodplain. This restoration would ideally be accompanied with a resizing of the Maine Street culvert to reduce erosive forces and scour at the culvert's outlet.

Figure 11. Reach 9 is a) narrowly confined and undermining granite blocks on the bank at the outlet of the Maine St. culvert but b) has a sinuous planform with abundant wood in the channel downstream.

Reach 10 – Meadowbrook Road to Coffin Pond

The upstream end of Reach 10 is largely a continuation of the excellent conditions observed in Reach 9 with a well-forested floodplain, meandering planform, and sandy substrate (Figure 12a). One long continuous side channel (possibly once the active main channel) is present that ends at the confluence of an unnamed tributary entering from the right bank. Downstream of the confluence, the channel begins to widen with a softer finer-grained substrate as the channel transitions into Coffin Pond (Figure 12b).

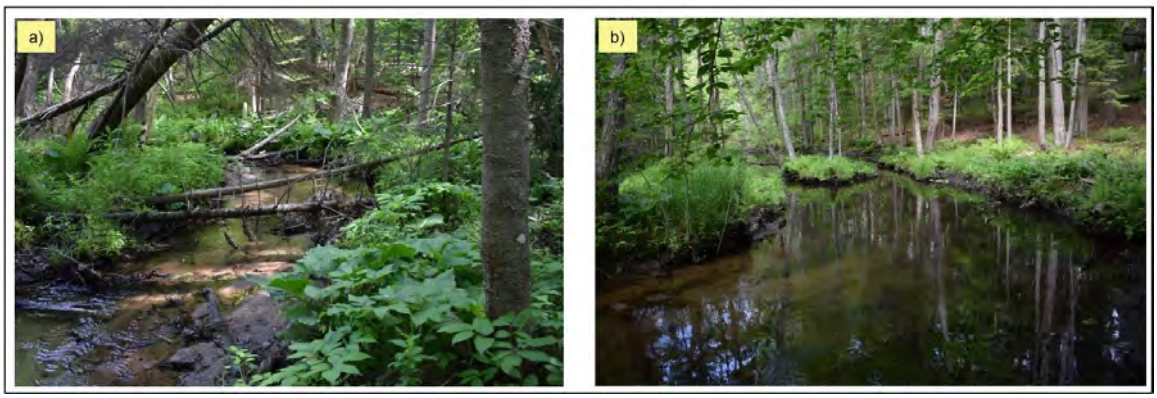

Figure 12. Reach 12 has a) a meandering planform upstream but is b) impounded further downstream.

Like Reach 9, the largely natural condition of the upper portion of Reach 10 does not require extensive restoration, although selective wood additions through the "chop and drop" method could enhance natural processes in those areas where less wood is present in the channel. Fluvial processes could be fully restored to the lower half of Reach 10 and Coffin Pond itself by removing the dam at the downstream end of the pond, but could likely only be done if and when dam repairs become cost prohibitive.

Reach 11 – Coffin Pond Dam to Harpswell Road

Immediately downstream of the Coffin Pond Dam, the channel has an armored rocky substrate (Figure 13a) that quickly transitions into a shallow channel infilled with a soft-fine-grained substrate due to backwatering upstream of the undersized culvert passing under Harpswell Road. Further evidence of the backwatering is seen in the form of numerous dead standing trees present on the wide floodplain (Figure 13b).

Restoration of fluvial processes in Reach 11 will depend on the resizing of the Harpswell Road culvert, a costly project that will likely occur only when the functional life of the existing culvert nears its end.

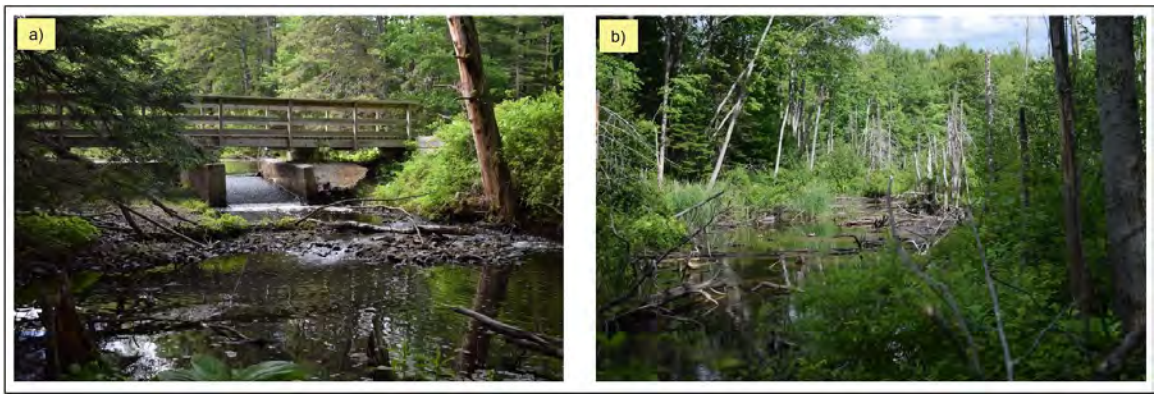

Figure 13. Reach 11 is a) armored on the bed of the channel downstream of the Coffin Pond Dam and b) impounded downstream by the Harpswell Road culvert.

Reach 12 – Harpswell Road to Brunswick Naval Air Station perimeter road

A deep scour pool is present at the outlet of the slightly perched Harpswell Road culvert with the majority of the flow directed to a channel to the left (looking downstream) with a minor portion flowing straight. The upper portion of the reach is covered with a dense growth of alders and becomes more forested with tall mature trees further downstream. The channel is highly sinuous with a high amplitude cutoff meander present (Figure 14 – aerial photo), suggesting the channel is dynamic and subject to shifting across the floodplain. This dynamic nature is likely enhanced by the abundant wood in the channel, including a tree that is blocking 40 feet of the channel after falling in alignment with and directly into the channel. Numerous sand bars are present that has reduced the depth of the channel, although deeper pools are formed around wood in the channel. The lower half of the reach is backwatered behind the culvert passing under the perimeter road and likely enhances the sediment deposition and shallow nature of the channel.

The upper half of the reach with good wood loading and sinuous planform does not require restoration. Similar fluvial processes could be enhanced in the lower half of the reach by resizing the culvert passing under the perimeter road.

Figure 14. A large abandoned meander and abundant wood in the channel suggest Reach 12 is dynamic.

Reach 13 – Brunswick Naval Air Station perimeter road to runway culvert

No scour is observed at the outlet of the twin 3-foot diameter culverts due to the rock armor placed at the outlet. A sinuous meandering planform is present through the reach with minor bank erosion present where the apices of meanders encounter the higher slopes at the back edge of the grassy floodplain (Figure 15a). The channel substrate is comprised of firm sand and fine gravel. While the amount of wood in the channel is minimal (Figure 15a), considerable wood was observed buried at the base of the banks as well as rooted stumps (Figure 15b), suggesting that approximately 1.0 ft of deposition has occurred across the floodplain through the reach. The rate and cause of this deposition is unknown but could be the result of beaver dams (evidence of beaver activity was observed at the lower end of the reach), a human-constructed dam (for which no evidence was seen), severe backwatering upstream of the culvert under the runway (which is not occurring now but perhaps an earlier culvert was much narrower and the floodplain remains blocked to this day), or temporary blockage of the brook for a period of months or years during construction of the Brunswick Naval Air Station (perhaps some construction documents if they still exist could corroborate this). Whatever the cause of deposition, the numerous rooted stumps suggest the floodplain was previously forested but has not reestablished on the recently deposited fine-grained sediment.

The meandering planform requires no restoration but wood additions in the channel would improve cover and flow complexity, while wood additions on the floodplain might encourage regeneration of the forest (by serving as nurse logs). Riparian planting could also be attempted to accelerate reforestation of the floodplain, but this should be first attempted over a small area to be sure the soil conditions and hydrology are conducive to reforestation.

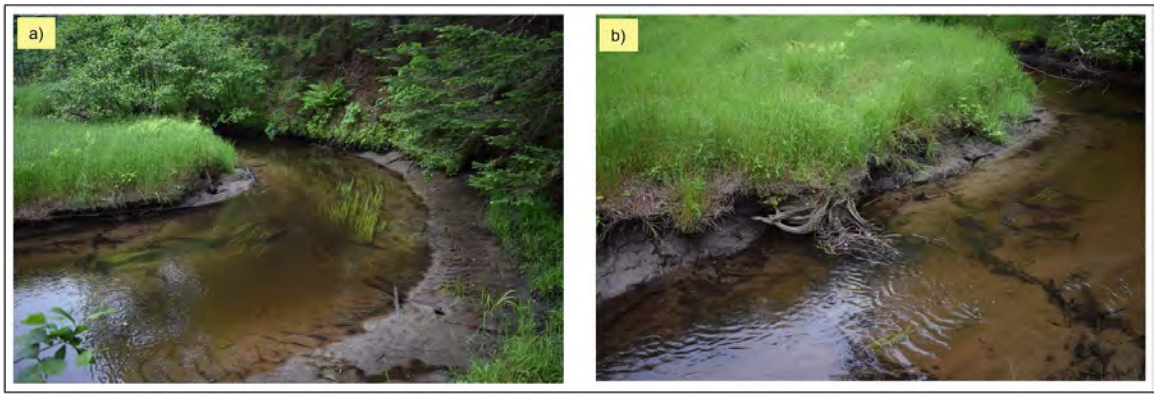

Figure 15. The sinuous Reach 13 has a) limited wood in the channel with minor bank erosion where encountering the valley sides and b) buried rooted stumps indicating 1 foot of deposition on the floodplain.

Reach 14 – Brunswick Naval Air Station runway culvert

Reach 14 consists of the long culvert passing under the Brunswick Naval Air Station's runway, so was not assessed. The culvert (and its installation), however, has likely had a significant impact on the adjacent reaches upstream and downstream. Full restoration of riverine processes to Mare Brook would require its removal or resizing to match the width of the channel and floodplain, either of which seem unlikely given the continuing use of the runway.

Reach 15 – Brunswick Naval Air Station runway culvert to Eagle Drive

While the upstream end of the runway culvert consists of two pipes, the culvert's outlet at the upstream end of Reach 15 has three approximately 3.5-foot pipes, so perhaps flow captured from a tributary converges at this point. The floodplain for most of the reach is partially forested with smaller trees than the well-forested floodplains further upstream, while the downstream 400 ft of the reach has a grass and alder dominated floodplain. The channel has a largely straight planform (perhaps artificially so) that does become more sinuous at the downstream end, but overall is much straighter than Reach 13. The banks are relatively high (compared to upstream) (Figure 16a) and is suggestive of channel incision related to sediment starvation downstream of the long railway culvert and/or channel formation after the draining of a beaver- or human-induced impoundment as suggested by the presence of a pond upstream of Eagle Drive on historical topographic maps and reference to a beaver marsh in earlier reports (see Section 2.0 above). Unlike Reach 13, no rooted stumps or buried wood is observed in the bank sediments.

The substrate largely consists of firm sand, but gravel and cobble are found at the mouth of a tributary on the left bank just downstream of the runway culvert so may be the result of human activities in the small tributary watershed. This delta bar of gravel and cobble has constricted the channel and increased flow velocities through this short stretch. Wood is relatively sparse in the channel (Figure 16b) but where it does occur (Figure 16a) deep scour pools have formed in response. Otherwise, the channel bed maintains a relatively uniform (generally shallow) depth. Long lateral bars, some with buried wood, form upstream of wood obstructions, suggesting significant sand transport is occurring through the reach. A silt-filled side channel (likely the main channel in the past) is present at the downstream end of the reach on the right bank floodplain and, in places, is a composite of multiple narrow anastomosing channels. The floodplain at the downstream end of the reach is persistently wet, perhaps related to the Eagle Drive culvert that closely matches the width of the channel but entirely blocks the wide floodplain. Some evidence of beaver activity is present at the lower end of the reach as well but no beaver dams in the channel were observed.

Restoration of the reach could include: 1) wood additions as the stream appears very responsive to the wood that is present (e.g., scour pools, narrowing of channel through deposition of bars); 2) the installation of floodplain relief culverts adjacent to the Eagle Drive culvert to reduce backwatering upstream; and 3) riparian plantings beginning with a small test plot to be sure the soils and hydrology will support the growth of large mature trees. The existing trees on the floodplain are not large enough to apply the "chop and drop" method and the floodplain soils are likely too soft to use heavy machinery, so large logs would have to be hand carried to the channel with work crews in order to complete wood additions.

Figure 16. Reach 15 has a) relatively high banks and b) limited wood in the channel.

Reach 16 – Eagle Drive to Merriconeag Stream confluence

The outlet of the Eagle Drive culvert is perched and has created a large scour area (including scouring of the banks) with a cobble bar formed downstream composed of sediment presumably derived from the scouring (Figure 17a). The channel downstream is sinuous (perhaps due to backwatering upstream of the Merriconeag Stream confluence) with a sandy substrate and flows along a fairly well-forested floodplain but portions of the floodplain are dominated by grass. As a result, considerable wood is found in the

channel (Figure 17b). The channel appears to be dynamic as evidenced by: 1) deep pools scoured around wood, 2) the presence of rooted stumps in the channel, 3) scour around leaning trees on the bank, 4) large sand bars formed on the outside bends of highly sinuous meanders, and 5) the burial of a Maine DEP water quality monitor in sand. This dynamism may be due, in part to the Merriconeag Stream confluence that is itself characterized by a complex, almost deltaic, network of multiple channels as the stream flows onto the wide floodplain of Mare Brook.

The dynamic nature of Reach 16 is largely a natural condition that results in excellent physical habitat conditions, so the need for restoration is limited. Limited wood additions through the "chop and drop" approach could be undertaken to enhance conditions in those short sections of the reach where limited wood is present in the channel.

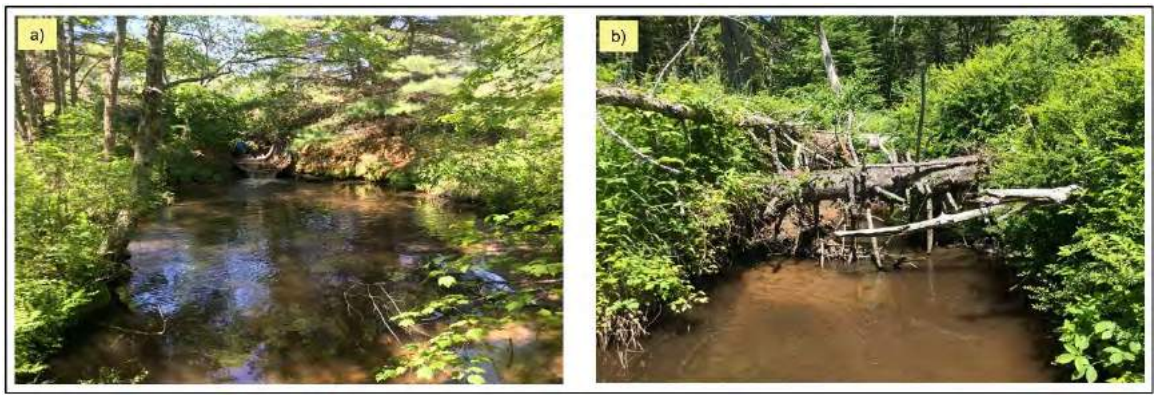

Figure 17. Reach 16 has a) experienced scour downstream of the perched culvert under Eagle Drive and b) considerable wood in the channel where the floodplain is well forested.

Reach 17 – Merriconeag Stream confluence to Liberty Crossing

Downstream of the Merriconeag Stream confluence, the morphology of Mare Brook quickly becomes tidally influenced, although tides probably extend above Liberty Crossing during only the highest tides. An open forested floodplain is present only in the uppermost part of the reach and is grassy elsewhere. The channel is largely straight with limited wood. A forested berm blocks the left bank floodplain near the downstream end of the reach (Figure 18) and occurs where large (artificially placed) rock crosses the channel to form a small step. The coincidence of these two features suggests a dam of some sort was built at this location in the past, perhaps to prevent tidal waters from advancing further upstream, but no archival information was found to document a dam was constructed at this location (See Section 2.0 above)
. At this location the channel complexity increases with water cascading over the rock step and a meander formed immediately downstream that conveys a portion of the flow along an otherwise straight channel (Figure 18). Given the presence of a dam at the site, the overall straight planform through most of the reach may be the result of human manipulation of the channel.

Natural fluvial and tidal processes in the reach could be enhanced by the removal of the berm running across and blocking the floodplain. The rocks crossing the stream are

adding complexity and could remain but perhaps reorganized to extend the benefits over a larger area. Wood additions would also improve conditions along the length of the reach. The "chop and drop" approach is not an option for Reach 17 given the grassy floodplain through most of the reach, so bringing wood in by hand crews is likely the most realistic option across the soft floodplain. However, if the berm were to be removed by heavy machinery, then wood could be added in that area at the same time.

Figure 18. Google Earth image of the downstream end of Reach 17 highlighting the forested berm blocking the floodplain and the associated meander formation downstream.

4.0 TOPOGRAPHIC SURVEYING AND CONCEPTUAL RESTORATION PLANS

Topographic surveying was completed along portions of three reaches to provide the more detailed geomorphic assessment data needed for developing conceptual restoration plans. The three sites were located in Reach 1, Reach 5, and Reach 9 and were selected for the potential to: 1) restore natural fluvial processes, 2) address channel instability and habitat degradation, and, taken together, 3) exemplify a range of restoration strategies that might be effective for "like" reaches elsewhere on Mare Brook. Restoration at all three sites is considered technically and practically feasible, so have a higher likelihood of implementation, despite the potential high costs for some. The three sites are described further below with the conceptual restoration designs provided in Appendix 2.

4.1 Site 1 – Reach 1: Wood additions and culvert replacement

Reach 1 at the upstream end of Mare Brook has a well-forested canopy that reduce summer water temperatures, but limited wood is present in the channel to provide cover habitat or a substrate for macroinvertebrate colonization in a channel dominated by a soft fine-grained substrate (Figure 3). The topographic survey measured the bankfull width of the channel at 15 ft, much greater than the expected bankfull width of less than 8 ft based on the regional curve for coastal and central Maine streams with a similar drainage basin area of less than 1.0 mi^2 (Dudley, 2004). The infilling of the channel with fine-grained sediment has narrowed the low-flow width of the channel to approximately 9 ft, indicating the channel is adjusting towards the expected natural bankfull width following human disturbance (i.e., likely channelization and wood removal). The undersized culvert passing under the recreational path is only 3.5 ft in diameter, significantly narrower than the existing and even expected bankfull width (Figure 3b). Consequently, the culvert will continue to create backwatering and instability even if the channel were successfully narrowed to the expected natural bankfull dimensions.

Given the conditions identified through the topographic surveying and detailed geomorphic assessment of Reach 1, two restoration measures are recommended: 1) "chop and drop" wood additions and 2) replacing the undersized culvert under the recreational path with a bridge spanning more than the entire channel's width (Appendix 2). "Chop and drop" wood additions are a cheap and relatively easy approach to provide cover habitat, a substrate for macroinvertebrate colonization, and flow complexity along streams flowing through well-forested areas such as Reach 1. "Chop and drop" is completed by directionally felling trees near, but not directly on, the stream bank to fall within the stream channel, adding hydraulic roughness and structure to the stream with many associated geomorphic and ecological benefits.

Trees are typically felled in groups, or clusters, to form log jams, thus maximizing their geomorphic impact while minimizing the risk of log transport out of the stream reach. Trees are felled such that the trunk and branches of the tree will become secured against standing trees or interlocked with other felled logs. This treatment does not require any heavy machinery or associated haul roads and, as a result, minimizes disturbance to riparian vegetation. As the logs are not typically anchored with cable, some transport of logs can be expected over time, where they often consolidate into stable channel-spanning log jams. "Chop and drop" is best applied along streams with ample, mature riparian trees where the tree height is greater than channel width and thus movement of the felled trees is minimized. Given the presence of culverts downstream, the felled trees could be anchored with steel cable to standing trees as extra insurance against log movement. For Reach 1, the wood additions should be focused along the channel margins to promote and accelerate the ongoing natural narrowing process.

By replacing the undersized culvert passing under the recreational path (Figure 3b) with a bridge that spans more than the width of the channel, natural flood conveyance can be restored and the natural continuity of sediment transport will no longer be disrupted. A bridge span of 17 ft is proposed, which exceeds the measured width of the channel (15

ft), the expected bankfull width of the channel (9 ft), and the current width of the culvert (3.5 ft). No floodplain is present at the crossing site, so additional accommodation for floodplain flow is not needed at this site. Details regarding the construction of the bridge will be determined in a more detailed design and permitting phase of the project. After a new bridge is constructed, scouring and widening of the banks (caused by eddies formed as flow is backwatered upstream of the narrow culvert) will be reduced, partial removal of the accumulated fine-grained sediment upstream of the bridge will be eliminated, and scour downstream (due to a loss in sediment transport from upstream) will be reduced (although severe scour was not observed during the assessment). Removal of the undersized culvert will ensure the benefits of the "chop and drop" wood additions will be fully realized.

4.2 Site 2 – Reach 5: Fill removal and bridge replacement

Reach 5 between Baribeau Drive and Barrows Street is for the most part in excellent condition with a well-forested floodplain, sinuous planform, and considerable wood in the channel (Figure 7a). However, portions of the floodplain have been blocked, most severely at the pedestrian bridge crossing the channel at the Coffin School (Figure 7b). The constriction of the floodplain (and possibly a portion of the channel as well) caused by the fill is resulting in backwatering upstream where the channel has been transformed more into a wetland than a well-defined free flowing channel.

Given these conditions identified through the topographic surveying and detailed geomorphic assessment of Reach 5, two restoration measures are recommended: 1) removal of the constricting fill and subsequently increasing the span of the footbridge and 2) addition of wood in the channel upstream of the footbridge (Appendix 2). Considerably more fill over the floodplain could be removed than just at the footbridge as remnants of the original floodplain level are still visible on the right bank away from the channel. Coffin School may also be built on a fill surface elevated above the original floodplain. Removal of additional fill, however, would require the removal of large mature trees shading the channel, elimination of current land uses (e.g., the school), and would be expensive and disruptive with little additional benefit gained given that the reach is already in good condition with considerable floodplain still accessible by the channel upstream of the pedestrian bridge.

The proposed wood additions should be considered an optional task given that wood loading in the channel is already quite good. However, adding addit6iona wood where presently less abundant could increase flow complexity and habitat in areas adjacent to the area of proposed fill removal. This might accelerate the recovery to the short-term disturbance to removing the fill and longer term channel response to the restored natural flow patterns. Given the school adjacent infrastructure and downstream culvert at Barrows Street, the proposed wood additions would be anchored by driving logs deep into the presumed soft soil below to hold logs crossing the channel in place. The resulting full-spanning log jams will mimic natural wood accumulations along Mare Brook and will increase flow complexity, cover habitat, and the dynamic nature of the channel.

4.3 Site 3 – Reach 9: Floodplain restoration, bank stabilization, and culvert replacement

Reach 9 immediately downstream of Maine Street is severely constricted by artificial fill that has raised the right bank floodplain. The floodplain and channel are 36 ft and 14 ft wide, respectively, only 150 ft downstream of Maine Street where the channel has been less altered by fill and other human alterations. In contrast, no floodplain is present immediately downstream of Maine Street and the culvert is only 6 ft wide, representing more than an 80 percent constriction of flood flows. The strong concentrated flow exiting the culvert has scoured beneath and caused the collapse of several stacked long granite blocks lining the banks of the channel for the first approximately 50 ft downstream of the culvert (Figure 11a). The bank is still protected for now by the blocks but the strong narrow flows provide little refuge for aquatic organisms.

The floodplain fill also extends upstream of Maine Street and includes the land on which the Brunswick Sewer District's pump station is situated. Much of the natural floodplain remains unaltered, however, and the channel appears more like a pond that has infilled with fine sediment due to the backwatering upstream of the undersized culvert. The channel is ill-defined and the lack of flow complexity and hard substrate provide poor aquatic habitat. The deficit of sediment moving downstream as a result of the fine sediment deposition upstream is contributing to the scour and undermining of the granite blocks at the culvert's outlet.

Given these conditions identified through the topographic surveying and detailed geomorphic assessment of Reach 9, three restoration measures are recommended: 1) removal of the artificial floodplain fill; 2) resizing of the Maine Street culvert, and 3) bank stabilization downstream of Maine Street using bioengineering techniques (Appendix 2). Approximately 835 yds^3 of fill can be removed downstream of Maine Street over an area 125 ft long by 36 ft wide and excavated to a depth of 5 ft along the left bank in order to match the elevation of the intact natural floodplain still present downstream. Fill removal upstream of Maine Street will be limited to a smaller area given that the presence of the pump station will constrain the removal to the area between the building and brook.

The undersized culvert under Maine Street can be replaced with a wider crossing in order to reduce the backwatering effect that disrupts natural flow patterns and sediment transport continuity. The U.S. Fish and Wildlife Service completed a design for a bridge with a 17-foot span (1.2x bankfull) (Abbott, 2018) that would be nearly three times the width of the existing culvert. While implementing the U.S. Fish and Wildlife Service design should largely eliminate the hydraulic impacts of the existing undersized culvert during bankfull (~ 2-year recurrence interval) and smaller flows, the design does not address the confining effect of the floodplain fill, so backwatering would still occur during larger floods. Full restoration of hydraulic and geomorphic conditions at the site would require removal of the floodplain fill and installation of a bridge that fully spans the channel and floodplain. Given that such a bridge may be cost prohibitive, modifying the U.S. Fish and Wildlife Service design to include floodplain relief culverts will

minimize backwatering during large floods by allowing some of the flow to be conveyed across the floodplain underneath Maine Street. The exact number and size of relief culverts would need to be optimized during future hydraulic modeling as part of a detailed design and permitting phase of the project. The installation of relief culverts will depend on at least the partial removal of the artificial fill on the floodplain both upstream and downstream of Maine Street.

Removal of the artificial floodplain fill downstream of Maine Street will reduce the erosive forces in the currently confined channel where the long granite blocks are being undermined. The right bank will still need bank stabilization after removal of fill on the left bank to prevent failure of the high bank with driveway and house near the bank's edge. Installation of a log crib wall will stabilize the bank with the root wads protruding into the water able to baffle flows while providing better cover and flow complexity than rock armor. The left bank can be left largely untreated so as to allow the channel to migrate freely across the restored floodplain. The backside of the restored floodplain can be stabilized with a log crib wall to ensure erosion does not further widen the floodplain and threaten the driveway and home that will be near the floodplain's back edge.

5.0 DEVELOPMENT OF A MONITORING PROTOCOL

Long-term monitoring is critical for better understanding how a stream channel is adjusting over time and for documenting the success of restoration efforts. For Mare Brook, 21 ground photographs were compiled during the course of the geomorphic assessment and their location noted in order to ensure the photographs can be retaken in future years from the same location and orientation to monitor changes over time (Appendix 3). The photographs selected typically contain a distinctive landmark that will assist in relocating the exact location of the photograph and are generally located in easy to access locations. Consequently, fewer photographs are located downstream of the Naval Air Station as access is more difficult.

The initial baseline photographs used in the monitoring protocol include views of the proposed restoration sites (see Section 3.0 above) such that changes associated with the restoration work can be documented. Photographs from other areas will also be useful in documenting the longevity of wood in the stream channel, changes occurring near undersized culverts, the severity and extent of bank erosion, and the rate or frequency of channel migration in areas where the channel is free to adjust across its floodplain.

Initially, the ground photographs should be retaken annually from the same location and orientation for a period of five years. Afterwards, the frequency of the photographs can be reduced to once every five years where very little change was recorded during the first five years. However, where notable changes have occurred, especially at sites where restoration projects may have been implemented, the photographs should continue to be retaken annually. Regardless of the proposed schedule for retaking the photographs, all of the photographs should be retaken as soon as possible following large flood events as such events are likely to result in the most significant changes along Mare Brook.

6.0 CONCLUSIONS

Human activities in and around Mare Brook have contributed to alterations in natural flow patterns and channel morphology, including channelization, stream crossings, artificial floodplain fill, and dams. While the channel is largely stable with limited erosion and channel incision, numerous undersized culverts crossing the stream have greatly altered natural flow patterns and, in turn channel morphology. Channel morphology varies in a downstream direction from one culvert to the next with slight channel incision at the culvert outlet transitioning to poor channel definition and ponding upstream of an undersized culvert inlet. The backwatering upstream of undersized culverts (and the Coffin Pond Dam) often extends far upstream with channel morphology sometimes altered for half the distance upstream to the next culvert.

In the areas upstream of the backwatering influence of undersized culverts, the morphological and habitat conditions of the channel are often excellent with a meandering planform, wood in the channel providing cover habitat and a substrate for macroinvertebrate colonization, and access to an often well-forested floodplain across which the channel is able to migrate and adjust. The most significant problem on Mare Brook is that these areas in excellent condition are often isolated from each other by the undersized culverts and associated fine sediment deposition upstream. While the migration of macroinvertebrates may be hindered by the longer culverts, the impact of even the shorter culverts is the disruption of fluvial processes caused by the upstream backwatering that buries suitable substrate for macroinvertebrate colonization in fine sediment and results in a loss of flow complexity (and creation of homogeneous habitat conditions).

The restoration of natural fluvial processes on Mare Brook will depend on the replacement of undersized culverts with stream crossings that span at least the full width of the bankfull channel. Ideally, future crossings would also span the entire floodplain but should at least include floodplain relief culverts to ensure floodwaters can be conveyed both in the channel and on the floodplain. In some areas, artificial fill has been placed on the floodplain (e.g., around Maine Street), so its removal should be considered as part of future restoration projects. The replacement of stream crossing cannot be done in isolation as a return to natural flow patterns in one location could exacerbate backwater flooding at the next downstream culvert. Consequently, a hydraulic model should be developed for the entire watershed so the effects of replacing stream crossings can be determined and stream crossing priorities developed that will ensure no unforeseen flooding problems develop.

The costs of hydraulic modeling and replacing the stream crossings will be quite high, so on-the-ground replacement of the larger stream crossings may take several years to implement. In the interim, wood additions on portions of the channel where minimal wood is currently present could be completed relatively quickly, inexpensively, and with minimal disturbance using the “chop and drop” technique. Furthermore, several small pedestrian crossings could be replaced sooner than those at major roads and thus demonstrate the benefits of properly sizing crossings before tackling the larger projects.

Wood additions and replacement of smaller crossings will provide immediate habitat and morphological benefits locally and later maximize the overall benefits when natural flow patterns are restored over wider areas as the larger stream crossing projects are ultimately implemented.

8.0 REFERENCES

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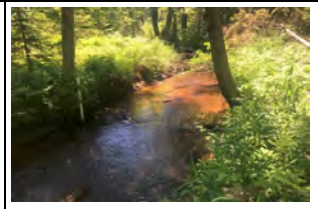
TABLES

Table 1. Summary of reach characteristics and restoration options on Mare Brook.

Reach #	Location	Length (ft)	Conditions	Human alterations	Restoration options	Degree*/Type of improvements	Complexity/Cost†	Ground photo
1	Windorf Circle to Matthew Drive	527	- Floodplain access - Good tree canopy - Wide channel - Minimal log cover - Soft substrate	- Undersized culverts - Armoring of bed downstream of Windorf Circle - Fine sediment upstream of culverts	1) Chop and drop 2) Replace undersized culvert w/footbridge	1) Moderate - narrow channel and improve flow complexity 2) Moderate - flow impoundment eliminated; coarsen substrate	1) Very low ($20k) 2) Very low ($20k)	
2	Matthew Drive to backside of senior housing center	564	- Floodplain access - Meandering planform - Narrow channel - Minimal log cover - Good tree canopy	- Slight incision downstream of culvert	1) Chop and drop	1) Moderate - reduce incision and improve flow complexity	1) Very low ($20k)	
3	Backside of senior housing center to Baribeau Drive	655	- Floodplain access - Good tree canopy - Wide channel - Fair wood loading - Sandy substrate	- Straightened(?) - Impounded reach due to undersized culvert	1) Resize Baribeau Drive culverts - multiple small culverts	1) High - extensive flow impoundment eliminated	1) Watch list - wait until culverts to be replaced ($250k)	
4	Baribeau Drive to area of no access	301	- Floodplain access - Narrow channel - Fair wood loading - Good tree canopy	- Armoring of bed downstream of Baribeau Dr. culvert - Slight incision downstream of culvert	1) Remove armor	1) Low - naturalize substrate over short length	1) Very low ($15k)	
5	No access area downstream to Barrows Street	1,889	- Floodplain access - Meandering planform - Good wood loading - Good tree canopy	- Floodplain in lower half constricted by fill -Barrows St. culvert undersized	1)Remove fill and replace foot bridge 2) Resize culvert	1) Moderate - flow impoundment reduced and restore floodplain 2) High - extensive flow impoundment eliminated	1) Low to moderate - depends on amount of fill removed ($100k) 2) Watch list - wait until culvert to be replaced ($200k)	
6	Barrows Street to a point even with Colonial Drive	389	- Narrow floodplain - Fair wood loading - Some canopy loss - Soft substrate - Multi-thread channel in places	- Armoring of bed downstream of Barrows St. culvert - Homes and road nearby	1) Remove armor 2) Wood additions or chop and drop	1) Low - naturalize substrate over short length 2) Low - increase complexity but good condition already	1) Very low ($15k) 2) Very low ($25k)	

7	From a point even with Colonial Dive to MacMillan Drive	206	- Narrow floodplain - Meandering planform - Narrow channel - Poor log cover - Limited canopy	- Limited wood in channel - Homes and road nearby	1) Anchored wood additions 2) Biostabilization by homes	1) Moderate - increase flow complexity and cover habitat 2) Low - only short length to be treated	1) Very low to low - need to anchor wood ($50k) 2) Very low to low - depending on length to be treated ($35k)	
8	MacMillan Drive to Maine Street	903	- Floodplain access - Good tree canopy - Upper half largely meandering - Lower half impounded with soft substrate	- Localized scour downstream of MacMillan Dr. culvert - Ponded upstream of culvert at Maine St. - Fill constricts channel at Maine St.	- Chop and drop - Replace Maine St. culvert	1) Moderate - improve flow complexity 2) High - eliminate flow impoundment; coarsen substrate	1) Very low ($20k) 2) Watch list - wait until culvert to be replaced ($250k)	
9	Maine Street to Meadowbrook Road	1,544	- Floodplain access - Good tree canopy - Meandering - Good wood loading - Firm sand and fine gravel substrate	- Severe scour downstream of Maine culvert - Fill constricts channel at Maine St.	- Chop and drop - Remove fill to restore floodplain	1) Low - increase complexity but good condition already 2) High - reduce scour in narrow channel downstream of Maine St.	1) Very low ($20k) 2) Moderate ($125k)	
10	Meadowbrook Road to Coffin Pond	982	- Floodplain access - Good tree canopy - Meandering - Fair wood loading	- Channel widens as approach pond	1) Chop and drop 2) Dam removal	1) Moderate - increase complexity and cover 2) High - eliminate impoundment and restore stream flow continuity	1) Very low ($20k) 2) Watch list - wait until costly dam repairs needed to discuss removal ($200k)	
11	Coffin Pond Dam to Harpswell Road	976	- Floodplain access - Good tree canopy - Swampy shallow channel - Numerous dead standing trees	- Entire reach largely impounded by undersized culvert at Harpswell Rd. .	1) Resize Harpswell culvert	1) High - eliminate impoundment and restore stream flow continuity	1) Watch list - wait until culvert to be replaced ($250k)	
12	Harpswell Road to Navy Base fence	1,854	- Floodplain access - Good tree canopy - Meandering planform - Good wood loading	- Scour downstream of Harpswell Rd. culvert - Lower half swampy due to culvert at fence	1) Resize culvert at fence	1) High - eliminate impoundment and restore stream flow continuity	2) Moderate ($125k)	

13	Navy Base fence to runway culvert	2,307	- Floodplain access - Limited canopy - Highly sinuous channel - Minimal log cover - Logs buried in bank	- Armoring downstream of culvert at fence - Impounded at higher level and for long duration in past	1) Remove armor 2) Wood additions in channel and on floodplain 3) Plant forested buffer	1) Low - naturalize substrate 2) Moderate - increase complexity and raise streambed 3) High - canopy for shade	1) Very low ($15k) 2) Moderate to high - long length could be done in phases 3) Very low - for initial test plot	
14	Runway culvert	3,922	N/A	-Entire reach enclosed in culvert	1) Daylight culvert	1) High - restore natural stream processes	1) Watch list - wait for major change in land use or airfield operations	
15	Runway culvert to Eagle Drive	2,112	- Higher banks than elsewhere - Limited canopy - Upper half straightened - Deep pools where wood present	- High banks due to incision downstream of runway culvert - Impounded upstream of Eagle Dr. culvert	1) Wood additions in channel and on floodplain 2) Plant forested buffer 3) Replace Eagle Dr. culvert	1) Moderate - increase complexity and raise streambed 2) High - canopy for shade 3) High - eliminate impoundment	1) Moderate - long length could be done in phases ($150k) 2) Very low - for initial test plot ($15k) 3) Moderate to high ($125k)	
16	Eagle Drive to confluence with Merriconeag Stream	1,547	- Floodplain access - Fair tree canopy - Meandering planform - Good wood loading	- Scour downstream of Eagle Dr. culvert	- Chop and drop	1) Low - increase complexity but already in good condition	1) Very low ($20k)	
17	Merriconeag Stream confluence to Liberty Crossing	1,270	- Floodplain access - Tidally influenced - Limited canopy - Poor log cover	- Forested berm crosses floodplain and rock crosses channel (old dam?)	- Wood additions - Remove berm	1) High - increase complexity and cover 2) Moderate - restore floodplain continuity	1) Low to moderate - depends on length and ease of access ($100k) 2) Moderate - difficult to access for fill removal ($175k)	

* - Categorized as low, moderate, or high. A "low" ranking does not imply the reach is in poor condition as little improvement may result from restoring a reach already in good condition.

† - Categorized as very low (<$50k), low ($50k-$100k), moderate ($100-$200k), high ($>200k), watch list (cost and complexity likely too high to complete for restoration purposes so will need to await an additional reason to arise to complete work such as a bridge replacement to properly resize a stream crossing). A best estimate given in parentheses for each reach and includes design and permitting costs.

Note: Suggestions for stream crossing resizing are mentioned for only the upstream reach but typically will also be beneficial for the downstream reach.

APPENDIX 1

(Rapid geomorphic assessment forms)

Section 2.3.1 **Data Collection Form – RGA**

Rapid Geomorphic Assessment (RGA)

(Part of the Stream Corridor Survey [Level 1])

Date: 6/9/2020 ***Sample ID:*** Reach 1 ***Recorder:*** JohnField

Location: Windorf Circle to MatthewDrive ***Crew:***

Form/ Process	Geomorphic Indicator		Present		Score
	Num	*Description*	*No*	*Yes*	*
Evidence of Aggradation (AI)	1	Lateral bars	x		
	2	Coarse materials in riffles embedded	x		
	3	Siltation in pools		x	
	4	Mid-channel bars		x	
	5	Deposition on point bars	x		
	6	Poor longitudinal sorting of bed materials	x		
	7	Soft, unconsolidated bed		x	
	8	Evidence of deposition in/around structures		x	
	9	Deposition in the overbank zone	x		
		Sum of Indices:	5	4	0.44
Evidence of Degradation (DI)	1	Channel incision into undisturbed overburden / bedrock	x		
	2	Elevated tree roots/root fan above channel bed	x		
	3	Bank height increases	x		
	4	Absence of depositional features (no bars)	x		
	5	Cut face on bar forms	x		
	6	Head cutting due to knick point migration	x		
	7	Suspended armour layer visible in bank	x		
		Sum of Indices:	7	0	0
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc		x	
	2	Occurrence of large organic debris		x	
	3	Exposed tree roots	x		
	4	Basal scour on inside meander bends	x		
	5	Toe erosion on both sides of channel through riffle	x		
	6	Steep bank angles through most of reach	x		
	7	Length of bank scour >50% through subject reach	x		
	8	Fracture lines along top of bank	x		
		Sum of Indices:	6	2	0.25
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chutes	x		
	2	Single thread channel to multiple channel	x		
	3	Evolution of pool-riffle form to low bed relief form	x		
	4	Cut-off channel(s)	x		
	5	Formation of island(s)		x	
	6	Thalweg alignment out of phase meander form		x	
	7	Bar forms poorly formed / reworked / removed	x		
		Sum of Indices:	5	2	0.29

*** Score value = #YES / Total #**
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4
CONDITION =
SI ≤ 0.20 = *in regime*
SI 0.21 – 0.40 = *transitional or stressed*
SI ≥ 0.41 = *in adjustment*

Stability Index: 0.25

Condition: Transitional or stressed

Field Geology Services

Appendix 1. Rapid geomorphic assessment data sheet.

Section 2.3.1 **Data Collection Form – RGA**

Rapid Geomorphic Assessment (RGA)

(Part of the Stream Corridor Survey [Level 1])

Date: 6/9/2020 ***Sample ID:*** Reach 2 ***Recorder:*** JohnField

Location: Downstream of Matthew Drive to backside of senior housing center where channel widens ***Crew:***

Form/ Process	Num	Geomorphic Indicator: Description	Present: No	Present: Yes	Score *
Evidence of Aggradation (AI)	1	Lateral bars	x		
	2	Coarse materials in riffles embedded	x		
	3	Siltation in pools		x	
	4	Mid-channel bars	x		
	5	Deposition on point bars	x		
	6	Poor longitudinal sorting of bed materials	x		
	7	Soft, unconsolidated bed		x	
	8	Evidence of deposition in/around structures	x		
	9	Deposition in the overbank zone	x		
		Sum of Indices:	7	2	0.44
Evidence of Degradation (DI)	1	Channel incision into undisturbed overburden / bedrock		x	
	2	Elevated tree roots/root fan above channel bed		x	
	3	Bank height increases		x	
	4	Absence of depositional features (no bars)		x	
	5	Cut face on bar forms	x		
	6	Head cutting due to knick point migration	x		
	7	Suspended armour layer visible in bank	x		
		Sum of Indices:	3	4	0.57
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc	x		
	2	Occurrence of large organic debris		x	
	3	Exposed tree roots	x		
	4	Basal scour on inside meander bends		x	
	5	Toe erosion on both sides of channel through riffle	x		
	6	Steep bank angles through most of reach		x	
	7	Length of bank scour >50% through subject reach	x		
	8	Fracture lines along top of bank	x		
		Sum of Indices:	5	3	0.38
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chutes	x		
	2	Single thread channel to multiple channel	x		
	3	Evolution of pool-riffle form to low bed relief form	x		
	4	Cut-off channel(s)	x		
	5	Formation of island(s)	x		
	6	Thalweg alignment out of phase meander form	x		
	7	Bar forms poorly formed / reworked / removed	x		
		Sum of Indices:	7	0	0

*** Score value = #YES / Total #**
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4
CONDITION =
SI ≤ 0.20 = *in regime*
SI 0.21 – 0.40 = *transitional or stressed*
SI ≥ 0.41 = *in adjustment*

Stability Index: 0.35

Condition: Transitional or stressed

Field Geology Services

Appendix 1. Rapid geomorphic assessment data sheet.

Section 2.3.1 **Data Collection Form – RGA**

Rapid Geomorphic Assessment (RGA)

(Part of the Stream Corridor Survey [Level 1])

Date: 6/9/2020 ***Sample ID:*** Reach 3 ***Recorder:*** JohnField

Location: Backside of senior housing center where channel widens to Baribeau Drive ***Crew:***

Form/ Process	Geomorphic Indicator		Present		Score
	Num	*Description*	*No*	*Yes*	*
Evidence of Aggradation (AI)	1	Lateral bars		x	
	2	Coarse materials in riffles embedded	x		
	3	Siltation in pools		x	
	4	Mid-channel bars		x	
	5	Deposition on point bars		x	
	6	Poor longitudinal sorting of bed materials		x	
	7	Soft, unconsolidated bed	x		
	8	Evidence of deposition in/around structures		x	
	9	Deposition in the overbank zone	x		
		Sum of Indices:	3	6	0.67
Evidence of Degradation (DI)	1	Channel incision into undisturbed overburden / bedrock	x		
	2	Elevated tree roots/root fan above channel bed	x		
	3	Bank height increases	x		
	4	Absence of depositional features (no bars)	x		
	5	Cut face on bar forms	x		
	6	Head cutting due to knick point migration	x		
	7	Suspended armour layer visible in bank	x		
		Sum of Indices:	7	0	0
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc		x	
	2	Occurrence of large organic debris		x	
	3	Exposed tree roots		x	
	4	Basal scour on inside meander bends	x		
	5	Toe erosion on both sides of channel through riffle	x		
	6	Steep bank angles through most of reach	x		
	7	Length of bank scour >50% through subject reach	x		
	8	Fracture lines along top of bank	x		
		Sum of Indices:	5	3	0.38
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chutes	x		
	2	Single thread channel to multiple channel	x		
	3	Evolution of pool-riffle form to low bed relief form	x		
	4	Cut-off channel(s)	x		
	5	Formation of island(s)	x		
	6	Thalweg alignment out of phase meander form	x		
	7	Bar forms poorly formed / reworked / removed	x		
		Sum of Indices:	7	0	0

*** Score value = #YES / Total #**
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4
CONDITION =
SI ≤ 0.20 = *in regime*
SI 0.21 – 0.40 = *transitional or stressed*
SI ≥ 0.41 = *in adjustment*

Stability Index: 0.15

Condition: In regime

Field Geology Services

Appendix 1. Rapid geomorphic assessment data sheet.

Section 2.3.1 **Data Collection Form – RGA**

Rapid Geomorphic Assessment (RGA)

(Part of the Stream Corridor Survey [Level 1])

Date: 6/9/2020 ***Sample ID:*** Reach 4 ***Recorder:*** JohnField

Location: Outlet of Baribeau Drive culverts including short lengh where no access granted ***Crew:***

Form/ Process	Geomorphic Indicator		Present		Score
	Num	*Description*	*No*	*Yes*	*
Evidence of Aggradation (AI)	1	Lateral bars		x	
	2	Coarse materials in riffles embedded	x		
	3	Siltation in pools		x	
	4	Mid-channel bars	x		
	5	Deposition on point bars	x		
	6	Poor longitudinal sorting of bed materials	x		
	7	Soft, unconsolidated bed		x	
	8	Evidence of deposition in/around structures		x	
	9	Deposition in the overbank zone	x		
		Sum of Indices:	5	4	0.44
Evidence of Degradation (DI)	1	Channel incision into undisturbed overburden / bedrock		x	
	2	Elevated tree roots/root fan above channel bed		x	
	3	Bank height increases		x	
	4	Absence of depositional features (no bars)	x		
	5	Cut face on bar forms	x		
	6	Head cutting due to knick point migration	x		
	7	Suspended armour layer visible in bank	x		
		Sum of Indices:	4	3	0.43
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc	x		
	2	Occurrence of large organic debris	x		
	3	Exposed tree roots	x		
	4	Basal scour on inside meander bends	x		
	5	Toe erosion on both sides of channel through riffle	x		
	6	Steep bank angles through most of reach	x		
	7	Length of bank scour >50% through subject reach	x		
	8	Fracture lines along top of bank	x		
		Sum of Indices:	8	0	0
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chutes	x		
	2	Single thread channel to multiple channel	x		
	3	Evolution of pool-riffle form to low bed relief form	x		
	4	Cut-off channel(s)	x		
	5	Formation of island(s)	x		
	6	Thalweg alignment out of phase meander form	x		
	7	Bar forms poorly formed / reworked / removed	x		
		Sum of Indices:	7	0	0

*** Score value = #YES / Total #**

STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4

CONDITION =

SI ≤ 0.20 = *in regime*

SI 0.21 – 0.40 = *transitional or stressed*

SI ≥ 0.41 = *in adjustment*

Stability Index: 0.22

Condition: Transitional or stressed

Section 2.3.1 **Data Collection Form – RGA**

Rapid Geomorphic Assessment (RGA)

(Part of the Stream Corridor Survey [Level 1])

Date: 6/9/2020 ***Sample ID:*** Reach 5 ***Recorder:*** JohnField

Location: Downstream of no access area to Barrows St. ***Crew:***

Form/ Process	Num	Geomorphic Indicator: Description	Present: No	Present: Yes	Score *
Evidence of Aggradation (AI)	1	Lateral bars	x		
	2	Coarse materials in riffles embedded	x		
	3	Siltation in pools		x	
	4	Mid-channel bars		x	
	5	Deposition on point bars	x		
	6	Poor longitudinal sorting of bed materials	x		
	7	Soft, unconsolidated bed		x	
	8	Evidence of deposition in/around structures		x	
	9	Deposition in the overbank zone	x		
		Sum of Indices:	5	4	0.44
Evidence of Degradation (DI)	1	Channel incision into undisturbed overburden / bedrock	x		
	2	Elevated tree roots/root fan above channel bed	x		
	3	Bank height increases	x		
	4	Absence of depositional features (no bars)	x		
	5	Cut face on bar forms	x		
	6	Head cutting due to knick point migration	x		
	7	Suspended armour layer visible in bank	x		
		Sum of Indices:	7	0	0
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc		x	
	2	Occurrence of large organic debris		x	
	3	Exposed tree roots		x	
	4	Basal scour on inside meander bends	x		
	5	Toe erosion on both sides of channel through riffle	x		
	6	Steep bank angles through most of reach	x		
	7	Length of bank scour >50% through subject reach	x		
	8	Fracture lines along top of bank	x		
		Sum of Indices:	5	3	0.38
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chutes		x	
	2	Single thread channel to multiple channel		x	
	3	Evolution of pool-riffle form to low bed relief form	x		
	4	Cut-off channel(s)		x	
	5	Formation of island(s)	x		
	6	Thalweg alignment out of phase meander form	x		
	7	Bar forms poorly formed / reworked / removed	x		
		Sum of Indices:	4	3	0.43

*** Score value = #YES / Total #**

STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4

CONDITION =

SI ≤ 0.20 = *in regime*

SI 0.21 – 0.40 = *transitional or stressed*

SI ≥ 0.41 = *in adjustment*

Stability Index: 0.31

Condition: Transitional or stressed

Section 2.3.1 **Data Collection Form – RGA**

Rapid Geomorphic Assessment (RGA)

(Part of the Stream Corridor Survey [Level 1])

Date: 6/9/2020 ***Sample ID:*** Reach 6 ***Recorder:*** JohnField

Location: Barrows St. to a point even with the end of Colonial Dr. ***Crew:***

Form/ Process	Geomorphic Indicator		Present		Score
	Num	*Description*	*No*	*Yes*	*
Evidence of Aggradation (AI)	1	Lateral bars		x	
	2	Coarse materials in riffles embedded	x		
	3	Siltation in pools		x	
	4	Mid-channel bars		x	
	5	Deposition on point bars	x		
	6	Poor longitudinal sorting of bed materials		x	
	7	Soft, unconsolidated bed		x	
	8	Evidence of deposition in/around structures		x	
	9	Deposition in the overbank zone		x	
		Sum of Indices:	2	7	0.78
Evidence of Degradation (DI)	1	Channel incision into undisturbed overburden / bedrock	x		
	2	Elevated tree roots/root fan above channel bed	x		
	3	Bank height increases	x		
	4	Absence of depositional features (no bars)	x		
	5	Cut face on bar forms	x		
	6	Head cutting due to knick point migration	x		
	7	Suspended armour layer visible in bank	x		
		Sum of Indices:	7	0	0
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc	x		
	2	Occurrence of large organic debris		x	
	3	Exposed tree roots		x	
	4	Basal scour on inside meander bends	x		
	5	Toe erosion on both sides of channel through riffle	x		
	6	Steep bank angles through most of reach	x		
	7	Length of bank scour >50% through subject reach	x		
	8	Fracture lines along top of bank	x		
		Sum of Indices:	6	2	0.25
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chutes		x	
	2	Single thread channel to multiple channel		x	
	3	Evolution of pool-riffle form to low bed relief form	x		
	4	Cut-off channel(s)		x	
	5	Formation of island(s)		x	
	6	Thalweg alignment out of phase meander form	x		
	7	Bar forms poorly formed / reworked / removed	x		
		Sum of Indices:	3	4	0.43

*** Score value = #YES / Total #**
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4
CONDITION =

SI ≤ 0.20 = *in regime*
SI 0.21 – 0.40 = *transitional or stressed*
SI ≥ 0.41 = *in adjustment*

Stability Index: 0.40

Condition: Transitional or stressed

Field Geology Services

Appendix 1. Rapid geomorphic assessment data sheet.

Section 2.3.1 **Data Collection Form – RGA**

Rapid Geomorphic Assessment (RGA)

(Part of the Stream Corridor Survey [Level 1])

Date: 6/9/2020 ***Sample ID:*** Reach 7 ***Recorder:*** JohnField

Location: From the point even with the end of Colonial Dr. to MacMillan Dr. ***Crew:***

Form/ Process	Geomorphic Indicator		Present		Score
	Num	*Description*	*No*	*Yes*	*
Evidence of Aggradation (AI)	1	Lateral bars	x		
	2	Coarse materials in riffles embedded	x		
	3	Siltation in pools	x		
	4	Mid-channel bars	x		
	5	Deposition on point bars	x		
	6	Poor longitudinal sorting of bed materials		x	
	7	Soft, unconsolidated bed		x	
	8	Evidence of deposition in/around structures	x		
	9	Deposition in the overbank zone	x		
		Sum of Indices:	7	2	0.22
Evidence of Degradation (DI)	1	Channel incision into undisturbed overburden / bedrock	x		
	2	Elevated tree roots/root fan above channel bed	x		
	3	Bank height increases	x		
	4	Absence of depositional features (no bars)	x		
	5	Cut face on bar forms	x		
	6	Head cutting due to knick point migration	x		
	7	Suspended armour layer visible in bank	x		
		Sum of Indices:	7	0	0
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc	x		
	2	Occurrence of large organic debris	x		
	3	Exposed tree roots	x		
	4	Basal scour on inside meander bends	x		
	5	Toe erosion on both sides of channel through riffle	x		
	6	Steep bank angles through most of reach	x		
	7	Length of bank scour >50% through subject reach	x		
	8	Fracture lines along top of bank	x		
		Sum of Indices:	8	0	0
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chutes	x		
	2	Single thread channel to multiple channel	x		
	3	Evolution of pool-riffle form to low bed relief form	x		
	4	Cut-off channel(s)	x		
	5	Formation of island(s)	x		
	6	Thalweg alignment out of phase meander form	x		
	7	Bar forms poorly formed / reworked / removed	x		
		Sum of Indices:	7	0	0

*** Score value = #YES / Total #**
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4
CONDITION =
SI ≤ 0.20 = *in regime*
SI 0.21 – 0.40 = *transitional or stressed*
SI ≥ 0.41 = *in adjustment*

Stability Index: 0.06

Condition: In regime

Field Geology Services

Appendix 1. Rapid geomorphic assessment data sheet.

Section 2.3.1 **Data Collection Form – RGA**

Rapid Geomorphic Assessment (RGA)

(Part of the Stream Corridor Survey [Level 1])

Date: 6/9/2020 ***Sample ID:*** Reach 8 ***Recorder:*** JohnField

Location: MacMillan Dr. to Maine St. ***Crew:***

Form/ Process	Geomorphic Indicator		Present		Score
	Num	*Description*	*No*	*Yes*	*
Evidence of Aggradation (AI)	1	Lateral bars	x		
	2	Coarse materials in riffles embedded	x		
	3	Siltation in pools		x	
	4	Mid-channel bars	x		
	5	Deposition on point bars	x		
	6	Poor longitudinal sorting of bed materials	x		
	7	Soft, unconsolidated bed		x	
	8	Evidence of deposition in/around structures		x	
	9	Deposition in the overbank zone		x	
		Sum of Indices:	5	4	0.44
Evidence of Degradation (DI)	1	Channel incision into undisturbed overburden / bedrock	x		
	2	Elevated tree roots/root fan above channel bed	x		
	3	Bank height increases	x		
	4	Absence of depositional features (no bars)	x		
	5	Cut face on bar forms	x		
	6	Head cutting due to knick point migration	x		
	7	Suspended armour layer visible in bank	x		
		Sum of Indices:	7	0	0
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc	x		
	2	Occurrence of large organic debris		x	
	3	Exposed tree roots	x		
	4	Basal scour on inside meander bends	x		
	5	Toe erosion on both sides of channel through riffle	x		
	6	Steep bank angles through most of reach	x		
	7	Length of bank scour >50% through subject reach	x		
	8	Fracture lines along top of bank	x		
		Sum of Indices:	7	1	0.13
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chutes		x	
	2	Single thread channel to multiple channel		x	
	3	Evolution of pool-riffle form to low bed relief form	x		
	4	Cut-off channel(s)	x		
	5	Formation of island(s)	x		
	6	Thalweg alignment out of phase meander form	x		
	7	Bar forms poorly formed / reworked / removed	x		
		Sum of Indices:	5	2	0.29

*** Score value = #YES / Total #**

STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4

CONDITION =

SI ≤ 0.20 = *in regime*

SI 0.21 – 0.40 = *transitional or stressed*

SI ≥ 0.41 = *in adjustment*

Stability Index: 0.22

Condition: Transitional or stressed

Section 2.3.1 **Data Collection Form – RGA**

Rapid Geomorphic Assessment (RGA)

(Part of the Stream Corridor Survey [Level 1])

Date: 6/9/2020 ***Sample ID:*** Reach 9 ***Recorder:*** JohnField

Location: Maine St. to Meadowbrook Rd. ***Crew:***

Form/ Process	Geomorphic Indicator		Present		Score
	Num	*Description*	*No*	*Yes*	*
Evidence of Aggradation (AI)	1	Lateral bars		x	
	2	Coarse materials in riffles embedded	x		
	3	Siltation in pools		x	
	4	Mid-channel bars	x		
	5	Deposition on point bars		x	
	6	Poor longitudinal sorting of bed materials	x		
	7	Soft, unconsolidated bed	x		
	8	Evidence of deposition in/around structures		x	
	9	Deposition in the overbank zone	x		
		Sum of Indices:	5	4	0.44
Evidence of Degradation (DI)	1	Channel incision into undisturbed overburden / bedrock	x		
	2	Elevated tree roots/root fan above channel bed	x		
	3	Bank height increases	x		
	4	Absence of depositional features (no bars)	x		
	5	Cut face on bar forms	x		
	6	Head cutting due to knick point migration	x		
	7	Suspended armour layer visible in bank	x		
		Sum of Indices:	7	0	0
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc	x		
	2	Occurrence of large organic debris		x	
	3	Exposed tree roots	x		
	4	Basal scour on inside meander bends	x		
	5	Toe erosion on both sides of channel through riffle	x		
	6	Steep bank angles through most of reach	x		
	7	Length of bank scour >50% through subject reach	x		
	8	Fracture lines along top of bank	x		
		Sum of Indices:	7	1	0.13
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chutes		x	
	2	Single thread channel to multiple channel	x		
	3	Evolution of pool-riffle form to low bed relief form	x		
	4	Cut-off channel(s)	x		
	5	Formation of island(s)	x		
	6	Thalweg alignment out of phase meander form	x		
	7	Bar forms poorly formed / reworked / removed	x		
		Sum of Indices:	6	1	0.14

*** Score value = #YES / Total #**
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4
CONDITION =

SI ≤ 0.20 = *in regime*
SI 0.21 – 0.40 = *transitional or stressed*
SI ≥ 0.41 = *in adjustment*

Stability Index: 0.18

Condition: In regime

Field Geology Services

Appendix 1. Rapid geomorphic assessment data sheet.

Section 2.3.1 **Data Collection Form – RGA**

Rapid Geomorphic Assessment (RGA)

(Part of the Stream Corridor Survey [Level 1])

Date: 6/9/2020 ***Sample ID:*** Reach 10 ***Recorder:*** JohnField

Location: Meadowbrook Rd. to Coffin Pond ***Crew:***

Form/ Process	Geomorphic Indicator		Present		Score
	Num	*Description*	*No*	*Yes*	*
Evidence of Aggradation (AI)	1	Lateral bars		x	
	2	Coarse materials in riffles embedded	x		
	3	Siltation in pools		x	
	4	Mid-channel bars	x		
	5	Deposition on point bars	x		
	6	Poor longitudinal sorting of bed materials	x		
	7	Soft, unconsolidated bed		x	
	8	Evidence of deposition in/around structures		x	
	9	Deposition in the overbank zone	x		
		Sum of Indices:	5	4	0.44
Evidence of Degradation (DI)	1	Channel incision into undisturbed overburden / bedrock	x		
	2	Elevated tree roots/root fan above channel bed	x		
	3	Bank height increases	x		
	4	Absence of depositional features (no bars)	x		
	5	Cut face on bar forms	x		
	6	Head cutting due to knick point migration	x		
	7	Suspended armour layer visible in bank	x		
		Sum of Indices:	7	0	0
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc	x		
	2	Occurrence of large organic debris		x	
	3	Exposed tree roots	x		
	4	Basal scour on inside meander bends	x		
	5	Toe erosion on both sides of channel through riffle	x		
	6	Steep bank angles through most of reach	x		
	7	Length of bank scour >50% through subject reach	x		
	8	Fracture lines along top of bank	x		
		Sum of Indices:	7	1	0.13
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chutes		x	
	2	Single thread channel to multiple channel		x	
	3	Evolution of pool-riffle form to low bed relief form	x		
	4	Cut-off channel(s)	x		
	5	Formation of island(s)	x		
	6	Thalweg alignment out of phase meander form	x		
	7	Bar forms poorly formed / reworked / removed	x		
		Sum of Indices:	5	2	0.29

*** Score value = #YES / Total #**
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4
CONDITION =

SI ≤ 0.20 = *in regime*
SI 0.21 – 0.40 = *transitional or stressed*
SI ≥ 0.41 = *in adjustment*

Stability Index: 0.22

Condition: Transitional or stressed

Field Geology Services

Appendix 1. Rapid geomorphic assessment data sheet.

Section 2.3.1 **Data Collection Form – RGA**

Rapid Geomorphic Assessment (RGA)

(Part of the Stream Corridor Survey [Level 1])

Date: 6/9/2020 ***Sample ID:*** Reach 11 ***Recorder:*** JohnField

Location: Coffin Pond Dam to Harpswell Rd. ***Crew:***

Form/ Process	Geomorphic Indicator		Present		Score
	Num	*Description*	*No*	*Yes*	*
Evidence of Aggradation (AI)	1	Lateral bars		x	
	2	Coarse materials in riffles embedded	x		
	3	Siltation in pools		x	
	4	Mid-channel bars		x	
	5	Deposition on point bars	x		
	6	Poor longitudinal sorting of bed materials	x		
	7	Soft, unconsolidated bed		x	
	8	Evidence of deposition in/around structures		x	
	9	Deposition in the overbank zone	x		
		Sum of Indices:	4	5	0.56
Evidence of Degradation (DI)	1	Channel incision into undisturbed overburden / bedrock	x		
	2	Elevated tree roots/root fan above channel bed	x		
	3	Bank height increases	x		
	4	Absence of depositional features (no bars)	x		
	5	Cut face on bar forms	x		
	6	Head cutting due to knick point migration	x		
	7	Suspended armour layer visible in bank	x		
		Sum of Indices:	7	0	0
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc	x		
	2	Occurrence of large organic debris		x	
	3	Exposed tree roots	x		
	4	Basal scour on inside meander bends	x		
	5	Toe erosion on both sides of channel through riffle	x		
	6	Steep bank angles through most of reach	x		
	7	Length of bank scour >50% through subject reach	x		
	8	Fracture lines along top of bank	x		
		Sum of Indices:	7	1	0.13
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chutes		x	
	2	Single thread channel to multiple channel		x	
	3	Evolution of pool-riffle form to low bed relief form	x		
	4	Cut-off channel(s)	x		
	5	Formation of island(s)	x		
	6	Thalweg alignment out of phase meander form	x		
	7	Bar forms poorly formed / reworked / removed	x		
		Sum of Indices:	5	2	0.29

*** Score value = #YES / Total #**

STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4

CONDITION =

SI ≤ 0.20 = *in regime*

SI 0.21 – 0.40 = *transitional or stressed*

SI ≥ 0.41 = *in adjustment*

Stability Index: 0.25

Condition: Transitional or stressed

Field Geology Services

Appendix 1. Rapid geomorphic assessment data sheet.

Section 2.3.1 **Data Collection Form – RGA**

Rapid Geomorphic Assessment (RGA)

(Part of the Stream Corridor Survey [Level 1])

Date: 6/17/2020 ***Sample ID:*** Reach 12 ***Recorder:*** JohnField

Location: Harpswell Rd. to Navy Base fence ***Crew:***

Form/ Process	Geomorphic Indicator		Present		Score
	Num	*Description*	*No*	*Yes*	*
Evidence of Aggradation (AI)	1	Lateral bars		x	
	2	Coarse materials in riffles embedded	x		
	3	Siltation in pools		x	
	4	Mid-channel bars		x	
	5	Deposition on point bars	x		
	6	Poor longitudinal sorting of bed materials		x	
	7	Soft, unconsolidated bed		x	
	8	Evidence of deposition in/around structures		x	
	9	Deposition in the overbank zone	x		
		Sum of Indices:	3	6	0.67
Evidence of Degradation (DI)	1	Channel incision into undisturbed overburden / bedrock	x		
	2	Elevated tree roots/root fan above channel bed	x		
	3	Bank height increases	x		
	4	Absence of depositional features (no bars)	x		
	5	Cut face on bar forms	x		
	6	Head cutting due to knick point migration	x		
	7	Suspended armour layer visible in bank	x		
		Sum of Indices:	7	0	0
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc		x	
	2	Occurrence of large organic debris		x	
	3	Exposed tree roots		x	
	4	Basal scour on inside meander bends	x		
	5	Toe erosion on both sides of channel through riffle	x		
	6	Steep bank angles through most of reach	x		
	7	Length of bank scour >50% through subject reach	x		
	8	Fracture lines along top of bank	x		
		Sum of Indices:	5	3	0.38
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chutes	x		
	2	Single thread channel to multiple channel		x	
	3	Evolution of pool-riffle form to low bed relief form	x		
	4	Cut-off channel(s)		x	
	5	Formation of island(s)	x		
	6	Thalweg alignment out of phase meander form	x		
	7	Bar forms poorly formed / reworked / removed	x		
		Sum of Indices:	5	2	0.29

*** Score value = #YES / Total #**
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4
CONDITION =
SI ≤ 0.20 = *in regime*
SI 0.21 – 0.40 = *transitional or stressed*
SI ≥ 0.41 = *in adjustment*

Stability Index: 0.34

Condition: Transitional or stressed

Field Geology Services

Appendix 1. Rapid geomorphic assessment data sheet.

Section 2.3.1 **Data Collection Form – RGA**

Rapid Geomorphic Assessment (RGA)

(Part of the Stream Corridor Survey [Level 1])

Date: 6/11/2020 ***Sample ID:*** Reach 13 ***Recorder:*** JohnField

Location: Navy Base fence to runway culvert ***Crew:***

Form/ Process	Geomorphic Indicator		Present		Score
	Num	*Description*	*No*	*Yes*	*
Evidence of Aggradation (AI)	1	Lateral bars		x	
	2	Coarse materials in riffles embedded	x		
	3	Siltation in pools		x	
	4	Mid-channel bars	x		
	5	Deposition on point bars		x	
	6	Poor longitudinal sorting of bed materials	x		
	7	Soft, unconsolidated bed		x	
	8	Evidence of deposition in/around structures		x	
	9	Deposition in the overbank zone	x		
		Sum of Indices:	4	5	0.56
Evidence of Degradation (DI)	1	Channel incision into undisturbed overburden / bedrock	x		
	2	Elevated tree roots/root fan above channel bed	x		
	3	Bank height increases	x		
	4	Absence of depositional features (no bars)	x		
	5	Cut face on bar forms	x		
	6	Head cutting due to knick point migration	x		
	7	Suspended armour layer visible in bank	x		
		Sum of Indices:	7	0	0
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc	x		
	2	Occurrence of large organic debris		x	
	3	Exposed tree roots	x		
	4	Basal scour on inside meander bends	x		
	5	Toe erosion on both sides of channel through riffle	x		
	6	Steep bank angles through most of reach	x		
	7	Length of bank scour >50% through subject reach	x		
	8	Fracture lines along top of bank	x		
		Sum of Indices:	7	1	0.13
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chutes		x	
	2	Single thread channel to multiple channel	x		
	3	Evolution of pool-riffle form to low bed relief form	x		
	4	Cut-off channel(s)	x		
	5	Formation of island(s)		x	
	6	Thalweg alignment out of phase meander form	x		
	7	Bar forms poorly formed / reworked / removed	x		
		Sum of Indices:	5	2	0.29

*** Score value = #YES / Total #**
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4
CONDITION =
SI ≤ 0.20 = *in regime*
SI 0.21 – 0.40 = *transitional or stressed*
SI ≥ 0.41 = *in adjustment*

Stability Index: 0.25

Condition: Transitional or stressed

Field Geology Services

Appendix 1. Rapid geomorphic assessment data sheet.

Section 2.3.1 **Data Collection Form – RGA**

Rapid Geomorphic Assessment (RGA)

(Part of the Stream Corridor Survey [Level 1])

Date: 6/11/2020 ***Sample ID:*** Reach 14 ***Recorder:*** JohnField

Location: Long runway culvert ***Crew:***

NOT ASSESSED

Form/ Process	Geomorphic Indicator		Present		Score
	Num	*Description*	*No*	*Yes*	*
Evidence of Aggradation (AI)	1	Lateral bars			
	2	Coarse materials in riffles embedded			
	3	Siltation in pools			
	4	Mid-channel bars			
	5	Deposition on point bars			
	6	Poor longitudinal sorting of bed materials			
	7	Soft, unconsolidated bed			
	8	Evidence of deposition in/around structures			
	9	Deposition in the overbank zone			
		Sum of Indices:			
Evidence of Degradation (DI)	1	Channel incision into undisturbed overburden / bedrock			
	2	Elevated tree roots/root fan above channel bed			
	3	Bank height increases			
	4	Absence of depositional features (no bars)			
	5	Cut face on bar forms			
	6	Head cutting due to knick point migration			
	7	Suspended armour layer visible in bank			
		Sum of Indices:			
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc			
	2	Occurrence of large organic debris			
	3	Exposed tree roots			
	4	Basal scour on inside meander bends			
	5	Toe erosion on both sides of channel through riffle			
	6	Steep bank angles through most of reach			
	7	Length of bank scour >50% through subject reach			
	8	Fracture lines along top of bank			
		Sum of Indices:			
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chutes			
	2	Single thread channel to multiple channel			
	3	Evolution of pool-riffle form to low bed relief form			
	4	Cut-off channel(s)			
	5	Formation of island(s)			
	6	Thalweg alignment out of phase meander form			
	7	Bar forms poorly formed / reworked / removed			
		Sum of Indices:			

*** Score value = #YES / Total #**
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4
CONDITION =

SI ≤ 0.20 = *in regime*
SI 0.21 – 0.40 = *transitional or stressed*
SI ≥ 0.41 = *in adjustment*

Stability Index:

Condition: Not assessed

Field Geology Services

Appendix 1. Rapid geomorphic assessment data sheet.

Section 2.3.1 **Data Collection Form – RGA**

Rapid Geomorphic Assessment (RGA)

(Part of the Stream Corridor Survey [Level 1])

Date: 6/17/2020 ***Sample ID:*** Reach 15 ***Recorder:*** JohnField

Location: Runway culvert to Eagle Dr. ***Crew:***

Form/ Process	Geomorphic Indicator		Present		Score
	Num	*Description*	*No*	*Yes*	*
Evidence of Aggradation (AI)	1	Lateral bars		x	
	2	Coarse materials in riffles embedded	x		
	3	Siltation in pools		x	
	4	Mid-channel bars	x		
	5	Deposition on point bars	x		
	6	Poor longitudinal sorting of bed materials		x	
	7	Soft, unconsolidated bed		x	
	8	Evidence of deposition in/around structures		x	
	9	Deposition in the overbank zone	x		
		Sum of Indices:	4	5	0.56
Evidence of Degradation (DI)	1	Channel incision into undisturbed overburden / bedrock	x		
	2	Elevated tree roots/root fan above channel bed	x		
	3	Bank height increases		x	
	4	Absence of depositional features (no bars)	x		
	5	Cut face on bar forms	x		
	6	Head cutting due to knick point migration	x		
	7	Suspended armour layer visible in bank	x		
		Sum of Indices:	7	0	0.14
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc	x		
	2	Occurrence of large organic debris	x		
	3	Exposed tree roots	x		
	4	Basal scour on inside meander bends	x		
	5	Toe erosion on both sides of channel through riffle	x		
	6	Steep bank angles through most of reach		x	
	7	Length of bank scour >50% through subject reach	x		
	8	Fracture lines along top of bank	x		
		Sum of Indices:	7	1	0.13
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chutes		x	
	2	Single thread channel to multiple channel		x	
	3	Evolution of pool-riffle form to low bed relief form	x		
	4	Cut-off channel(s)		x	
	5	Formation of island(s)		x	
	6	Thalweg alignment out of phase meander form	x		
	7	Bar forms poorly formed / reworked / removed	x		
		Sum of Indices:	3	4	0.57

*** Score value = #YES / Total #**

STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4

CONDITION =

SI ≤ 0.20 = *in regime*

SI 0.21 – 0.40 = *transitional or stressed*

SI ≥ 0.41 = *in adjustment*

Stability Index: 0.35

Condition: Transitional or stressed

Section 2.3.1 **Data Collection Form – RGA**

Rapid Geomorphic Assessment (RGA)

(Part of the Stream Corridor Survey [Level 1])

Date: 6/17/2020 ***Sample ID:*** Reach 16 ***Recorder:*** JohnField

Location: Eagle Dr. to confluence with Merriconeag Stream ***Crew:***

Form/ Process	Geomorphic Indicator		Present		Score *
	Num	*Description*	*No*	*Yes*	
Evidence of Aggradation (AI)	1	Lateral bars		x	
	2	Coarse materials in riffles embedded		x	
	3	Siltation in pools		x	
	4	Mid-channel bars	x		
	5	Deposition on point bars		x	
	6	Poor longitudinal sorting of bed materials		x	
	7	Soft, unconsolidated bed		x	
	8	Evidence of deposition in/around structures		x	
	9	Deposition in the overbank zone	x		
		Sum of Indices:	2	7	0.78
Evidence of Degradation (DI)	1	Channel incision into undisturbed overburden / bedrock	x		
	2	Elevated tree roots/root fan above channel bed	x		
	3	Bank height increases		x	
	4	Absence of depositional features (no bars)	x		
	5	Cut face on bar forms	x		
	6	Head cutting due to knick point migration	x		
	7	Suspended armour layer visible in bank	x		
		Sum of Indices:	6	1	0.14
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc		x	
	2	Occurrence of large organic debris		x	
	3	Exposed tree roots		x	
	4	Basal scour on inside meander bends	x		
	5	Toe erosion on both sides of channel through riffle	x		
	6	Steep bank angles through most of reach	x		
	7	Length of bank scour >50% through subject reach	x		
	8	Fracture lines along top of bank	x		
		Sum of Indices:	5	3	0.38
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chutes	x		
	2	Single thread channel to multiple channel	x		
	3	Evolution of pool-riffle form to low bed relief form	x		
	4	Cut-off channel(s)	x		
	5	Formation of island(s)	x		
	6	Thalweg alignment out of phase meander form	x		
	7	Bar forms poorly formed / reworked / removed	x		
		Sum of Indices:	7	0	0

*** Score value = #YES / Total #**
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4
CONDITION =
SI ≤ 0.20 = *in regime*
SI 0.21 – 0.40 = *transitional or stressed*
SI ≥ 0.41 = *in adjustment*

Stability Index:	0.33
Condition:	Transitional or stressed

Section 2.3.1 **Data Collection Form – RGA**

Rapid Geomorphic Assessment (RGA)

(Part of the Stream Corridor Survey [Level 1])

Date: 6/17/2020 ***Sample ID:*** Reach 17 ***Recorder:*** JohnField

Location: Merriconeag Stream confluence to Liberty Crossing ***Crew:***

Form/ Process	Geomorphic Indicator		Present		Score
	Num	*Description*	*No*	*Yes*	*
Evidence of Aggradation (AI)	1	Lateral bars		x	
	2	Coarse materials in riffles embedded		x	
	3	Siltation in pools		x	
	4	Mid-channel bars	x		
	5	Deposition on point bars		x	
	6	Poor longitudinal sorting of bed materials		x	
	7	Soft, unconsolidated bed		x	
	8	Evidence of deposition in/around structures		x	
	9	Deposition in the overbank zone		x	
		Sum of Indices:	1	8	0.89
Evidence of Degradation (DI)	1	Channel incision into undisturbed overburden / bedrock	x		
	2	Elevated tree roots/root fan above channel bed	x		
	3	Bank height increases	x		
	4	Absence of depositional features (no bars)	x		
	5	Cut face on bar forms	x		
	6	Head cutting due to knick point migration	x		
	7	Suspended armour layer visible in bank	x		
		Sum of Indices:	7	0	0
Evidence of Widening (WI)	1	Fallen / leaning trees / fence posts / etc		x	
	2	Occurrence of large organic debris		x	
	3	Exposed tree roots	x		
	4	Basal scour on inside meander bends	x		
	5	Toe erosion on both sides of channel through riffle	x		
	6	Steep bank angles through most of reach	x		
	7	Length of bank scour >50% through subject reach	x		
	8	Fracture lines along top of bank	x		
		Sum of Indices:	6	2	0.25
Evidence of Planimetric Form Adjustment (PI)	1	Formation of chutes		x	
	2	Single thread channel to multiple channel	x		
	3	Evolution of pool-riffle form to low bed relief form	x		
	4	Cut-off channel(s)	x		
	5	Formation of island(s)	x		
	6	Thalweg alignment out of phase meander form	x		
	7	Bar forms poorly formed / reworked / removed	x		
		Sum of Indices:	6	1	0.14

*** Score value = #YES / Total #**
STABILITY INDEX (SI) = (AI + DI + WI + PI) / 4
CONDITION =

SI ≤ 0.20 = *in regime*
SI 0.21 – 0.40 = *transitional or stressed*
SI ≥ 0.41 = *in adjustment*

Stability Index: 0.32

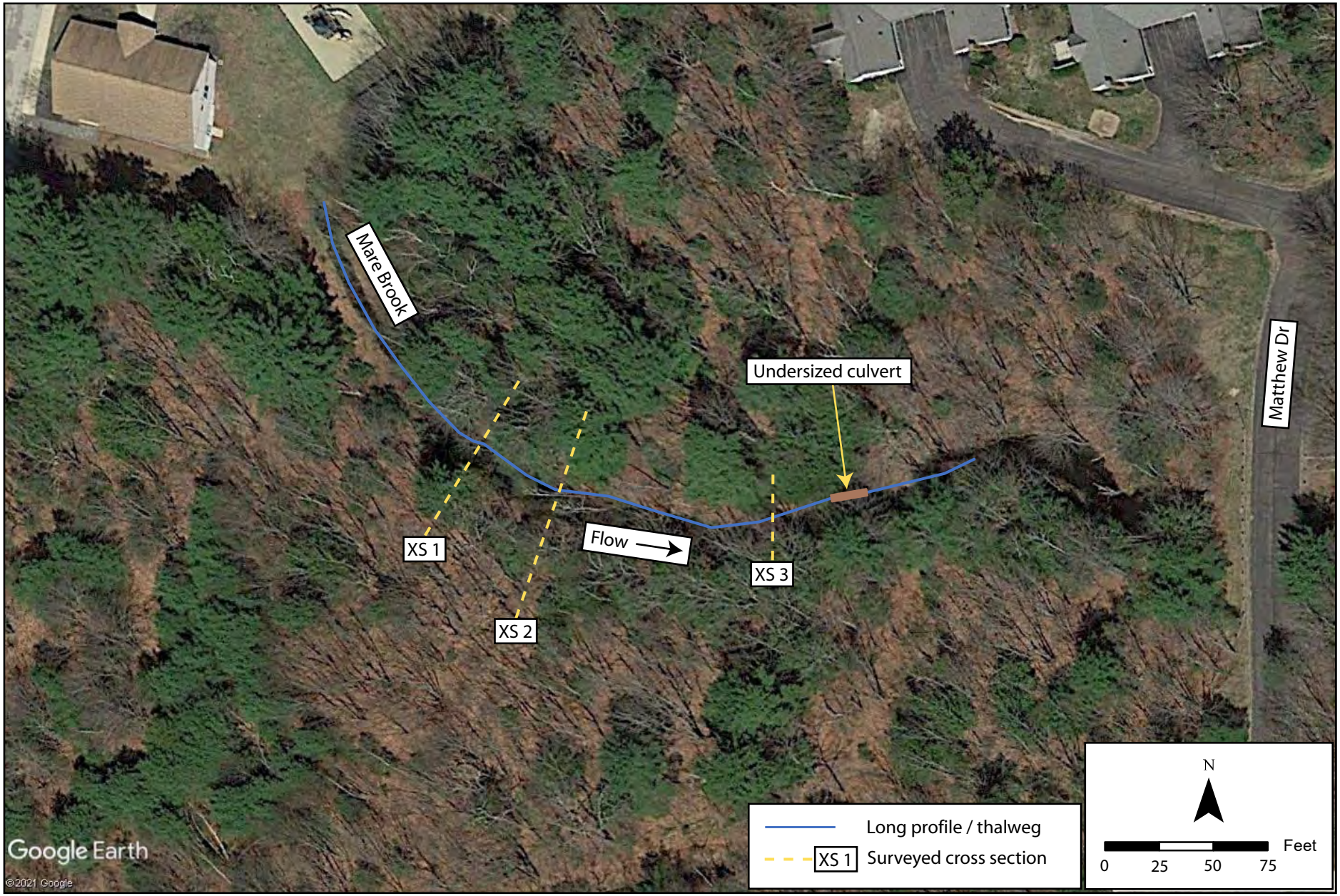
Condition: Transitional or stressed

Field Geology Services

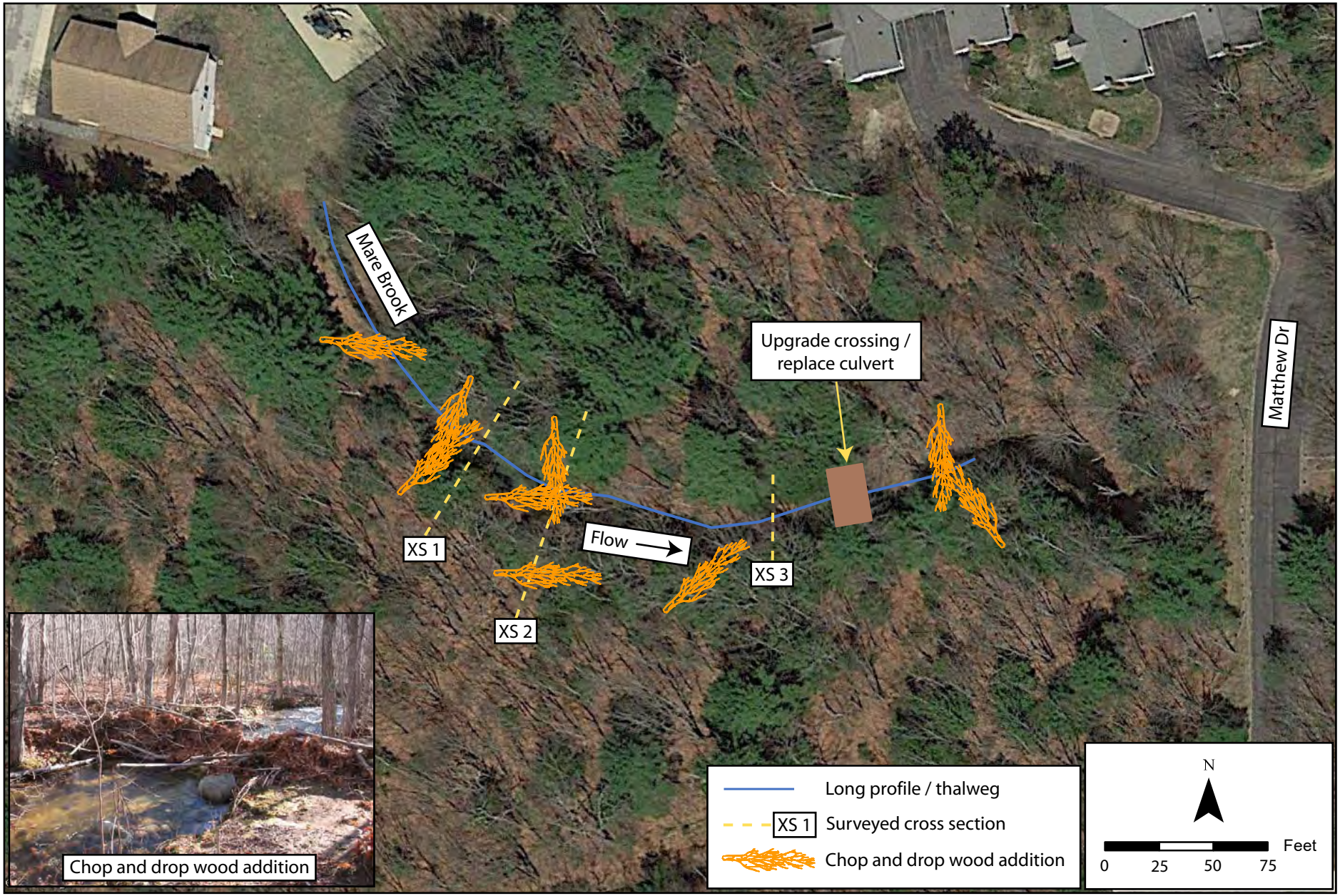
Appendix 1. Rapid geomorphic assessment data sheet.

APPENDIX 2

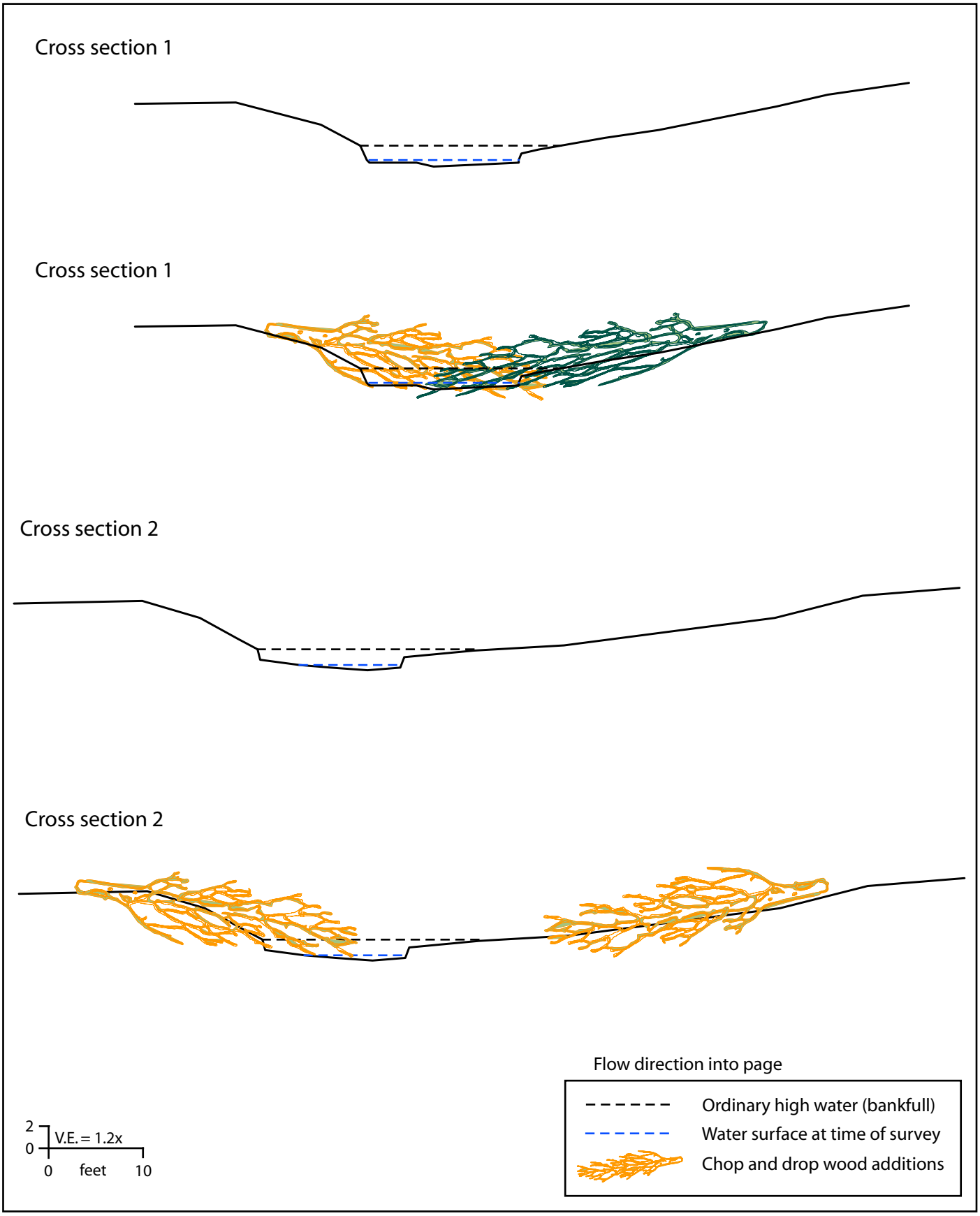
(Conceptual restoration designs)



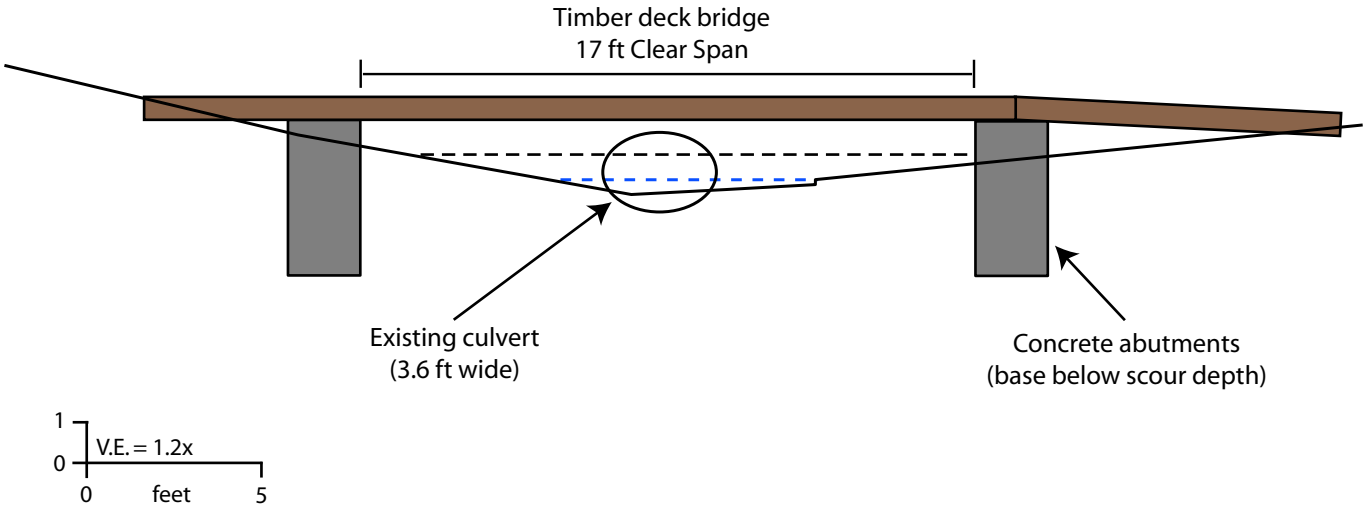
Appendix 2. Site 1 - Reach 1: Existing planview.



Appendix 2. Site 1 - Reach 1: Proposed planview.



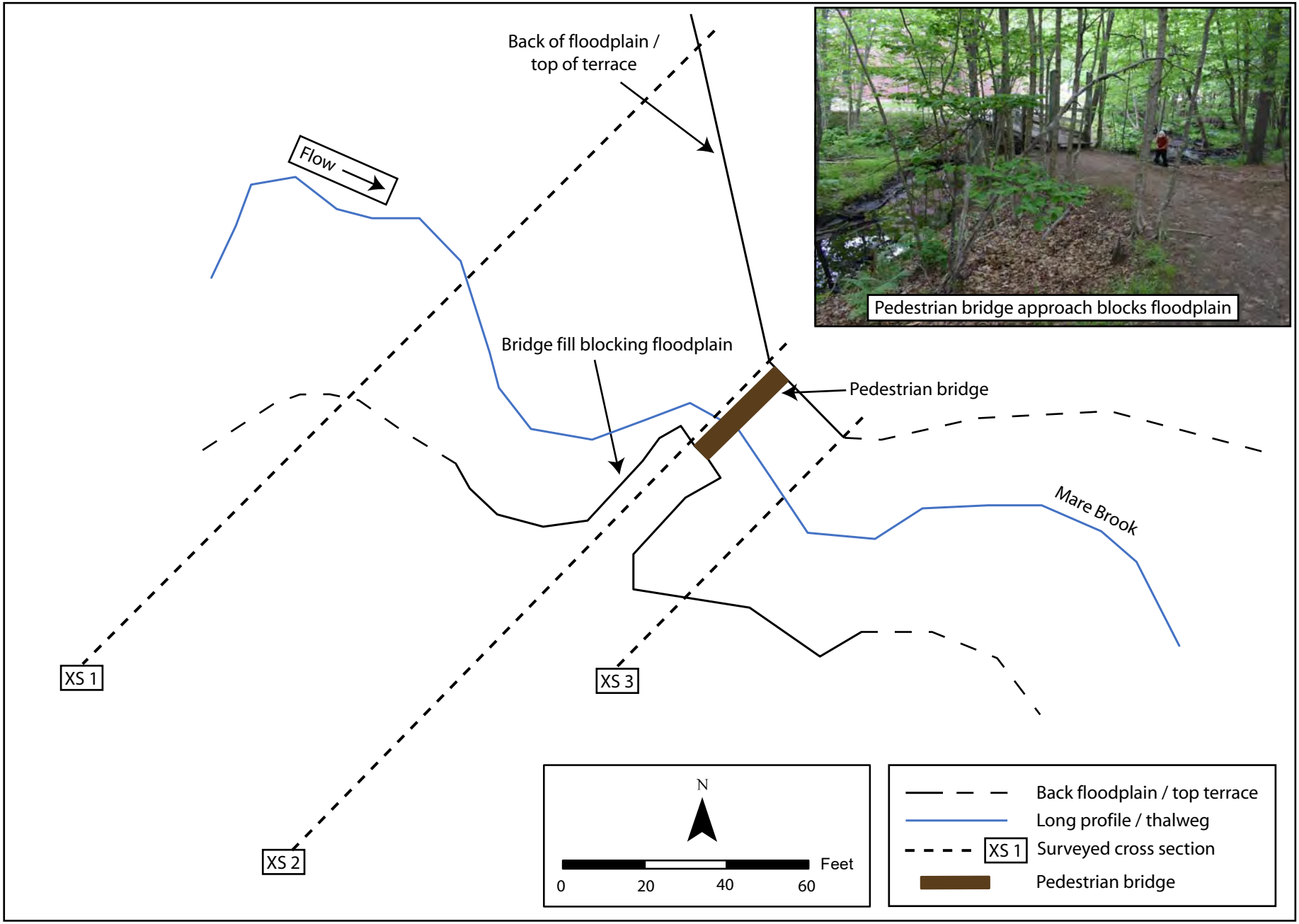
Appendix 2. Site 1 - Reach 1: Chop and drop treatment depicted on surveyed Cross sections 1 and 2.



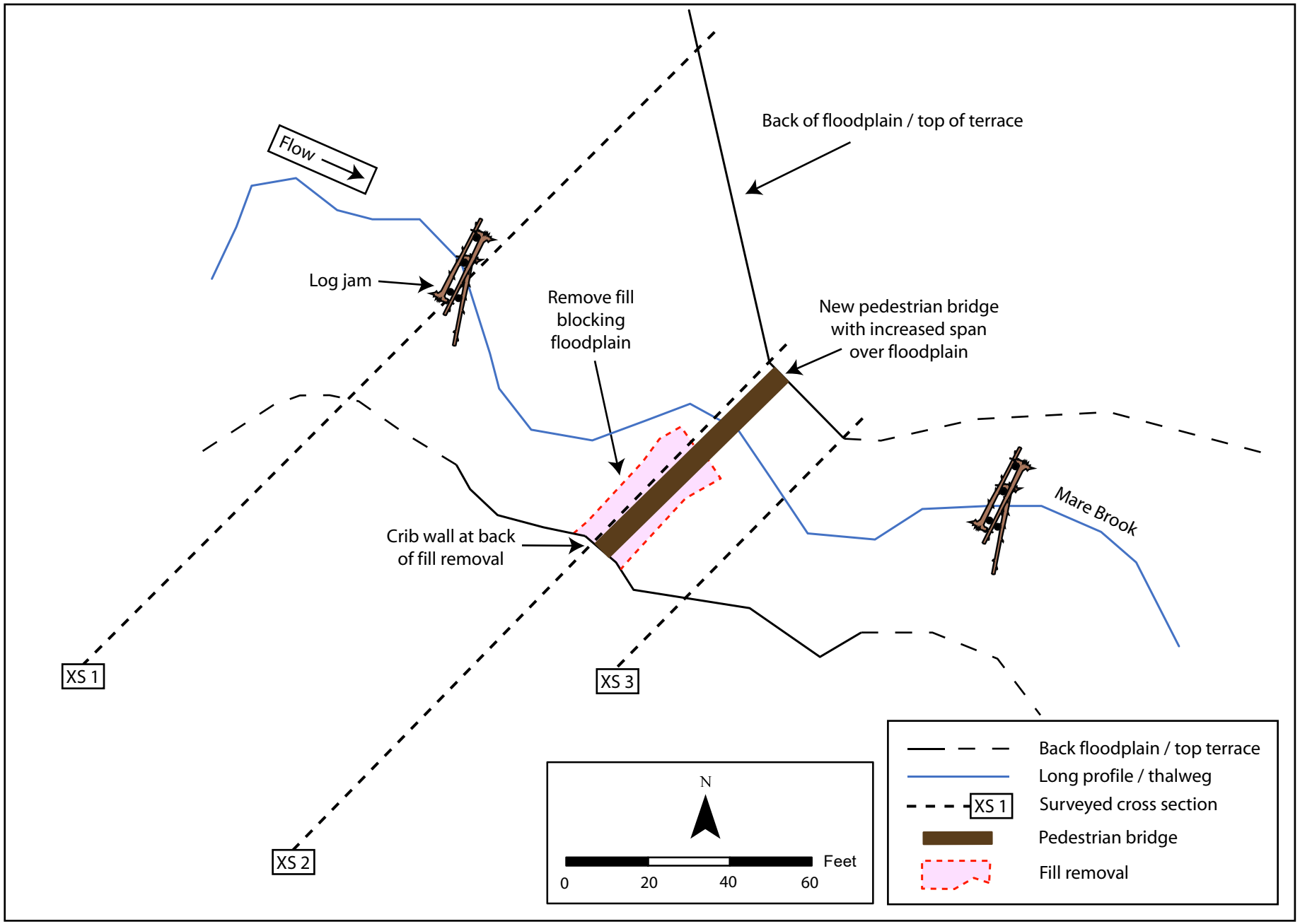
Flow direction into page

- – – Ordinary high water (bankfull)
- – – Water surface at time of survey

Appendix 2. Site 1 - Reach 1: Culvert replacement depicted on surveyed Cross section 3.



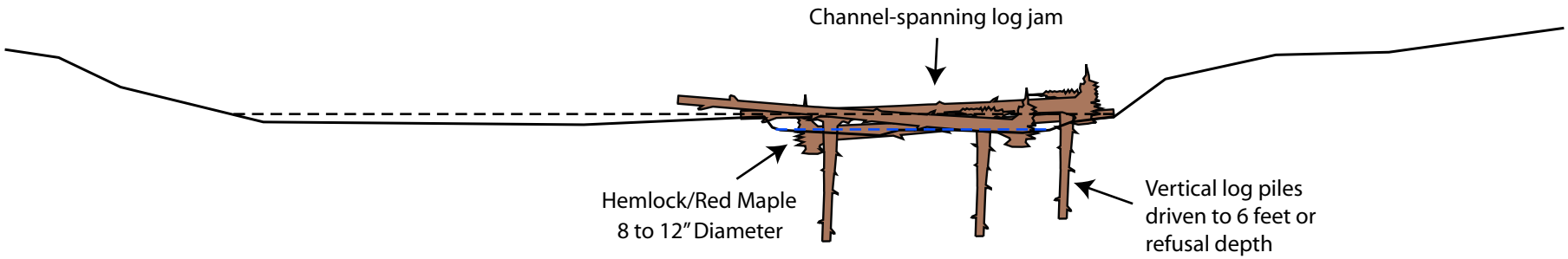
Appendix 2. Site 2 - Reach 5: Existing plan view.

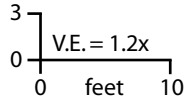


Appendix 2. Site 2 - Reach 5: Proposed plan view.

Cross section 1 - Existing

Cross section 1 - Proposed



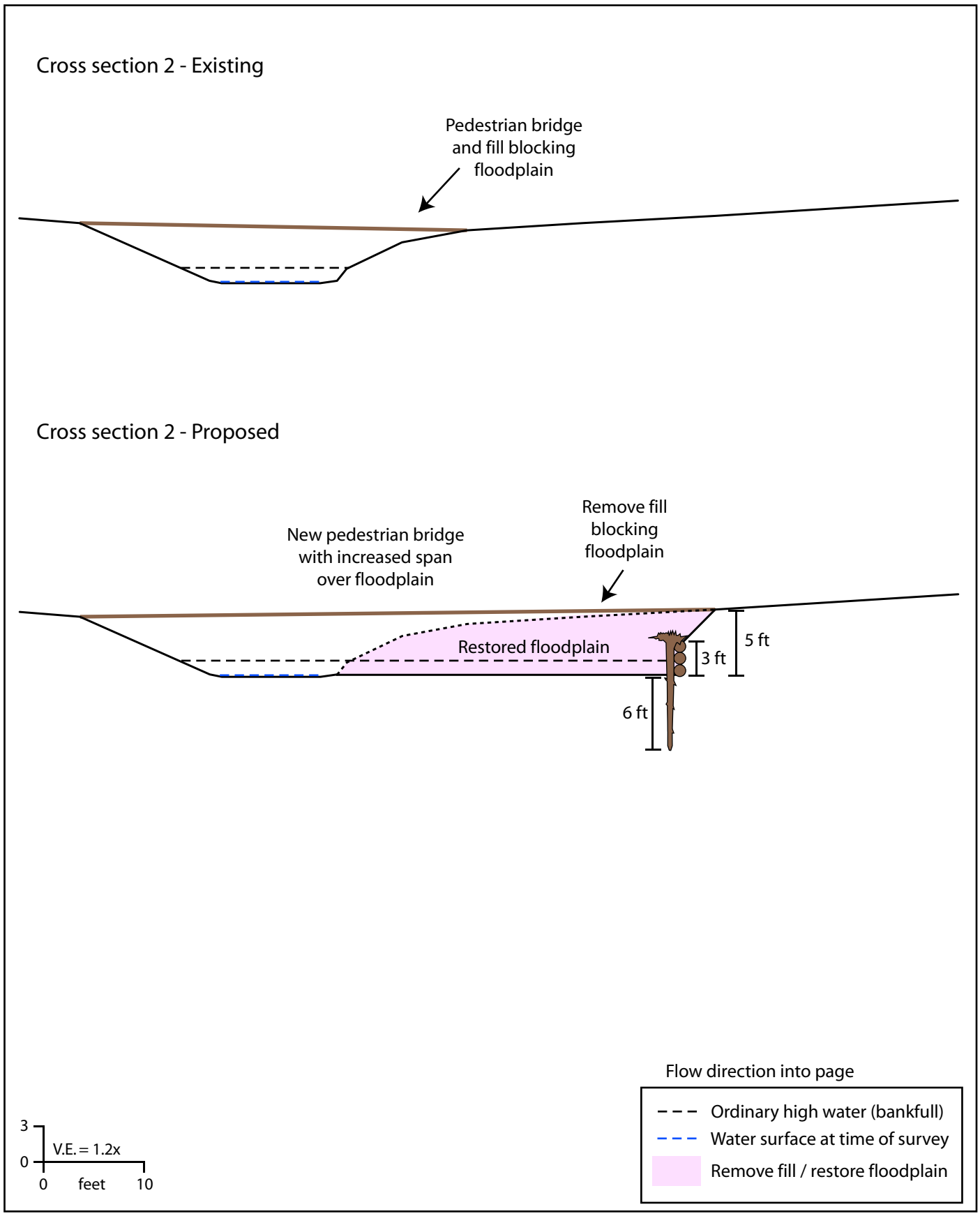


Flow direction into page

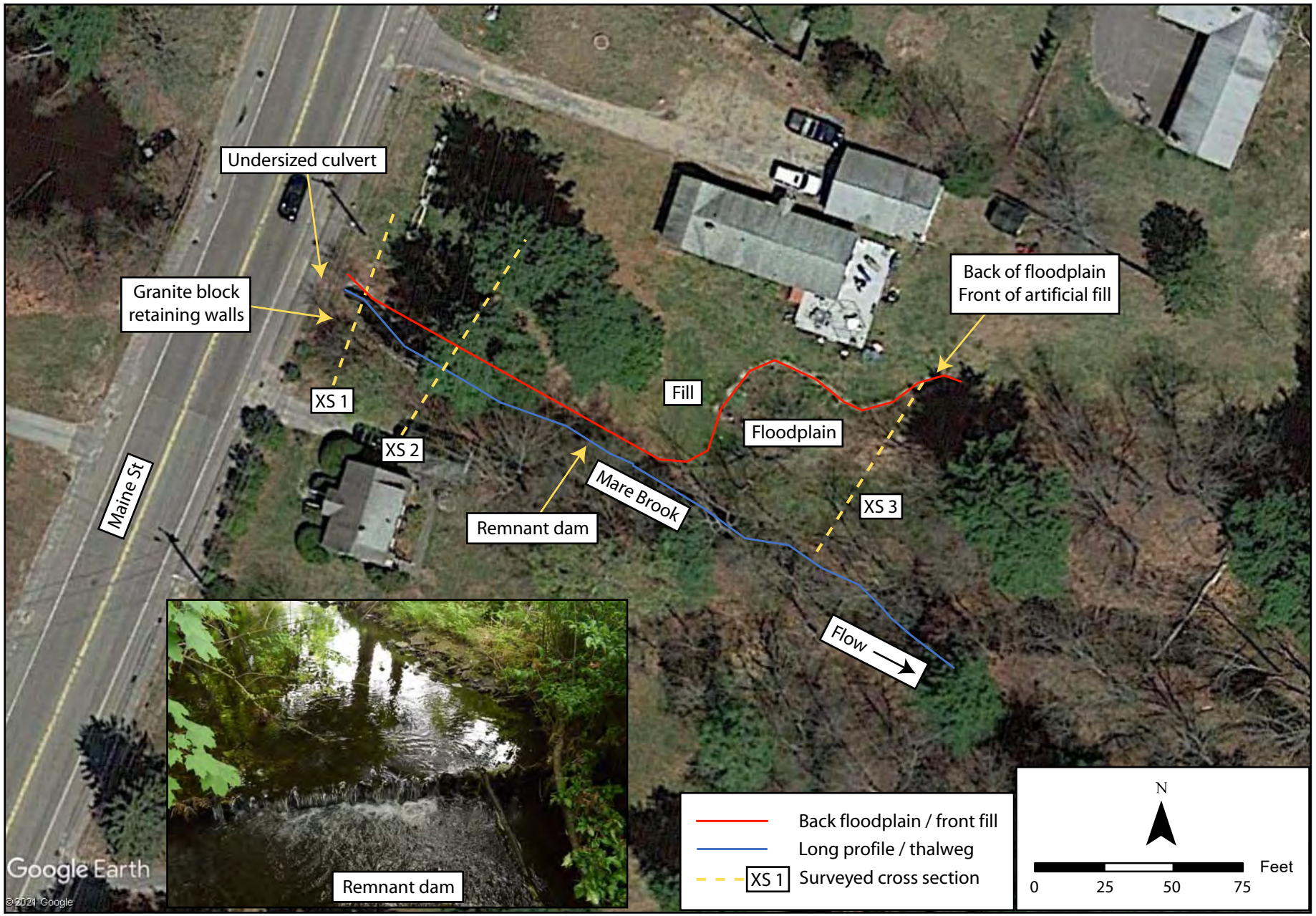
Ordinary high water (bankfull)

Water surface at time of survey

Appendix 2. Site 2 - Reach 5: Cross section 1.

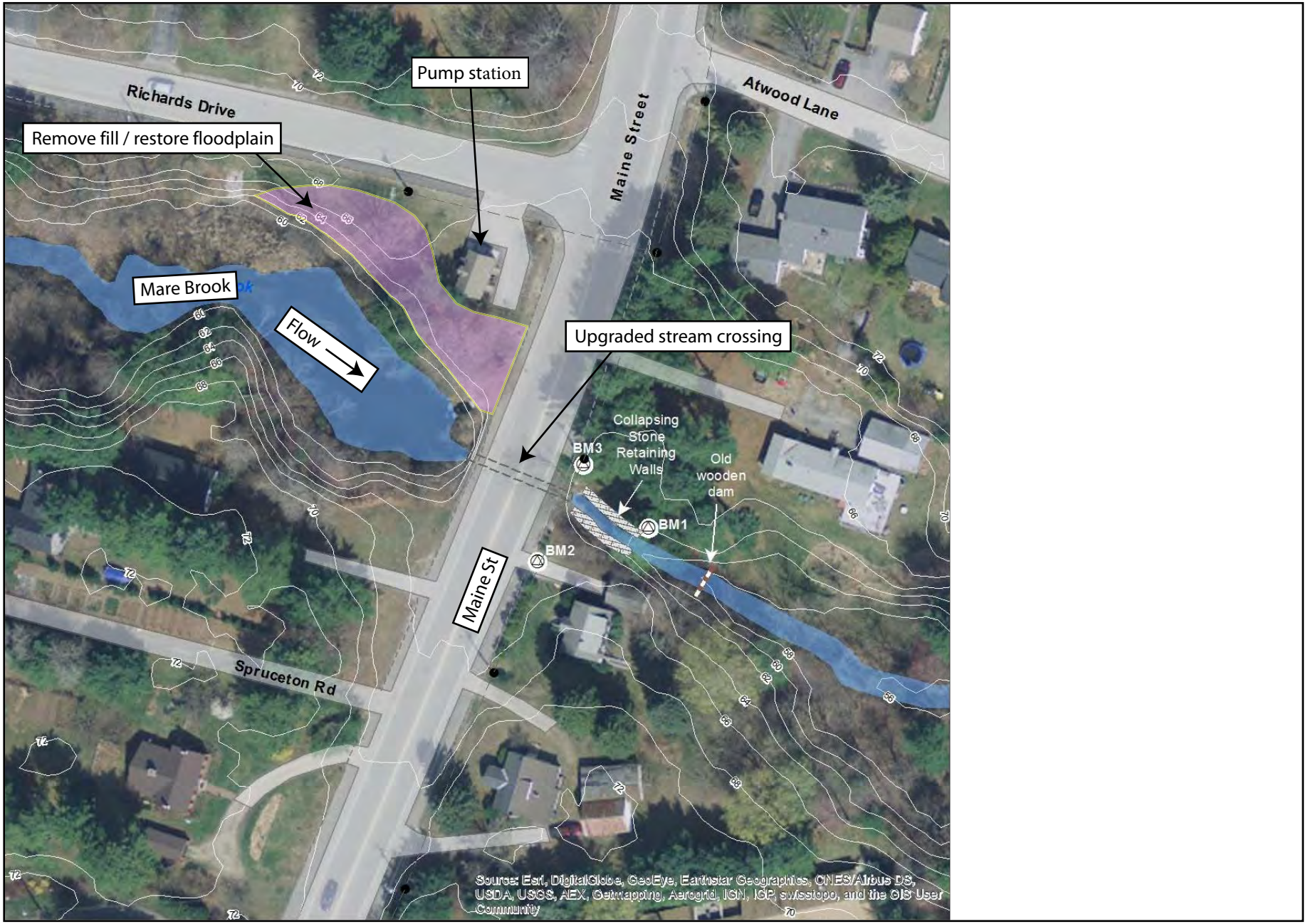


Appendix 2. Site 2 - Reach 5: Cross section 2.



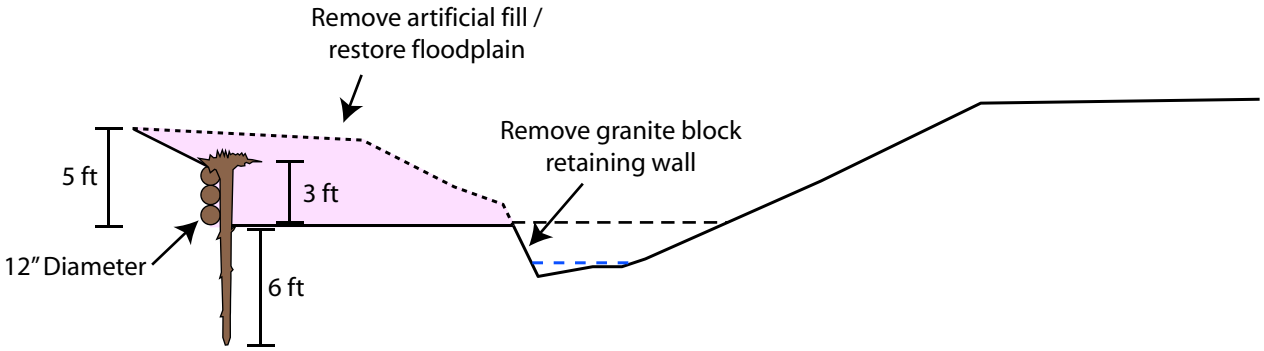
Appendix 2. Site 3 - Reach 9: Existing plan view.

Appendix 2. Site 3 - Reach 9: Proposed plan view - fill removal.

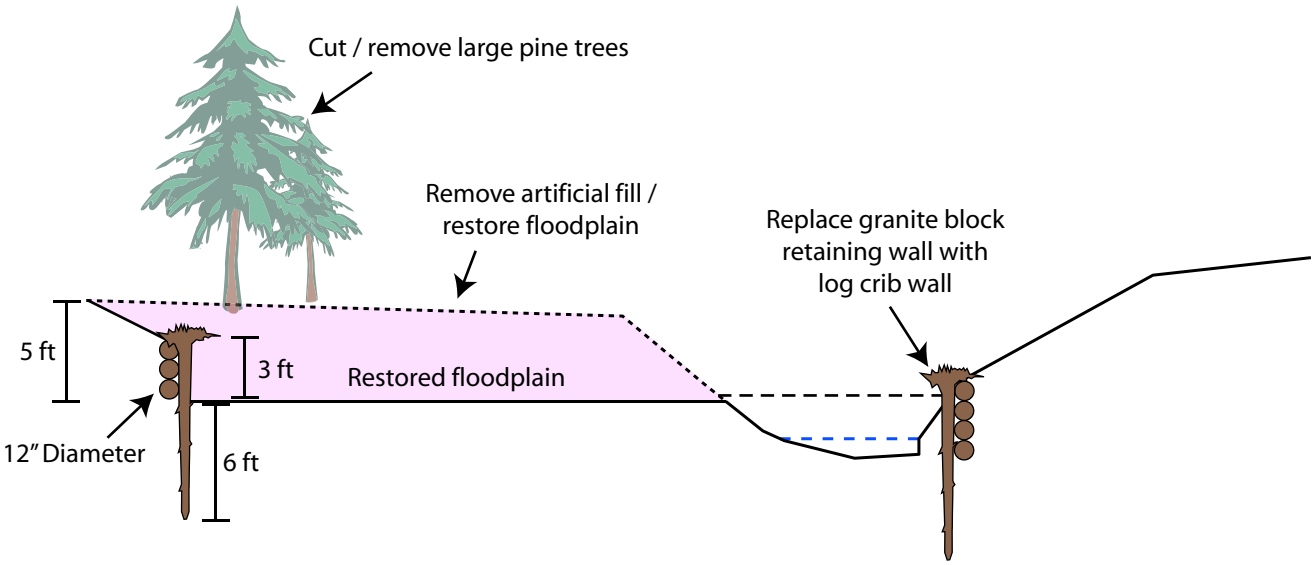


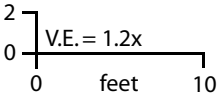
Appendix 2. Site 3 - Reach 9: Proposed plan view - culvert replacement with upstream fill removal. Modified from Abbott (2018).

Cross section 1



Cross section 2



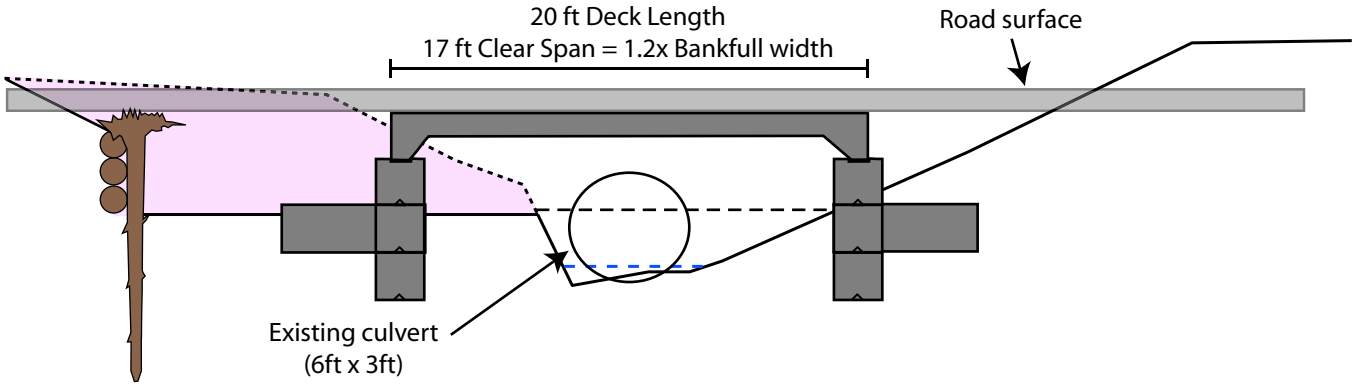


Flow direction into page

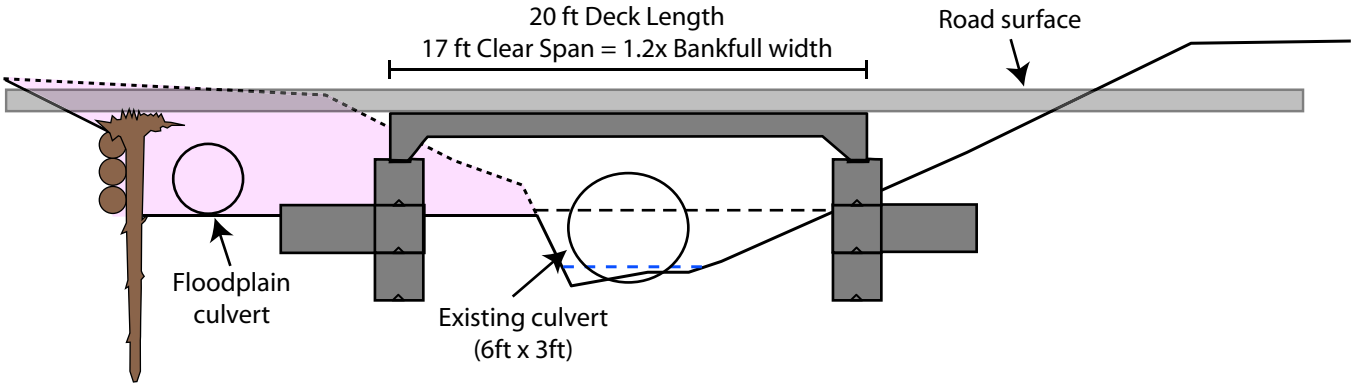
- Ordinary high water (bankfull)
- Water surface at time of survey
- Remove fill / restore floodplain

Appendix 2. Site 3 - Reach 9: Channel cross sections.

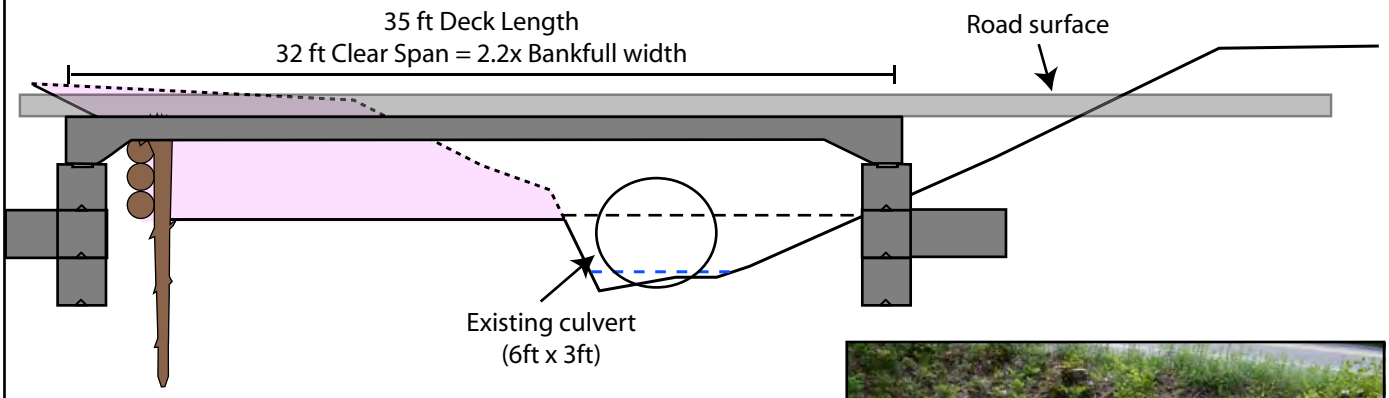
Cross section 1 - USFW recommended replacement option



Cross section 1 - USFW recommended replacement option with floodplain culvert



Cross section 1 - Floodplain-spanning bridge



Flow direction into page

- Ordinary high water (bankfull)
- Water surface at time of survey
- Remove fill / restore floodplain

2
0
V.E. = 1.2x
0 feet 10

Appendix 2. Site 3 - Reach 9: Culvert replacement options.

APPENDIX 3

(Monitoring photographs)

June 2020

Future date

Comparison photograph not yet taken

Appendix 3. Photo 1 – Reach 1: Upstream view of culvert outlet behind Jade Integrated Health on Windorf Circle.

June 2020

Future date

Comparison photograph not yet taken

Appendix 3. Photo 2 – Reach 1: Downstream view from left bank (looking downstream). (Note three trees in foreground to relocate site of photograph.)

June 2020

Future date

Comparison photograph not yet taken

Appendix 3. Photo 3 – Reach 1: Downstream view from left bank of culvert under recreational path.

June 2020

Future date

Comparison photograph not yet taken

Appendix 3. Photo 4 – Reach 1: Upstream view from right bank on recreational path of culvert underneath recreational path.

June 2020

Future date

Comparison photograph not yet taken

Appendix 3. Photo 5 – Reach 1: Downstream view from left bank of culvert inlet under Mathew Drive.

June 2020

Future date

Comparison photograph not yet taken

Appendix 3. Photo 6 – Reach 2: Upstream view from left bank of culvert outlet under Matthew Drive.

June 2020

Future date

Comparison photograph not yet taken

Appendix 3. Photo 7 – Reach 2: Upstream view from left bank of pedestrian bridge.

June 2020

Future date

Comparison photograph not yet taken

Appendix 3. Photo 8 – Reach 4: Upstream view from right bank of culvert outlet under Baribeau Drive.

June 2020

Future date

Comparison photograph not yet taken

Appendix 3. Photo 9 – Reach 5: Downstream view from right bank of pedestrian bridge.

June 2020

Future date

Comparison photograph not yet taken

Appendix 3. Photo 10 – Reach 5: Downstream view from pedestrian bridge.

June 2020

Future date

Comparison photograph not yet taken

Appendix 3. Photo 11 – Reach 7: Downstream view from right bank of erosion at apex of meander near residential home.

June 2020

Future date

Comparison photograph not yet taken

Appendix 3. Photo 12 – Reach 7: Upstream view from MacMillan Drive.

June 2020

Future date

Comparison photograph not yet taken

Appendix 3. Photo 13 – Reach 8: Upstream view from Maine Street.

June 2020

Future date

Comparison photograph not yet taken

Appendix 3. Photo 14 – Reach 9: Downstream view from Maine Street.

June 2020

Future date

Comparison photograph not yet taken

Appendix 3. Photo 15 – Reach 9: Upstream view of granite blocks and Maine Street culvert outlet.

June 2020

Future date

Comparison photograph not yet taken

Appendix 3. Photo 16 – Reach 9: Downstream view from downstream end of granite blocks.

June 2020

Future date

Comparison photograph not yet taken

Appendix 3. Photo 17 – Reach 11: Upstream view from right bank of Coffin Pond Dam.

June 2020

Future date

Comparison photograph not yet taken

Appendix 3. Photo 18 – Reach 13: Downstream view from perimeter road.

June 2020

Future date

Comparison photograph not yet taken

Appendix 3. Photo 19 – Reach 13: Downstream view from enter of channel. (Note overhead pipe crossing stream.)

June 2020

Future date

Comparison photograph not yet taken

Appendix 3. Photo 20 – Reach 15: Upstream view of runway culvert outlet.

June 2020

Future date

Comparison photograph not yet taken

Appendix 3. Photo 21 – Reach 15: Downstream view from right bank of culvert inlet under Eagle Drive.

Appendix B
Culvert and Outfall Inspections on Mare Brook

Summary of Culvert Inspections on Mare Brook

Culvert #	Location	Length (ft) / Size (in)	Material/Shape	Condition	Recommendation	Requirements	Estimated Cost†	Ground photo
1	Thornton Oaks Trail Network	Twin 78' / 30"	Reinforced Concrete Pipe / Round	Pipe condition = good Inlet condition = poor, restrictive to flow Outlet condition = good	1) Remove culverts, restore channel 2) Replace with footbridge	1) Local permitting 2) Private landowner coordination	Low with landowner labor $4 - 5K	
2	Thornton Oaks Trail Network	6' / 36"	Corrugated Metal Pipe Round	Pipe condition = poor, undersized rusted Inlet condition = poor, restrictive to flow Outlet condition = poor, deflected	1) Remove culverts, restore channel 2) Replace with footbridge	1) Local permitting 2) Private landowner coordination	Low with landowner labor $4 - 5K	
3	Thornton Oaks, Mathews Drive	Twin 35' / 48"	Reinforced Concrete Pipe / Round	Pipe condition = good Inlet condition = good, slightly undersized Outlet condition = good, minimal scour	None	Not applicable	None at this time	
4	Baribeau Drive Crossing Flood Control	72' / 30"	Corrugated Metal Pipe Round	Pipe condition = good Inlet condition = fair Outlet condition = poor, obstructions present	1) Remove culvert along with Culvert 5, 2) Restore channel, 3) Replace with open bottom culvert	1) Federal, State permitting, 2) Hydrologic and Hydraulic (H&H) Model needed	High $175 - 200K	

Summary of Culvert Inspections on Mare Brook

Culvert #	Location	Length (ft) / Size (in)	Material/Shape	Condition	Recommendation	Requirements	Estimated Cost†	Ground photo
5	Baribeau Drive Crossing Main Pipe	Twin 47' / 30"	Reinforced Concrete Pipe Round	Pipe condition = good,undersized with ponding Inlet condition = fair, restrictive to flow Outlet condition = good, some incision	1) Remove culverts along with Culvert 4, 2) Restore channel, 3) Replace with open bottom culvert	1) Federal, State permitting, 2) Hydrologic and Hydraulic (H&H) Model needed	High $175 - 200K	
6	Baribeau Drive Southern Tributary Crossing	Two 35' / 18"	Reinforced Concrete Pipe / Round	Pipe condition = good Inlet condition = fair, some obstructions Outlet condition = poor, onstructed flow	1) Remove vegetation at inlet & outlet 2) Add riprap armor as needed	1) None	Low with Town labor $1,000 - 1,500K	
7	Mid Coast Regional Health Property - Southern Trubutary	69' / 24"	Corrugated Metal Pipe / Round	Pipe condition = poor, deflected Inlet condition = fair, concrete wingwall Outlet condition = fair, riprap apron	None	Not Applicable	Not Applicable	
8	Mid Coast Senior Health Grounds	66' / 15"	Reinforced Concrete Pipe / Round	Pipe condition = good Inlet condition = armored, limited flow Outlet condition = armored	none	Not Applicable	Not Applicable	

Summary of Culvert Inspections on Mare Brook

Culvert #	Location	Length (ft) / Size (in)	Material/Shape	Condition	Recommendation	Requirements	Estimated Cost†	Ground photo
9	Western Thornton Oaks Property - Southern Tributary	21' / 18"	Plastic at one end and PE N-12 Pipe at other end Round	Pipe condition = fair Inlet condition = poor, vegetation blocking flow Outlet condition = poor, vegetation blocking flow	1) Upgrade inlet/outlet 2) Replace culvert	1) Local/Private landowner coordination	Low with landowner /Town labor $2,000 - 2,500K	
10	Barrows Street Crossing	Twin 31' / 24" & 48"	Corrugated Metal Pipes / Round	Pipe condition = poor, rusted bottoms Inlet condition = poor, restrictive to flow Outlet condition = poor with scouring	1) Remove undersized culverts, restore channel 2) Replace with larger opening	1) Federal, State permitting, 2) Hydrologic and Hydraulic (H&H) Model needed	Moderate with Town labor $65 - 80K	
13	Colonial Drive Tributary Crossing	35' / 60"	PE N-12 Pipe / Round	Pipe condition = good Inlet condition = good, riprap apron Outlet condition = good, riprap w/slight erosion	1) Add riprap at outlet	1) Town labor	Low with Town labor $500	
14	MacMillan Drive Crossing	Twin 31' / 24" & 48""	Corrugated Metal Pipe Round	Pipe condition = poor, undersized rusted Inlet condition = fair, restrictive to flow Outlet condition = fair	1) Remove culverts, restore channel 2) Replace with open bottom culvert	1) Federal, State permitting, 2) Hydrologic and Hydraulic (H&H) Model needed	Moderate with Town labor $75 - 100K	

Summary of Culvert Inspections on Mare Brook

Culvert #	Location	Length (ft) / Size (in)	Material/Shape	Condition	Recommendation	Requirements	Estimated Cost†	Ground photo
15	Richards Drive Tributary Crossing	31' / 36"	Corrugated Metal Pipe Round	Pipe condition = poor, undersized rusted Inlet condition = poor, restrictive to flow Outlet condition = poor, obstructed	1) Remove culverts, restore channel 2) Upsize culvert	1) Local permitting 2) Town labor	Moderate with Town labor $25 - 35K	
16	Maine Street Crossing	27' / 84"	Corrugated Metal Pipe / Eliptical	Pipe condition = fair, undersized Inlet condition = fair, restrictive to flow Outlet condition = fair, failing cribstone	1) Remove culverts, restore channel 2) Replace with open bottom culvert	1) Federal, State permitting, 2) Hydrologic and Hydraulic (H&H) Model needed	High $200 - 225K	
17	Meadowbrook Road Crossing	40' / 48"	Corrugated Metal Pipe Round	Pipe condition = fair, undersized Inlet condition = poor, restrictive to flow with ponding Outlet condition = fair, deflected	1) Remove culvert, restore channel 2) Upsize culvert	1) Federal, State permitting, 2) Hydrologic and Hydraulic (H&H) Model needed	High $100 - 125K	
18	Sparwell Lane Tributary Crossing	29' / 30"	Corrugated Metal Pipe Round	Pipe condition = poor, undersized rusted Inlet condition = poor, restrictive to flow Outlet condition = poor, heavy sediment	1) Upsize culvert 2) Rebuild road	1) Federal, State permitting, 2) Hydrologic and Hydraulic (H&H) Model needed	High $100 - 125K	

Summary of Culvert Inspections on Mare Brook

Culvert #	Location	Length (ft) / Size (in)	Material/Shape	Condition	Recommendation	Requirements	Estimated Cost†	Ground photo
19	Shulman Park Entrance Tributary Crossing	20' / 24"	PE N-12 Pipe / Round	Pipe condition = good, new install Inlet condition = good Outlet condition = good	None	Not applicable	None at this time	
20	Alder Dive Tributary Crossing	24' / 36"	Corrugated Metal Pipe Round	Pipe condition = good Inlet condition = good, no flow restriction Outlet condition = good	None	Not applicable	None at this time	
21	Parkview Hospital Circle - Tributary	33' / 24"	PE N-12 Pipe Round	Pipe condition = good Inlet condition = good, some damage Outlet condition = good	None	Not applicable	None at this time	
22	Parkview Hospital Circle 2 - Tributary	19' / 24"	Reinforced Concrete Pipe Round	Pipe condition = good Inlet condition = good Outlet condition = good, outlet control structure for pond	None	Not applicable	None at this time	

Summary of Culvert Inspections on Mare Brook

Culvert #	Location	Length (ft) / Size (in)	Material/Shape	Condition	Recommendation	Requirements	Estimated Cost†	Ground photo
23	Harpswell Road Crossing	32' / 60"	Corrugated Metal Pipe Round	Pipe condition = poor, undersized rusted Inlet condition = poor, restrictive to flow Outlet condition = poor, scoured	1) Remove culvert, restore channel 2) Replace with open bottom culvert	1) Federal, State permitting, 2) Hydrologic and Hydraulic (H&H) Model needed	High $200 - 225K	
24	Merriconeag Road Crossing	24' / 72"x36"	Concrete Box Culvert Rectangular	Pipe condition = good, drainage fair Inlet condition = good, no restriction Outlet condition = fair, perched outlet	1) Add riprap at outlet	1) Town labor	Low with Town labor $500	
25	Merriconeag Road Crossing (2)	10' / multiple pipes	PE N-12 Pipe Round	Pipe condition = good, undersized Inlet condition = poor, restrictive to flow Outlet condition = poor, blockage	1) Remove culverts, restore channel 2) Upsize culvert	1) Town labor	Low with Town labor $10 - 12K	
27	Puritan Road Tributary Crossing	23' / 24"	Corrugated Metal Pipe Round	Pipe condition = good Inlet condition = fair, vegetation removal Outlet condition = good	None	Not applicable	None at this time	

Summary of Culvert Inspections on Mare Brook

Culvert #	Location	Length (ft) / Size (in)	Material/Shape	Condition	Recommendation	Requirements	Estimated Cost†	Ground photo
28	Puritan Road Tributary Crossing (2)	23' / 36"	PE N-12 Pipe Round	Pipe condition = fair Inlet condition = fair, some pipe damage Outlet condition = good	None	Not applicable	None at this time	
29	Eagle Drive Crossing	96"	CMP Round	Pipe condition = fair Inlet condition = fair, some obstruction Outlet condition = hanging	Remove vegetation at trash racks	Routine maintenance	Low - $500	

:ion = 11/18-20/2020

noderate ($10,000-$100,000), high ($>100,000)

Note:

Culvert Inspection Form

Date Mapped:	November 18, 2020 11:08 AM	**Culvert No:**	cul01
Name and Location of Road Crossing:	Thornton Oaks Trail Network		
Stream Name:	Mare Brook	**Tributary To:**	
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Beginning of Mare Brook. Part of a series of culverts behind Thornton Oaks interwoven with a trail network. Connects to a retention pond via trapezoidal channel.		
Pipe Condition:	Good	**Drainage Condition:**	Poor

Description of Existing Culvert

Shape:	Round		
Material:	Reinforced Concrete Pipe		
Size:	30”	**Approximate Length:**	78’
Does roadway have a history of flooding?	No		
Bed material within culvert:	concrete		
Tidal Influence?	No		
Additional Observations:	Two Pipes, Bend		
Is the culvert hanging?			No
Is there evidence of high water above the top of the culvert?			No
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, No – Corrosion, No – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			No
Is the culvert shape deflected?			No
Is water seeping along the outside of the culvert (piping)?			No
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron
Inlet Condition? Poor	**Inlet Obstruction?** Yes
Vegetation removal needed?	Yes

Culvert Outlet	
Outlet Type:	Riprap Apron
Outlet Condition? Good	**Outlet Obstruction?** No
Vegetation removal needed?	No
Additional Notes:	45-degree bend in pipe

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul01 Inlet Pipe

cul01 Inlet Stream

cul01 Outlet Pipe

cul01 Outlet Stream

Culvert Inspection Form

Date Mapped:	November 18, 2020 11:16 AM	**Culvert No:**	cul02
Name and Location of Road Crossing:	Thornton Oaks Trail Network		
Stream Name:	Mare Brook	**Tributary To:**	
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Part of the trail network behind Thornton Oaks. Heavily walked area. Past concerns of erosion.		
Pipe Condition:	Poor	**Drainage Condition:**	Poor

Description of Existing Culvert

Shape:	Round		
Material:	Corrugated Metal Pipe		
Size:	36”	**Approximate Length:**	6’
Does roadway have a history of flooding?	No		
Bed material within culvert:	pipe/earth		
Tidal Influence?	No		
Additional Observations:	deflected pipe, erosion around edges		
Is the culvert hanging?			No
Is there evidence of high water above the top of the culvert?			No
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, Yes – Corrosion, Yes – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			Yes
Is the culvert shape deflected?			Yes
Is water seeping along the outside of the culvert (piping)?			Yes
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron/Embankment
Inlet Condition? Poor	**Inlet Obstruction?** No
Vegetation removal needed?	No

Culvert Outlet	
Outlet Type:	Riprap Apron/Embankment
Outlet Condition? Poor	**Outlet Obstruction?** No
Vegetation removal needed?	No
Additional Notes:	undersized, erosion present, should be replaced with bridge

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul02 Inlet Pipe 	cul02 Inlet Stream 
cul02 Outlet Pipe 	cul02 Outlet Stream 

Culvert Inspection Form

Date Mapped:	November 18, 2020 11:26 AM	**Culvert No:**	cul03
Name and Location of Road Crossing:	Thornton Oaks, Matthews Drive		
Stream Name:	Mare Brook	**Tributary To:**	
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Identical dual pipe culvert under Matthew Drive. No past concerns.		
Pipe Condition:	Good	**Drainage Condition:**	Good

Description of Existing Culvert

Shape:	Round		
Material:	Reinforced Concrete Pipe		
Size:	48”	**Approximate Length:**	35’
Does roadway have a history of flooding?	No		
Bed material within culvert:	concrete		
Tidal Influence?	No		
Additional Observations:	Undersized, Dual Pipes		
Is the culvert hanging?			No
Is there evidence of high water above the top of the culvert?			No
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, No – Corrosion, No – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			Yes
Is the culvert shape deflected?			No
Is water seeping along the outside of the culvert (piping)?			No
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron/Embankment
Inlet Condition? Good	**Inlet Obstruction?** No
Vegetation removal needed?	No

Culvert Outlet	
Outlet Type:	Riprap Apron/Embankment
Outlet Condition? Good	**Outlet Obstruction?** No
Vegetation removal needed?	No
Additional Notes:	

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul03 Inlet Pipe

cul03 Inlet Stream

cul03 Outlet Pipe

cul03 Outlet Stream

Culvert Inspection Form

Date Mapped:	November 18, 2020 11:56 AM	**Culvert No:**	cul04
Name and Location of Road Crossing:	Baribeau Drive		
Stream Name:	Mare Brook	**Tributary To:**	
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Culvert underneath Baribeau Drive. Moderately traveled road. Bend exists somewhere along pipe. Condition inside is unknown. Ponding at inlet. No other past concerns.		
Pipe Condition:	Fair	**Drainage Condition:**	Good

Description of Existing Culvert

Shape:	Round		
Material:	Corrugated Metal Pipe		
Size:	30”	**Approximate Length:**	71’
Does roadway have a history of flooding?	No		
Bed material within culvert:	eroded		
Tidal Influence?	No		
Additional Observations:	Undersized, Bend in Pipe		
Is the culvert hanging?			No
Is there evidence of high water above the top of the culvert?			No
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, Yes – Corrosion, No – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			No
Is the culvert shape deflected?			No
Is water seeping along the outside of the culvert (piping)?			No
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron/Embankment
Inlet Condition? Good	**Inlet Obstruction?** No
Vegetation removal needed?	Yes

Culvert Outlet	
Outlet Type:	Riprap Apron/Embankment
Outlet Condition? Fair	**Outlet Obstruction?** No
Vegetation removal needed?	Yes
Additional Notes:	60-degree bend in pipe

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul04 Inlet Pipe

cul04 Inlet Stream

cul04 Outlet Pipe

cul04 Outlet Stream

Culvert Inspection Form

Date Mapped:	November 18, 2020 11:51 AM	**Culvert No:**	cul05
Name and Location of Road Crossing:	Baribeau Drive		
Stream Name:	Mare Brook	**Tributary To:**	
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Identical dual culverts under Baribeau Drive. Moderately traveled road. Ponding at inlet of culverts. No other past concerns.		
Pipe Condition:	Good	**Drainage Condition:**	Good

Description of Existing Culvert

Shape:	Round		
Material:	Reinforced Concrete Pipe		
Size:	30”	**Approximate Length:**	47’
Does roadway have a history of flooding?	No		
Bed material within culvert:	concrete/rocks		
Tidal Influence?	No		
Additional Observations:	Dual Pipes, Undersized		
Is the culvert hanging?			No
Is there evidence of high water above the top of the culvert?			No
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, No – Corrosion, No – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			Yes
Is the culvert shape deflected?			Yes
Is water seeping along the outside of the culvert (piping)?			No
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron/Embankment
Inlet Condition? Fair	**Inlet Obstruction?** Yes
Vegetation removal needed?	Yes

Culvert Outlet	
Outlet Type:	Riprap Apron/Embankment
Outlet Condition? Good	**Outlet Obstruction?** No
Vegetation removal needed?	Yes
Additional Notes:	slight deflection, two pipes

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul05 Inlet Pipe

cul05 Inlet Stream

cul05 Outlet Pipe

cul05 Outlet Stream

Culvert Inspection Form

Date Mapped:	November 18, 2020 12:11 PM	**Culvert No:**	cul06
Name and Location of Road Crossing:	Baribeau Drive		
Stream Name:	Mare Brook	**Tributary To:**	
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Identical dual culverts under Baribeau Drive next to the entrance of Thornton Oaks. Partially Paved channels at inlet to help facilitate water flow from driveway entrance		
Pipe Condition:	Good	**Drainage Condition:**	Fair

Description of Existing Culvert

Shape:	Round		
Material:	Reinforced Concrete		
Size:	18”	**Approximate Length:**	35’
Does roadway have a history of flooding?	No		
Bed material within culvert:	concrete		
Tidal Influence?	No		
Additional Observations:	Dual Pipe		
Is the culvert hanging?			No
Is there evidence of high water above the top of the culvert?			No
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, No – Corrosion, No – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			Yes
Is the culvert shape deflected?			No
Is water seeping along the outside of the culvert (piping)?			No
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron/Embankment
Inlet Condition? Fair	**Inlet Obstruction?** Yes
Vegetation removal needed?	Yes

Culvert Outlet	
Outlet Type:	Riprap Apron/Embankment
Outlet Condition? Poor	**Outlet Obstruction?** Yes
Vegetation removal needed?	Yes
Additional Notes:	two pipes, obstructions present

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul06 Inlet Pipe 	cul06 Inlet Stream 
cul06 Outlet Pipe 	cul06 Outlet Stream 

Culvert Inspection Form

Date Mapped:	November 18, 2020 12:23 PM	**Culvert No:**	cul07
Name and Location of Road Crossing:	Midcoast Regional Health		
Stream Name:	Mare Brook	**Tributary To:**	
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Old culvert located within the grounds of Midcoast Regional Health. Inside condition is unknown. Major obstruction to stream flow. No water flow.		
Pipe Condition:	Poor	**Drainage Condition:**	Fair

Description of Existing Culvert

Shape:	Round		
Material:	Corrugated Metal Pipe		
Size:	24”	**Approximate Length:**	69’
Does roadway have a history of flooding?	No		
Bed material within culvert:	rocks		
Tidal Influence?	No		
Additional Observations:	Old Pipe, Under Building, Deflected		
Is the culvert hanging?			No
Is there evidence of high water above the top of the culvert?			No
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, Yes – Corrosion, No – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			Yes
Is the culvert shape deflected?			No
Is water seeping along the outside of the culvert (piping)?			No
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Concrete Wingwall
Inlet Condition? Fair	**Inlet Obstruction?** No
Vegetation removal needed?	No

Culvert Outlet	
Outlet Type:	Riprap Apron/Embankment
Outlet Condition? Fair	**Outlet Obstruction?** No
Vegetation removal needed?	Yes
Additional Notes:	

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul07 Inlet Pipe 	cul07 Inlet Stream 
cul07 Outlet Pipe 	cul07 Outlet Stream 

Culvert Inspection Form

Date Mapped:	November 18, 2020 12:31 PM	**Culvert No:**	cul08
Name and Location of Road Crossing:	Mid Coast Senior Health		
Stream Name:	Mare Brook	**Tributary To:**	
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Culvert located within the grounds of Midcoast Regional Health. No water flow.		
Pipe Condition:	Good	**Drainage Condition:**	Good

Description of Existing Culvert

Shape:	Round		
Material:	Reinforced Concrete Pipe		
Size:	15”	**Approximate Length:**	66’
Does roadway have a history of flooding?	No		
Bed material within culvert:	concrete		
Tidal Influence?	No		
Additional Observations:			
Is the culvert hanging?			Yes
Is there evidence of high water above the top of the culvert?			No
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, No – Corrosion, No – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			Yes
Is the culvert shape deflected?			No
Is water seeping along the outside of the culvert (piping)?			No
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron/Embankment
Inlet Condition? Good	**Inlet Obstruction?** No
Vegetation removal needed?	Yes

Culvert Outlet	
Outlet Type:	Riprap Apron/Embankment
Outlet Condition? Good	**Outlet Obstruction?** No
Vegetation removal needed?	Yes
Additional Notes:	

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul08 Inlet Pipe 	cul08 Inlet Stream 
cul08 Outlet Pipe 	cul08 Outlet Stream 

Culvert Inspection Form

Date Mapped:	November 18, 2020 12:44 PM	**Culvert No:**	cul09
Name and Location of Road Crossing:	Midcoast Regional Health		
Stream Name:	Mare Brook	**Tributary To:**	
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Old culvert located within the grounds of Midcoast Regional Health. Two different pipe materials connected together. Inside condition is unknown. Major obstruction to stream flow. No water flow.		
Pipe Condition:	Good	**Drainage Condition:**	Poor

Description of Existing Culvert

Shape:	Round		
Material:	HDPE		
Size:	15”	**Approximate Length:**	21’
Does roadway have a history of flooding?	No		
Bed material within culvert:	Unknown		
Tidal Influence?	No		
Additional Observations:	No Outlet, Different Material, Unknown		
Is the culvert hanging?			No
Is there evidence of high water above the top of the culvert?			No
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, No – Corrosion, No – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? Yes	**Condition of extension:** Fair		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			No
Is the culvert shape deflected?			
Is water seeping along the outside of the culvert (piping)?			No
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron
Inlet Condition? Poor	**Inlet Obstruction?** No
Vegetation removal needed?	Yes

Culvert Outlet	
Outlet Type:	Riprap Apron
Outlet Condition? Poor	**Outlet Obstruction?** No
Vegetation removal needed?	Yes
Additional Notes:	two differnt pipes connected together

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul09 Inlet Pipe 	cul09 Inlet Stream 
cul09 Outlet Pipe 	cul09 Outlet Stream 

Culvert Inspection Form

Date Mapped:	November 20, 2020 10:25 AM	**Culvert No:**	cul10
Name and Location of Road Crossing:	Barrows Street		
Stream Name:	Mare Brook	**Tributary To:**	
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Two different culvert sizes underneath Barrows Drive. Some ponding at inlet. No other past concerns.		
Pipe Condition:	Poor	**Drainage Condition:**	Fair

Description of Existing Culvert

Shape:	Round		
Material:	Corrugated Metal Pipe		
Size:	48” & 24”	**Approximate Length:**	31’
Does roadway have a history of flooding?	No		
Bed material within culvert:	eaeth and rock		
Tidal Influence?	No		
Additional Observations:	Two Pipes, One 24” and One 48”, Same Condition, Eroded Bottom		
Is the culvert hanging?			No
Is there evidence of high water above the top of the culvert?			Yes
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, Yes – Corrosion, Yes – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			Yes
Is the culvert shape deflected?			Yes
Is water seeping along the outside of the culvert (piping)?			Yes
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron/Embankment
Inlet Condition? Poor	**Inlet Obstruction?** Yes
Vegetation removal needed?	No

Culvert Outlet	
Outlet Type:	Riprap Apron/Embankment
Outlet Condition? Poor	**Outlet Obstruction?** No
Vegetation removal needed?	Yes
Additional Notes:	pipes need to be replaced, undersized, eroded.

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul10 Inlet Pipe

cul10 Inlet Stream

cul10 Outlet Pipe

cul10 Outlet Stream

Culvert Inspection Form

Date Mapped:	November 20, 2020 11:00 AM	**Culvert No:**	cul13
Name and Location of Road Crossing:	Colonial Drive		
Stream Name:	Unknown	**Tributary To:**	Mare Brook
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	New culvert installation at Colonial Drive. Past concerns of flooding fixed with new culvert.		
Pipe Condition:	Good	**Drainage Condition:**	Good

Description of Existing Culvert

Shape:	Round		
Material:	HDPE		
Size:	60”	**Approximate Length:**	35’
Does roadway have a history of flooding?	Yes		
Bed material within culvert:	sandy, organic		
Tidal Influence?	No		
Additional Observations:	Newer Culvert Installation		
Is the culvert hanging?			No
Is there evidence of high water above the top of the culvert?			No
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, No – Corrosion, No – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			Yes
Is the culvert shape deflected?			No
Is water seeping along the outside of the culvert (piping)?			No
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron/Embankment
Inlet Condition? Good	**Inlet Obstruction?** No
Vegetation removal needed?	No

Culvert Outlet	
Outlet Type:	Riprap Apron/Embankment
Outlet Condition? Good	**Outlet Obstruction?** No
Vegetation removal needed?	No
Additional Notes:	some erosion at riprap

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul13 Inlet Pipe 	cul13 Inlet Stream 
cul13 Outlet Pipe 	cul13 Outlet Stream 

Culvert Inspection Form

Date Mapped:	November 20, 2020 11:15 AM	**Culvert No:**	cul14
Name and Location of Road Crossing:	Macmillan Drive		
Stream Name:	Mare Brook	**Tributary To:**	
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Two culverts of different sizes at Macmillan Drive. Metal culvert shoots used to facilitate drainage from the road installed at both inlet and outlet. No other past concerns.		
Pipe Condition:	Poor	**Drainage Condition:**	Good

Description of Existing Culvert

Shape:	Round		
Material:	Corrugated Metal Pipe		
Size:	48” & 24”	**Approximate Length:**	31’
Does roadway have a history of flooding?	No		
Bed material within culvert:	eaeth and rock		
Tidal Influence?	No		
Additional Observations:	Two Pipes, One 24” and One 48”, Same Condition, Eroded Bottom, In Need of Repairs		
Is the culvert hanging?			No
Is there evidence of high water above the top of the culvert?			Yes
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, Yes – Corrosion, Yes – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			Yes
Is the culvert shape deflected?			Yes
Is water seeping along the outside of the culvert (piping)?			Yes
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron/Embankment
Inlet Condition? Good	**Inlet Obstruction?** Yes
Vegetation removal needed?	No

Culvert Outlet	
Outlet Type:	Riprap Apron/Embankment
Outlet Condition? Good	**Outlet Obstruction?** Yes
Vegetation removal needed?	No
Additional Notes:	bottom eroded, undersized, replace

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul14 Inlet Pipe 	cul14 Inlet Stream 
cul14 Outlet Pipe 	cul14 Outlet Stream 

Culvert Inspection Form

Date Mapped:	November 20, 2020 11:26 AM	**Culvert No:**	cul15
Name and Location of Road Crossing:	Richards Drive		
Stream Name:	Unknown	**Tributary To:**	Mare Brook
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Tributary stream to Mare Brook. Old culvert under Richards Drive restricts flow. No other past concerns		
Pipe Condition:	Poor	**Drainage Condition:**	Poor

Description of Existing Culvert

Shape:	Round		
Material:	Corrugated Metal Pipe		
Size:	36”	**Approximate Length:**	31’
Does roadway have a history of flooding?	No		
Bed material within culvert:	eroded		
Tidal Influence?	No		
Additional Observations:	Culvert Extension? Failed Pipe, Replace		
Is the culvert hanging?			No
Is there evidence of high water above the top of the culvert?			Yes
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, Yes – Corrosion, Yes – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? Yes	**Condition of extension:** Poor		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			No
Is the culvert shape deflected?			Yes
Is water seeping along the outside of the culvert (piping)?			Yes
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron/Embankment
Inlet Condition? Poor	**Inlet Obstruction?** Yes
Vegetation removal needed?	Yes

Culvert Outlet	
Outlet Type:	Riprap Apron/Embankment
Outlet Condition? Poor	**Outlet Obstruction?** Yes
Vegetation removal needed?	Yes
Additional Notes:	failed culvert, might be extended

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul15 Inlet Pipe 	cul15 Inlet Stream 
cul15 Outlet Pipe 	cul15 Outlet Stream 

Culvert Inspection Form

Date Mapped:	November 20, 2020 11:39 AM	**Culvert No:**	cul16
Name and Location of Road Crossing:	Maine Street		
Stream Name:	Mare Brook	**Tributary To:**	
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Large culvert under heavily travelled street. Ponding at inlet. Old crib stone retaining wall deteriorating. Some past concerns of flooding.		
Pipe Condition:	Fair	**Drainage Condition:**	Fair

Description of Existing Culvert

Shape:	Elliptical		
Material:	Corrugated Metal Pipe		
Size:	84” long by 42” high	**Approximate Length:**	27’
Does roadway have a history of flooding?	Yes		
Bed material within culvert:	metal, slight erosion		
Tidal Influence?	No		
Additional Observations:	Some Erosion Present Around Culvert		
Is the culvert hanging?			No
Is there evidence of high water above the top of the culvert?			Yes
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, Yes – Corrosion, Yes – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			Yes
Is the culvert shape deflected?			Yes
Is water seeping along the outside of the culvert (piping)?			Yes
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron/Embankment
Inlet Condition? Fair	**Inlet Obstruction?** Yes
Vegetation removal needed?	Yes

Culvert Outlet	
Outlet Type:	Riprap Apron/Embankment
Outlet Condition? Fair	**Outlet Obstruction?** No
Vegetation removal needed?	Yes
Additional Notes:	cribstone embankment at outlet

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul16 Inlet Pipe 	cul16 Inlet Stream 
cul16 Outlet Pipe 	cul16 Outlet Stream 

Culvert Inspection Form

Date Mapped:	November 20, 2020 11:55 AM	**Culvert No:**	cul17
Name and Location of Road Crossing:	Meadowbrook Road		
Stream Name:	Mare Brook	**Tributary To:**	
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Culvert underneath Meadowbrook Road. Steep embankments. Residential neighborhood with minimal vehicle traffic. A few outfalls present. No other past concerns.		
Pipe Condition:	Good	**Drainage Condition:**	Good

Description of Existing Culvert

Shape:	Round		
Material:	Corrugated Metal Pipe		
Size:	48”	**Approximate Length:**	40’
Does roadway have a history of flooding?	No		
Bed material within culvert:	metal		
Tidal Influence?	No		
Additional Observations:	Undersized, Erosion Around Embankment		
Is the culvert hanging?			No
Is there evidence of high water above the top of the culvert?			Yes
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, No – Corrosion, No – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			Yes
Is the culvert shape deflected?			Yes
Is water seeping along the outside of the culvert (piping)?			Yes
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron/Embankment
Inlet Condition? Fair	**Inlet Obstruction?** No
Vegetation removal needed?	Yes

Culvert Outlet	
Outlet Type:	Riprap Apron/Embankment
Outlet Condition? Good	**Outlet Obstruction?** No
Vegetation removal needed?	No
Additional Notes:	deflecting culvert, in good shape, erosion around soil

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul17 Inlet Pipe 	cul17 Inlet Stream 
cul17 Outlet Pipe 	cul17 Outlet Stream 

Culvert Inspection Form

Date Mapped:	November 20, 2020 12:11 PM	**Culvert No:**	cul18
Name and Location of Road Crossing:	Sparwell Lane		
Stream Name:	Unknown	**Tributary To:**	Mare Brook
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Culvert under Sparwell Lane. Steep embankments with erosion present. Residential neighborhood with minimal vehicle traffic. Makeshift shoot made of pavement present to facilitate drainage from the road to the outlet side of the culvert.		
Pipe Condition:	Poor	**Drainage Condition:**	Poor

Description of Existing Culvert

Shape:	Round		
Material:	Corrugated Metal Pipe		
Size:	30”	**Approximate Length:**	29’
Does roadway have a history of flooding?	No		
Bed material within culvert:	sand, metal		
Tidal Influence?	No		
Additional Observations:	Failed Culvert, Sediment Deposits in Stream, Eroded Bottom and Around Embankment		
Is the culvert hanging?			No
Is there evidence of high water above the top of the culvert?			Yes
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, Yes – Corrosion, Yes – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			Yes
Is the culvert shape deflected?			Yes
Is water seeping along the outside of the culvert (piping)?			Yes
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron/Embankment
Inlet Condition? Poor	**Inlet Obstruction?** No
Vegetation removal needed?	Yes

Culvert Outlet	
Outlet Type:	Riprap Apron/Embankment
Outlet Condition? Poor	**Outlet Obstruction?** No
Vegetation removal needed?	Yes
Additional Notes:	erosion on both sides, failed culvert

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul18 Inlet Pipe

cul18 Inlet Stream

cul18 Outlet Pipe

cul18 Outlet Stream

Culvert Inspection Form

Date Mapped:	November 20, 2020 12:24 PM	**Culvert No:**	cul19
Name and Location of Road Crossing:	Shulman Park Entrance		
Stream Name:	Unknown	**Tributary To:**	Mare Brook
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	New culvert installation. No past concerns.		
Pipe Condition:	Good	**Drainage Condition:**	Good

Description of Existing Culvert

Shape:	Round		
Material:	HDPE		
Size:	24”	**Approximate Length:**	20’
Does roadway have a history of flooding?	No		
Bed material within culvert:	sand, plastic		
Tidal Influence?	No		
Additional Observations:	Some Excess Sand Present		
Is the culvert hanging?			No
Is there evidence of high water above the top of the culvert?			No
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, No – Corrosion, No – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			Yes
Is the culvert shape deflected?			No
Is water seeping along the outside of the culvert (piping)?			No
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron
Inlet Condition? Good	**Inlet Obstruction?** No
Vegetation removal needed?	No

Culvert Outlet	
Outlet Type:	Riprap Apron
Outlet Condition? Good	**Outlet Obstruction?** No
Vegetation removal needed?	No
Additional Notes:	recently installed, some sediment within bed

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul19 Inlet Pipe 	cul19 Inlet Stream 
cul19 Outlet Pipe 	cul19 Outlet Stream 

Culvert Inspection Form

Date Mapped:	November 20, 2020 12:37 PM	**Culvert No:**	cul20
Name and Location of Road Crossing:	Alder Dive		
Stream Name:	Unknown	**Tributary To:**	Mare Brook
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Culvert under Alder Drive. Residential Street, little vehicle traffic. No other past concerns.		
Pipe Condition:	Good	**Drainage Condition:**	Good

Description of Existing Culvert

Shape:	Round		
Material:	Corrugated Metal Pipe		
Size:	36”	**Approximate Length:**	24’
Does roadway have a history of flooding?	No		
Bed material within culvert:	sand/rock		
Tidal Influence?	No		
Additional Observations:			
Is the culvert hanging?			No
Is there evidence of high water above the top of the culvert?			No
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, Yes – Corrosion, No – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			Yes
Is the culvert shape deflected?			No
Is water seeping along the outside of the culvert (piping)?			No
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron/Embankment
Inlet Condition? Good	**Inlet Obstruction?** No
Vegetation removal needed?	No

Culvert Outlet	
Outlet Type:	Riprap Apron/Embankment
Outlet Condition? Good	**Outlet Obstruction?** No
Vegetation removal needed?	No
Additional Notes:	

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul20 Inlet Pipe 	cul20 Inlet Stream 
cul20 Outlet Pipe 	cul20 Outlet Stream 

Culvert Inspection Form

Date Mapped:	November 20, 2020 12:57 PM	**Culvert No:**	cul21
Name and Location of Road Crossing:	Parkview Hospital Circle		
Stream Name:	Unknown	**Tributary To:**	Mare Brook
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Culvert at the south entrance of Parkview Hospital. Stone rip rap and some erosion around the edges. No other past concerns.		
Pipe Condition:	Good	**Drainage Condition:**	Good

Description of Existing Culvert

Shape:	Round		
Material:	HDPE		
Size:	24”	**Approximate Length:**	33’
Does roadway have a history of flooding?	No		
Bed material within culvert:	sand/earthen		
Tidal Influence?	No		
Additional Observations:			
Is the culvert hanging?	No		
Is there evidence of high water above the top of the culvert?	No		
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, No – Corrosion, No – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			Yes
Is the culvert shape deflected?			No
Is water seeping along the outside of the culvert (piping)?			No
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron/Embankment
Inlet Condition? Good	**Inlet Obstruction?** No
Vegetation removal needed?	No

Culvert Outlet	
Outlet Type:	Riprap Apron/Embankment
Outlet Condition? Good	**Outlet Obstruction?** No
Vegetation removal needed?	No
Additional Notes:	inlet pipe damaged but still functional

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul21 Inlet Pipe 	cul21 Inlet Stream 
cul21 Outlet Pipe 	cul21 Outlet Stream 

Culvert Inspection Form

Date Mapped:	November 20, 2020 1:08 PM	**Culvert No:**	cul22
Name and Location of Road Crossing:	Parkview Hospital Circle		
Stream Name:	Unknown	**Tributary To:**	Mare Brook
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Culvert at north entrance of Parkview Hospital. An outlet control structure is used at the inlet to control the pond depth and flow through the culvert. Presents difficulty for fish passage. No other past concerns.		
Pipe Condition:	Good	**Drainage Condition:**	Fair

Description of Existing Culvert

Shape:	Round		
Material:	Reinforced Concrete Pipe		
Size:	24”	**Approximate Length:**	19’
Does roadway have a history of flooding?	No		
Bed material within culvert:	rocks		
Tidal Influence?	No		
Additional Observations:	Water Flow Control Structure at Inlet		
Is the culvert hanging?			No
Is there evidence of high water above the top of the culvert?			No
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	Yes		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, No – Corrosion, No – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			Yes
Is the culvert shape deflected?			No
Is water seeping along the outside of the culvert (piping)?			No
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Concrete Wingwall
Inlet Condition? Good	**Inlet Obstruction?** No
Vegetation removal needed?	No

Culvert Outlet	
Outlet Type:	Riprap Apron/Embankment
Outlet Condition? Fair	**Outlet Obstruction?** Yes
Vegetation removal needed?	No
Additional Notes:	inlet control structure from pond, some obstruction at pipe outlet

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul22 Inlet Pipe 	cul22 Inlet Stream 
cul22 Outlet Pipe 	cul22 Outlet Stream 

Culvert Inspection Form

Date Mapped:	November 30, 2020 10:12 AM	**Culvert No:**	cul23
Name and Location of Road Crossing:	Harspwell Road		
Stream Name:	Mare Brook	**Tributary To:**	
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Large culvert under Harpswell Road. Two larger pond areas, on the inlet side, flow through this culvert. A deep pond is present on the outlet side where the culvert overhangs. Heavily traveled road. No other past concerns.		
Pipe Condition:	**Poor**	**Drainage Condition:**	**Good**

Description of Existing Culvert

Shape:	Round		
Material:	Corrugated Metal Pipe		
Size:	60”	**Approximate Length:**	32’
Does roadway have a history of flooding?	No		
Bed material within culvert:	rock and earth, bottom eroded away		
Tidal Influence?	No		
Additional Observations:			
Is the culvert hanging?			No
Is there evidence of high water above the top of the culvert?			Yes
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, Yes – Corrosion, Yes – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			Yes
Is the culvert shape deflected?			Yes
Is water seeping along the outside of the culvert (piping)?			Yes
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron/Embankment
Inlet Condition? Poor	**Inlet Obstruction?** Yes
Vegetation removal needed?	Yes

Culvert Outlet	
Outlet Type:	Riprap Apron/Embankment
Outlet Condition? Poor	**Outlet Obstruction?** No
Vegetation removal needed?	No
Additional Notes:	erosion, undersized, debris present, grate ripped off inlet

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul23 Inlet Pipe

cul23 Inlet Stream

cul23 Outlet Pipe

cul23 Outlet Stream

Culvert Inspection Form

Date Mapped:	November 30, 2020 10:45 AM	**Culvert No:**	cul24
Name and Location of Road Crossing:	Merriconeag Road		
Stream Name:	Unknown	**Tributary To:**	Mare Brook
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Box culvert located on Brunswick Naval Air Station property under Merriconeag Road. Moderately traveled street. Stream runs through a golf course. High overhang. No other past concerns.		
Pipe Condition:	**Good**	**Drainage Condition:**	**Good**

Description of Existing Culvert

Shape:	Box		
Material:	Reinforced Concrete Pipe		
Size:	72” Wide by 36” Tall	**Approximate Length:**	24’
Does roadway have a history of flooding?	No		
Bed material within culvert:	concrete		
Tidal Influence?	No		
Additional Observations:			
Is the culvert hanging?			Yes
Is there evidence of high water above the top of the culvert?			No
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, No – Corrosion, No – Joint Gaps or Open Seems		
Box Culvert? Yes	**Cracks vertical/ horizontal on sides/walls?** No	**Undermining of footing of three-sided culvert?** No	**Exposed footings?** Yes
Culvert extended? No	**Condition of extension:** Unknown		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			Yes
Is the culvert shape deflected?			No
Is water seeping along the outside of the culvert (piping)?			No
Should the culvert be video inspected?			No
Addition Observation:			
Culvert Inlet			
Inlet Type:	Riprap Apron/Embankment		
Inlet Condition? Good		**Inlet Obstruction?** No	
Vegetation removal needed?		No	
Culvert Outlet			
Outlet Type:	Riprap Apron/Embankment		
Outlet Condition? Good		**Outlet Obstruction?** No	
Vegetation removal needed?		Yes	
Additional Notes:		erosion around outlet, 4 ft overhang, debris in stream	

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul24 Inlet Pipe 	cul24 Inlet Stream 
cul24 Outlet Pipe 	cul24 Outlet Stream 

Culvert Inspection Form

Date Mapped:	November 30, 2020 10:57 AM	**Culvert No:**	cul25
Name and Location of Road Crossing:	Merriconeag Road		
Stream Name:	Unknown	**Tributary To:**	Mare Brook
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Culvert(s) installed under golf cart path. Multiple sizes. Overhanging. Past concerns of flooding.		
Pipe Condition:	Good	**Drainage Condition:**	Poor

Description of Existing Culvert

Shape:	Round		
Material:	HDPE		
Size:	3 – 12”	**Approximate Length:**	10’
Does roadway have a history of flooding?	Yes		
Bed material within culvert:	N/A		
Tidal Influence?	No		
Additional Observations:	Multiple Pipes, Same Condition, Massive Blockage, Poor Inlet Flow		
Is the culvert hanging?			Yes
Is there evidence of high water above the top of the culvert?			Yes
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, No – Corrosion, No – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			No
Is the culvert shape deflected?			No
Is water seeping along the outside of the culvert (piping)?			No
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron
Inlet Condition? Poor	**Inlet Obstruction?** Yes
Vegetation removal needed?	Yes

Culvert Outlet	
Outlet Type:	Riprap Apron
Outlet Condition? Poor	**Outlet Obstruction?** Yes
Vegetation removal needed?	Yes
Additional Notes:	road blocking stream, undersized, poor outlet condition, needs to be addressed

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul25 Inlet Pipe 	cul25 Inlet Stream 
cul25 Outlet Pipe 	cul25 Outlet Stream 

Culvert Inspection Form

Date Mapped:	November 30, 2020 10:57 AM	**Culvert No:**	cul26
Name and Location of Road Crossing:	Merriconeag Road		
Stream Name:	Unknown	**Tributary To:**	Mare Brook
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Culvert(s) installed under golf cart path. Multiple sizes. Overhanging. Past concerns of flooding.		
Pipe Condition:	Good	**Drainage Condition:**	Poor

Description of Existing Culvert

Shape:	Round		
Material:	HDPE		
Size:	2 – 18”	**Approximate Length:**	10’
Does roadway have a history of flooding?	Yes		
Bed material within culvert:	N/A		
Tidal Influence?	No		
Additional Observations:	Multiple Pipes, Same Condition, Massive Blockage, Poor Inlet Flow		
Is the culvert hanging?			Yes
Is there evidence of high water above the top of the culvert?			Yes
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, No – Corrosion, No – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			No
Is the culvert shape deflected?			No
Is water seeping along the outside of the culvert (piping)?			No
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron
Inlet Condition? Poor	**Inlet Obstruction?** Yes
Vegetation removal needed?	Yes

Culvert Outlet	
Outlet Type:	Riprap Apron
Outlet Condition? Poor	**Outlet Obstruction?** Yes
Vegetation removal needed?	Yes
Additional Notes:	road blocking stream, undersized, poor outlet condition, needs to be addressed

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul26 Inlet Pipe 	cul26 Inlet Stream 
cul26 Outlet Pipe 	cul26 Outlet Stream 

Culvert Inspection Form

Date Mapped:	November 30, 2020 11:22 AM	**Culvert No:**	cul27
Name and Location of Road Crossing:	Purington Road		
Stream Name:	Unknown	**Tributary To:**	Mare Brook
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Culvert under Purington Road Located at the edge of the Brunswick Naval Air Station. Fencing present at inlet. No other past concerns.		
Pipe Condition:	Good	**Drainage Condition:**	Good

Description of Existing Culvert

Shape:	Round		
Material:	Corrugated Metal Pipe		
Size:	24”	**Approximate Length:**	23’
Does roadway have a history of flooding?	Yes		
Bed material within culvert:	pipe material		
Tidal Influence?	No		
Additional Observations:			
Is the culvert hanging?	No		
Is there evidence of high water above the top of the culvert?	Yes		
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, Yes – Corrosion, No – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			Yes
Is the culvert shape deflected?			No
Is water seeping along the outside of the culvert (piping)?			No
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron/Embankment
Inlet Condition? Fair	**Inlet Obstruction?** No
Vegetation removal needed?	Yes

Culvert Outlet	
Outlet Type:	Riprap Apron/Embankment
Outlet Condition? Good	**Outlet Obstruction?** No
Vegetation removal needed?	No
Additional Notes:	erosion around outside of culvert

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul27 Inlet Pipe

cul27 Inlet Stream

cul27 Outlet Pipe

cul27 Outlet Stream

Culvert Inspection Form

Date Mapped:	November 30, 2020 11:28 AM	**Culvert No:**	cul28
Name and Location of Road Crossing:	Purington Road		
Stream Name:	Unknown	**Tributary To:**	Mare Brook
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Culvert under Purington Road Located at the edge of the Brunswick Naval Air Station. Fencing present at inlet. No other past concerns.		
Pipe Condition:	**Fair**	**Drainage Condition:**	**Good**

Description of Existing Culvert

Shape:	Round		
Material:	HDPE		
Size:	36”	**Approximate Length:**	23’
Does roadway have a history of flooding?	Yes		
Bed material within culvert:	pipe material		
Tidal Influence?	No		
Additional Observations:			
Is the culvert hanging?			No
Is there evidence of high water above the top of the culvert?			Yes
Addition Observation:			

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, No – Corrosion, Yes – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?**	**Undermining of footing of three-sided culvert?**	**Exposed footings?**
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			Yes
Is the culvert shape deflected?			No
Is water seeping along the outside of the culvert (piping)?			No
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Riprap Apron/Embankment
Inlet Condition? Fair	**Inlet Obstruction?** No
Vegetation removal needed?	No

Culvert Outlet	
Outlet Type:	Riprap Apron/Embankment
Outlet Condition? Good	**Outlet Obstruction?** No
Vegetation removal needed?	No
Additional Notes:	end of unlet is damaged, undersized

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul28 Inlet Pipe 	cul28 Inlet Stream 
cul28 Outlet Pipe 	cul28 Outlet Stream 

Culvert Inspection Form

Date Mapped:	November 1, 2021 11:13 AM	**Culvert No:**	cul29
Name and Location of Road Crossing:	Eagle Drive		
Stream Name:	Mare Brook	**Tributary To:**	
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org		
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org		
Brief Narrative of Culvert Area & Any Past Concerns:	Culvert Under Eagle Drive Located in the Brunswick Landing. Fencing present at outlet, no other past concerns		
Pipe Condition:	**Fair**	**Drainage Condition:**	**Fair**

Description of Existing Culvert

Shape:	Round		
Material:	CMP		
Size:	96”	**Approximate Length:**	80’
Does roadway have a history of flooding?	No		
Bed material within culvert:	Unknown		
Tidal Influence?	No		
Additional Observations:			

Is the culvert hanging?	Yes
Is there evidence of high water above the top of the culvert?	No
Addition Observation:	

Description of Existing Culvert			
Culvert lining?	No		
Condition inside culvert:	No – Cracking, No – Spalling, No – Abrasion, No – Corrosion, No – Joint Gaps or Open Seems		
Box Culvert? No	**Cracks vertical/ horizontal on sides/walls?** No	**Undermining of footing of three-sided culvert?** No	**Exposed footings?** No
Culvert extended? No	**Condition of extension:** N/A		**Extension pipe smaller than original pipe?** No
Is there a line of sight along the crown and spring line?			Yes
Is the culvert shape deflected?			No
Is water seeping along the outside of the culvert (piping)?			No
Should the culvert be video inspected?			No
Addition Observation:			

Culvert Inlet	
Inlet Type:	Concrete Wingwall
Inlet Condition? Fair	**Inlet Obstruction?** Yes
Vegetation removal needed?	Yes

Culvert Outlet	
Outlet Type:	Concrete Wingwall
Outlet Condition? Fair	**Outlet Obstruction?** Yes
Vegetation removal needed?	Yes
Additional Notes:	Concrete wigwalls, some vegetation blocking inlet and outlet, trash/animal guard. outlet inexcessible

Appendix B- Culvert and Outfall Inspections on Mare Brook

cul29 Inlet Pipe

cul29 Inlet Stream

cul29 Outlet Pipe

cul29 Outlet Stream

Summary of Outfall Inspections on Mare Brook

Outfall #	Location	Size (in)	Material/Shape	Condition	Recommendation	Requirements	Estimated Cost†	Ground photo
11	Western basin outlet	24	Reinforced Concrete Pipe / Round	• Adequately sized • Pipe structure in good shape • Limited erosion at outlet	None	Not applicable	None at this time	
12	At Harpswell Road Crossing	24	Corrugated Metal Pipe / Round	• Significant sediment at inlet • Pipe structure in fair shape • Restricted flow due to sediment	Clear sediment at inlet and outlet	Town labor	Low $500	
13	Macmillan Drive Crossing	15	PVC Pipe / Round	• Significant sediment at inlet • Pipe structure in good shape • Restricted flow due to sediment build-up	Clear sediment at catch basin and pipe	Town labor	Low $500	
17	Off Sparwell Lane	15	Clay Pipe Round	• Adequately sized • Pipe structure in bad shape • Pipe section missing and erosion at outlet	Retrofit outlet with new section and outlet protection	Town permitting and labor	Moderate $10 - 12K with Town Labor	

Summary of Outfall Inspections on Mare Brook

Outfall #	Location	Size (in)	Material/Shape	Condition	Recommendation	Requirements	Estimated Cost†	Ground photo
18	Off Hemlock Road	12	Corrugated Metal Pipe Round	• Adequately sized • Pipe structure in fair shape • Sediment at outlet	Remove sediment build-up and retrofit outlet with riprap protection	Town permitting and labor	Low $500 - 1,000 with Town Labor	
19	Off Breckam Road	12	Clay Pipe / Round	• Adequately sized • Pipe structure in poor shape • Submerged at outlet, heavy vegetation	Replace outfall pipe and provide outlet protection	Town permitting and labor/Private land	Moderate $10,000 - 15,000 with Town Labor	
20	Off MacMillan Drive	18	Corrugated Metal Pipe & Concrete / 1/2 circle	• Concrete foundation failing • Sediment at outlet and in stream	Remove outfall and replace with road catch basin	Town permitting and labor	Moderate $12,500 - 17,500 with Town Labor	
21	Off Magean Street	15	Corrugated Metal Pipe / Round	• Pipe rusted and failing • Outlet structure needs to be replaced	Replace outfall pipe and add new structure	Town permitting and labor/Private land	Moderate $15,000 - 20,000 with Town Labor	

Summary of Outfall Inspections on Mare Brook

Outfall #	Location	Size (in)	Material/Shape	Condition	Recommendation	Requirements	Estimated Cost†	Ground photo
22	Off Arrowhead Drive	36	PE N-12 Pipe / Round	• Adequately sized • Pipe structure in good shape • No erosion at outlet	None	Not applicable	None at this time	
23	Off Windorf Circle	36	PE N-12 Pipe / Round	• Adequately sized • Pipe structure in good shape • Concrete wingwalls at outlet	None	Not applicable	None at this time	

Date of Inspection = 11/18/2020 & 7/22/2021

† - Categorized as low ($500-$10,000), moderate ($10,000-$100,000), high ($>100,000)

Note:

Outfall Inspection Form

Location Information

Date Mapped: November 18, 2020 11:52 AM	**Outfall ID:** out11
Name and Location of Road Crossing: Western Edge of Watershed	
Stream Name: Mare Brook	**Tributary To:**
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org

Weather: Party Cloudy/Sunny	**Temperature:** 32	**Wind:** Yes
Precipitation in Past 3 Days? Yes		**How much?** 0.5”
Dry Weather Inspection Form Used? Yes		
Pipe Flow: None		**Seepage Flow:** None

Outfall Description

Submerged: No	
Open Pipe:	**Type:**
	Shape:
	Dimensions (in):
Open Drainage:	**Type:** CMP
	Shape: Circle
	Dimensions (in): 24 in Diameter

Dry Weather Inspection

Submerged:	
Obvious Debris/Pollution:	**None (0):**
	Foam (3):
	Floating Green Scum (8):
	Oil/Film (9):
	Vegetative (9):
	Sewage Solids (10):
	TOTAL:
Odor:	**None/Natural (0):**
	Musty (5):
	Sewage/Septic (10):
	TOTAL:
Water Clarity:	**Clear (0):**
	Cloudy (5):
	Opaque (10):
	TOTAL:
GRAND TOTAL SCORE:	

Additional Information

Sediment Condition: Open	**Structure Condition:** Good
Trash/Litter: No	**Yard Waste Observed:** No

General Comments: sediment in channel

Actions Taken: none

Follow-up Required? No

Appendix B- Culvert and Outfall Inspections on Mare Brook

out11	out11
	

Outfall Inspection Form

Location Information

Date Mapped: November 30, 2020 11:28 AM	**Outfall ID:** out12
Name and Location of Road Crossing: Harpswell Road Crossing	
Stream Name: Mare Brook	**Tributary To:**
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org

Weather: Cloudy	**Temperature:** 35	**Wind:** No
Precipitation in Past 3 Days? Yes		**How much?** 0.5”
Dry Weather Inspection Form Used? No		
Pipe Flow: None		**Seepage Flow:** None

Outfall Description

Submerged: No	
Open Pipe:	**Type:**
	Shape:
	Dimensions (in):
Open Drainage:	**Type:** CMP
	Shape: Circle
	Dimensions (in): **24** in Diameter

Dry Weather Inspection

Submerged:	
Obvious Debris/Pollution:	**None (0):**
	Foam (3):
	Floating Green Scum (8):
	Oil/Film (9):
	Vegetative (9):
	Sewage Solids (10):
	TOTAL:
Odor:	**None/Natural (0):**
	Musty (5):
	Sewage/Septic (10):
	TOTAL:
Water Clarity:	**Clear (0):**
	Cloudy (5):
	Opaque (10):
	TOTAL:
GRAND TOTAL SCORE:	

Additional Information

Sediment Condition: 1/2 Full	**Structure Condition:** Fair
Trash/Litter: No	**Yard Waste Observed:** No

General Comments: lots of sediment backing up flow

Actions Taken: none

Follow-up Required? No

Appendix B- Culvert and Outfall Inspections on Mare Brook

out12

out12

out12

out12

Outfall Inspection Form

Location Information

Date Mapped: April 20, 2021 1:28 PM	**Outfall ID:** out13
Name and Location of Road Crossing: Macmillan Drive Roadway Crossing	
Stream Name: Mare Brook	**Tributary To:**
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org

Weather: Party Cloudy/Sunny	**Temperature:** 61	**Wind:** No
Precipitation in Past 3 Days? No		**How much?**
Dry Weather Inspection Form Used? Yes		
Pipe Flow: None		**Seepage Flow:** None

Outfall Description

Submerged: No	
Open Pipe:	**Type:**
	Shape:
	Dimensions (in):
Open Drainage:	**Type:** PVC
	Shape: Circle
	Dimensions (in): 15 in Diameter

Dry Weather Inspection

Submerged:	
Obvious Debris/Pollution:	**None (0):**
	Foam (3):
	Floating Green Scum (8):
	Oil/Film (9):
	Vegetative (9):
	Sewage Solids (10):
	TOTAL:
Odor:	**None/Natural (0):**
	Musty (5):
	Sewage/Septic (10):
	TOTAL:
Water Clarity:	**Clear (0):**
	Cloudy (5):
	Opaque (10):
	TOTAL:
GRAND TOTAL SCORE:	

Additional Information

Sediment Condition: Full	**Structure Condition:** Good
Trash/Litter: No	**Yard Waste Observed:** No

General Comments: Catch basin with limited sump, sediment in outfall

Actions Taken: No

Follow-up Required? No

Appendix B- Culvert and Outfall Inspections on Mare Brook

out13

out13

out13

out13

Outfall Inspection Form

Location Information

Date Mapped: July 22, 2021 9:26 AM	**Outfall ID:** out17
Name and Location of Road Crossing: Off Sparwell Lane	
Stream Name: Mare Brook	**Tributary To:**
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org

Weather: Clear	**Temperature:** 70	**Wind:** Yes
Precipitation in Past 3 Days? Yes		**How much?** 1.17 in
Dry Weather Inspection Form Used? Yes		
Pipe Flow: None		**Seepage Flow:** Steady

Outfall Description

Submerged: No	
Open Pipe:	**Type:**
	Shape:
	Dimensions (in):
Open Drainage:	**Type:** Clay
	Shape: Circle
	Dimensions (in): 16 in Diameter

Dry Weather Inspection

Submerged:	
Obvious Debris/Pollution:	**None (0):**
	Foam (3):
	Floating Green Scum (8):
	Oil/Film (9):
	Vegetative (9):
	Sewage Solids (10):
	TOTAL:
Odor:	**None/Natural (0):**
	Musty (5):
	Sewage/Septic (10):
	TOTAL:
Water Clarity:	**Clear (0):**
	Cloudy (5):
	Opaque (10):
	TOTAL:
GRAND TOTAL SCORE:	

Additional Information

Sediment Condition: Open	**Structure Condition:** Poor
Trash/Litter: No	**Yard Waste Observed:** Yes

General Comments: Pipe in bad condition, lots of erosion around pipe.

Actions Taken: None, needs to be addresses

Follow-up Required? Yes

Appendix B- Culvert and Outfall Inspections on Mare Brook

out17

out17

out17

out17

Outfall Inspection Form

Location Information

Date Mapped: July 22, 2021 10:03 AM	**Outfall ID:** out18
Name and Location of Road Crossing: Off Hemlock Road between Laurel Roadd & Sparwell Lane	
Stream Name: Mare Brook	**Tributary To:**
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org

Weather: Clear	**Temperature:** 70	**Wind:** No
Precipitation in Past 3 Days? Yes		**How much?** 1.17
Dry Weather Inspection Form Used? Yes		
Pipe Flow: None		**Seepage Flow:** None

Outfall Description

Submerged: No	
Open Pipe:	**Type:**
	Shape:
	Dimensions (in):
Open Drainage:	**Type:** CMP
	Shape: Circle
	Dimensions (in): 12 in Diameter

Dry Weather Inspection

Submerged:	
Obvious Debris/Pollution:	**None (0):**
	Foam (3):
	Floating Green Scum (8):
	Oil/Film (9):
	Vegetative (9):
	Sewage Solids (10):
	TOTAL:
Odor:	**None/Natural (0):**
	Musty (5):
	Sewage/Septic (10):
	TOTAL:
Water Clarity:	**Clear (0):**
	Cloudy (5):
	Opaque (10):
	TOTAL:
GRAND TOTAL SCORE:	

Additional Information

Sediment Condition: 1/4 Full	**Structure Condition:** Fair
Trash/Litter: No	**Yard Waste Observed:** Yes
General Comments: Add outlet treatment	
Actions Taken: None	
Follow-up Required? No	

Appendix B- Culvert and Outfall Inspections on Mare Brook

out18

out18

out18

out18

Outfall Inspection Form

Location Information

Date Mapped: July 22, 2021 10:21 AM	**Outfall ID:** out19
Name and Location of Road Crossing: Off Breckan Road	
Stream Name: Mare Brook	**Tributary To:**
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org

Weather: Clear	**Temperature:** 70	**Wind:** No
Precipitation in Past 3 Days? Yes		**How much?** 1.17
Dry Weather Inspection Form Used? Yes		
Pipe Flow: Steady		**Seepage Flow:** None

Outfall Description

Submerged: Yes	
Open Pipe:	**Type:**
	Shape:
	Dimensions (in):
Open Drainage:	**Type:** Clay
	Shape: Circle
	Dimensions (in): 12 in Diameter

Dry Weather Inspection

Submerged:	
Obvious Debris/Pollution:	**None (0):**
	Foam (3):
	Floating Green Scum (8):
	Oil/Film (9):
	Vegetative (9):
	Sewage Solids (10):
	TOTAL:
Odor:	**None/Natural (0):**
	Musty (5):
	Sewage/Septic (10):
	TOTAL:
Water Clarity:	**Clear (0):**
	Cloudy (5):
	Opaque (10):
	TOTAL:
GRAND TOTAL SCORE:	

Additional Information

Sediment Condition: 1/4 Full	**Structure Condition:** Poor
Trash/Litter: No	**Yard Waste Observed:** Yes

General Comments: Old clay pipe, partially submerged, lots of vegetation, invasive

Actions Taken: None

Follow-up Required? Yes

Appendix B- Culvert and Outfall Inspections on Mare Brook

out19

out19

out19

out19

Outfall Inspection Form

Location Information

Date Mapped: July 22, 2021 10:46 AM	**Outfall ID:** out20
Name and Location of Road Crossing: Off Macmillan Drive	
Stream Name: Mare Brook	**Tributary To:**
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org

Weather: Clear	**Temperature:** 70	**Wind:** No
Precipitation in Past 3 Days? Yes		**How much?** 1.17 in
Dry Weather Inspection Form Used? No		
Pipe Flow: None		**Seepage Flow:** None

Outfall Description

Submerged: No	
Open Pipe:	**Type:** CMP + Concrete
	Shape: Half Circle
	Dimensions (in): 18 in Diameter
Open Drainage:	**Type:**
	Shape:
	Dimensions (in):

Dry Weather Inspection

Submerged:	
Obvious Debris/Pollution:	**None (0):**
	Foam (3):
	Floating Green Scum (8):
	Oil/Film (9):
	Vegetative (9):
	Sewage Solids (10):
	TOTAL:
Odor:	**None/Natural (0):**
	Musty (5):
	Sewage/Septic (10):
	TOTAL:
Water Clarity:	**Clear (0):**
	Cloudy (5):
	Opaque (10):
	TOTAL:
GRAND TOTAL SCORE:	

Additional Information

Sediment Condition: Open	**Structure Condition:** Poor
Trash/Litter: No	**Yard Waste Observed:** No

General Comments: Replace outfall

Actions Taken: None

Follow-up Required? Yes

Appendix B- Culvert and Outfall Inspections on Mare Brook

out20

out20

out20

out20

Outfall Inspection Form

Location Information

Date Mapped: July 22, 2021 11:07 AM	**Outfall ID:** out21
Name and Location of Road Crossing: Off Magean Street	
Stream Name: Mare Brook	**Tributary To:**
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org

Weather: Clear	**Temperature:** 70	**Wind:** No
Precipitation in Past 3 Days? Yes		**How much?** 1.17 in
Dry Weather Inspection Form Used? Yes		
Pipe Flow: None		**Seepage Flow:** None

Outfall Description

Submerged: No	
Open Pipe:	**Type:**
	Shape:
	Dimensions (in):
Open Drainage:	**Type:** CMP
	Shape: Circle
	Dimensions (in): 15 in Diameter

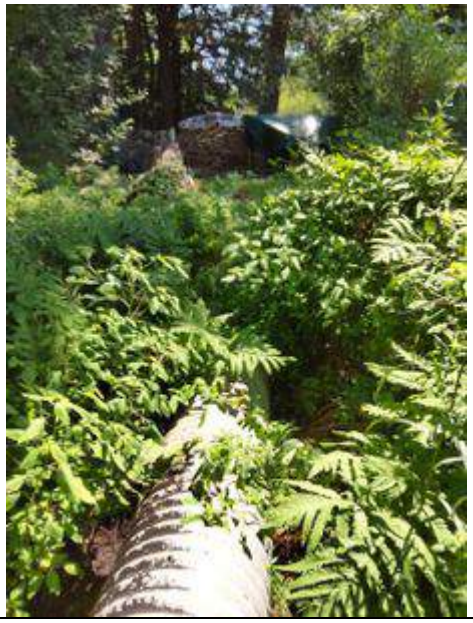
Dry Weather Inspection

Submerged:	
Obvious Debris/Pollution:	**None (0):**
	Foam (3):
	Floating Green Scum (8):
	Oil/Film (9):
	Vegetative (9):
	Sewage Solids (10):
	TOTAL:
Odor:	**None/Natural (0):**
	Musty (5):
	Sewage/Septic (10):
	TOTAL:
Water Clarity:	**Clear (0):**
	Cloudy (5):
	Opaque (10):
	TOTAL:
GRAND TOTAL SCORE:	

Additional Information

Sediment Condition: Open	**Structure Condition:** Poor
Trash/Litter: No	**Yard Waste Observed:** Yes
General Comments: Rusted on bottom	
Actions Taken: No	
Follow-up Required? Yes	

Appendix B- Culvert and Outfall Inspections on Mare Brook

out21 	out21 
out21 	out21 

Outfall Inspection Form

Location Information

Date Mapped: July 22, 2021, 12:00 PM	**Outfall ID:** out22
Name and Location of Road Crossing: Off Arrowhead Drive at Western End of Stream	
Stream Name: Mare Brook	**Tributary To:**
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org

Weather: Clear	**Temperature:** 70	**Wind:** No
Precipitation in Past 3 Days? Yes		**How much?** 1.17 in
Dry Weather Inspection Form Used? Yes		
Pipe Flow: Steady		**Seepage Flow:** None

Outfall Description

Submerged:	
Open Pipe:	**Type:**
	Shape:
	Dimensions (in):
Open Drainage:	**Type:** HDPE
	Shape: Circle
	Dimensions (in): 36 in Diameter

Dry Weather Inspection

Submerged:	
Obvious Debris/Pollution:	**None (0):**
	Foam (3):
	Floating Green Scum (8):
	Oil/Film (9):
	Vegetative (9):
	Sewage Solids (10):
	TOTAL:
Odor:	**None/Natural (0):**
	Musty (5):
	Sewage/Septic (10):
	TOTAL:
Water Clarity:	**Clear (0):**
	Cloudy (5):
	Opaque (10):
	TOTAL:
GRAND TOTAL SCORE:	

Additional Information

Sediment Condition: Open	**Structure Condition:** Good
Trash/Litter: No	**Yard Waste Observed:** No

General Comments: None

Actions Taken: None

Follow-up Required? No

Appendix B- Culvert and Outfall Inspections on Mare Brook

out22

out22

Outfall Inspection Form

Location Information

Date Mapped: July 22, 2021 12:22 PM	**Outfall ID:** out23
Name and Location of Road Crossing: Off Windorf Circle	
Stream Name: Mare Brook	**Tributary To:**
Town of Brunswick Representative: (name, phone, e-mail)	Matthew Pelletier, Assistant Engineer 2077214145 mpelletier@brunswickme.org
Other Party Representative: (Company, name, phone, e-mail)	Chris Baldwin, District Engineer Cumberland County Soil & Water Conservation District 2078924700 cbaldwin@cumberlandswcd.org

Weather: Clear	**Temperature:** 70	**Wind:** No
Precipitation in Past 3 Days? Yes		**How much?** 1.17 in
Dry Weather Inspection Form Used? Yes		
Pipe Flow: Steady		**Seepage Flow:** None

Outfall Description

Submerged: No	
Open Pipe:	**Type:**
	Shape:
	Dimensions (in):
Open Drainage:	**Type:** HDPE
	Shape: Circle with Concrete Wingwalls
	Dimensions (in): 36 in Diameter

Dry Weather Inspection

Submerged:	
Obvious Debris/Pollution:	**None (0):**
	Foam (3):
	Floating Green Scum (8):
	Oil/Film (9):
	Vegetative (9):
	Sewage Solids (10):
	TOTAL:
Odor:	**None/Natural (0):**
	Musty (5):
	Sewage/Septic (10):
	TOTAL:
Water Clarity:	**Clear (0):**
	Cloudy (5):
	Opaque (10):
	TOTAL:
GRAND TOTAL SCORE:	

Additional Information

Sediment Condition: Open	**Structure Condition:** Good
Trash/Litter: No	**Yard Waste Observed:** No
General Comments: Perfect Outfall	
Actions Taken: None	
Follow-up Required? No	

Appendix B- Culvert and Outfall Inspections on Mare Brook

out23 	out23 
out23 	out23