MASSACHUSETTS
watershed·based plans

WATERSHED-BASED PLAN

Clesson Brook (MA33-15)
Within the Towns of Buckland, Ashfield, and Hawley

December 2024

WBP #1531

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Prepared For:

MassDEP
Commonwealth of Massachusetts
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Executive Summary

Introduction

The purpose of a Massachusetts Watershed-Based Plan (WBP) is to organize information about Massachusetts' watersheds, and present the information in a format that will enhance the development and implementation of projects that will restore water quality and beneficial uses in the Commonwealth. The Massachusetts WBP follows the United States Environmental Protection Agency's (EPA's) recommended format for "nine-element" watershed plans. The Franklin Regional Council of Governments (FRCOG) developed this WBP with funding, input, and collaboration from the Massachusetts Department of Environmental Protection (MassDEP) and an Action Grant from the EEA's Municipal Vulnerability Preparedness (MVP) Program.

This WBP was prepared for the Clesson Brook Watershed, which is in the towns of Buckland, Hawley, and Ashfield. It receives water from nine perennial streams: Cooley Brook, Ford Brook, Ruddock Brook, Shepard Brook, Smith Brook, Taylor Brook, and an Unnamed Tributary.

The WBP for Clesson Brook builds on the work completed as a part of the MVP Action Grant for the Clesson Brook Watershed Based Assessment & Climate Resiliency Plan Project. In addition to a portion of this WBP, the MVP program funded the following assessments, which were completed by GZA GeoEnvironmental Inc. and Field Geology Services from 2021-2023:

- Fluvial Geomorphic Assessment of Clesson Brook;
- Hydrologic and Hydraulic Model of the Clesson Brook Watershed;
- Comprehensive assessment of road-stream crossings along the Clesson Brook and its main tributaries;
- Identification and mapping of vulnerable Clesson Brook Watershed segments;
- Prioritization of parcels within the Clesson Brook Watershed for conservation;
- Identification of 12 potential restoration projects; and
- Development of four conceptual designs.

The assessments and designs have been incorporated throughout this WBP to ensure the Plan is responsive to the impacts of climate change. The goal of this WBP is to identify appropriate management strategies and projects to protect and restore the health and climate resiliency of the Clesson Brook Watershed and address sediment loading.

Impairments and Pollution Sources

According to the 2022 Massachusetts Integrated List of Waters, the Clesson Brook has no impairments.

The 2017 Watershed-Based Plan to Maintain the Health and Improve the Resiliency of the Deerfield River Watershed (Project 15-04/319) ranked the Clesson Brook subwatershed in the top third of healthy subwatersheds in the Deerfield Basin.[1] However, the health and climate resiliency of the watershed is threatened by very little protected land in the upland tributary areas and the watershed as a whole, the amount

[1] Watershed-Based Plan to Maintain the Health and Improve the Resiliency of the Deerfield River Watershed (Project 15-04/319), Franklin Regional Council of Governments, 2017: https://frcog.org/publications/deerfield-river-watershed-based-resiliency-plan/

of agricultural uses along the stream corridors, stormwater runoff from Rte. 112 and other roads that are adjacent to Clesson Brook and its tributaries, and moderate to high erosion and sediment loading.

Goals, Management Measures, and Funding

Water quality goals for this WBP are primarily focused on reducing sediment loading to the Clesson Brook. This WBP includes an adaptive sequence to establish and track specific water quality goals. First, an interim goal has been established to reduce sediment loading by 546 tons and to reduce phosphorus and nitrogen loading by any amount over the next 5 years.

It is expected that goals will be accomplished through the installation of structural Best Management Practices (BMPs) to reduce fluvial erosion, as well as implementation of non-structural BMPs (e.g. land conservation projects) and watershed education and outreach.

Funding for both structural and nonstructural BMPs could be obtained from a variety of sources including grant funding, Town funds, volunteer efforts, and other sources.

Public Education and Outreach

Public education and outreach will be aimed at educating Buckland, Hawley, and Ashfield Town staff, students, and residents about the health of Clesson Brook, including the potential sources of nonpoint source pollution (contaminants released in a wide area rather than from one single source, such as a pipe) and fluvial geomorphic impairments (disturbance to stream channel shape, water flow, and sediment movement in a stream channel). Education and outreach will help to promote a comprehensive approach to ongoing stormwater management.

The public education and outreach goals can be achieved by engaging Town of Buckland, Hawley, and Ashfield staff, local students, and town-wide residents through online resources, a local presentation, in-situ informational signage and tours, and a variety of other means. It is expected that these programs will be evaluated by tracking attendance at events and other tools applicable to the type of outreach performed.

Implementation Schedule and Evaluation Criteria

Project activities will be implemented based on the information outlined in the following elements for inspection, implementation of structural BMPs, public education and outreach activities, and a schedule for periodic updates to the WBP. Other indirect evaluation metrics are also included, such as the number of landowners who implement climate resiliency projects on their land. The long-term goal of this WBP is to greatly reduce the amount of fluvial erosion and mobilized sediment affecting the health of Clesson Brook.

Introduction

What is a Watershed-Based Plan?

Purpose & Need

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

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

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

This WBP includes nine elements (a through i) in accordance with EPA Guidelines:

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

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

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

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

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

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

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

h) A set of **criteria to determine if loading reductions are being achieved** over time and substantial progress is being made toward attaining water quality standards and, if not, the criteria for determining whether this WBP needs to be revised or, if a NPS total maximum daily load (TMDL) has been established, whether the TMDL needs to be revised.

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

General Watershed Information

This WBP was prepared for waterbodies located with the Clesson Brook Watershed in Buckland, Ashfield, and Hawley. Waterbodies include Clesson Brook, Cooley Brook, Ford Brook, Ruddock Brook, Shepherd Brook, Smith Brook, Taylor Brook, Upper Branch Clesson Brook, and an Unnamed Tributary, as listed in Table 1. The entire watershed measures 11,605 acres.

Table 1: General Watershed Information

Watershed Name (Assessment Unit ID):	Clesson Brook (MA33-15) ; Cooley Brook (MA33-45) ; Ford Brook ; Ruddock Brook (MA33-79) ; Shepherd Brook ; Smith Brook (MA33-26) ; Taylor Brook ; Unnamed Tributary (MA33-116) ; Upper Branch Clesson Brook
Major Basin:	Deerfield River
Watershed Area (within MA):	11,605 (ac)

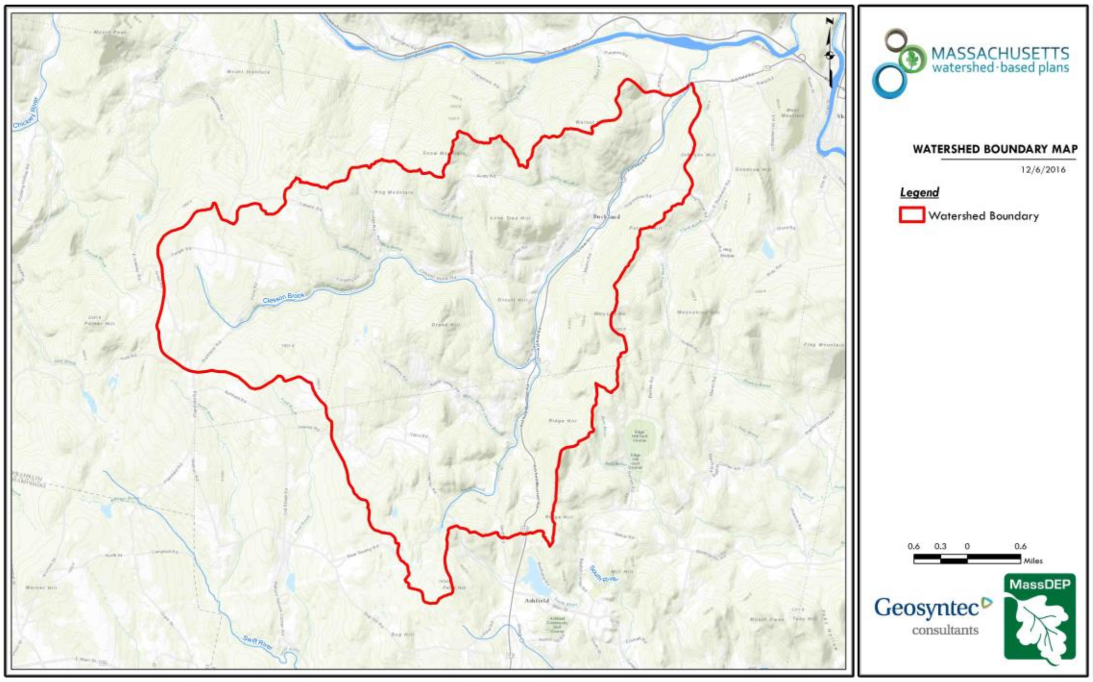


Figure 1: Watershed Boundary Map (MassGIS, 2007; MassGIS, 1999; MassGIS, 2001; USGS, 2016)

Flowing northeast through the towns of Buckland, Ashfield, and Hawley, Clesson Brook is a major Hydrologic Unit Code (HUC-12) tributary to the Deerfield River. With a drainage area of 11,605 acres the Clesson Brook Watershed makes up the majority of the Town of Buckland. The watershed's topography is characterized by steep and hilly terrain with a mean basin slope of 17%.[2] Major tributaries to Clesson Brook include Smith Brook, Taylor Brook, and Clark Brook. The watershed is approximately 83% forested, 9% agricultural, and 4% developed with the remaining drainage area split between water/wetlands, grasslands, and bare lands.[3]

Route 112 and several other main town roads are located along the stream corridors of Clesson Brook and its tributaries. The floodplain of the Clesson Brook transitions from being very restricted to moderately restricted from upstream to downstream with the floodplain widest where the Clesson Brook discharges into the Deerfield River. Where Clesson Brook has a floodplain, it is predominantly agricultural with patches of low-density development, forests, and wetlands. Agricultural practices currently active in the watershed include dairy, cattle and livestock, corn, hay, vegetable row crops, nurseries, and many apple and fruit orchards. The majority of agriculture is concentrated along the stream corridor in the lower half of the watershed. Agriculture is an important part of the economy and land use in the Clesson Brook Watershed.

Developed land makes up 11% of the land use in the watershed, while there is little permanently protected land. Of all the HUC-12 sub-watersheds in the Deerfield River watershed, Clesson Brook has the least amount of protected land in upland areas. There is very little permanently protected land around upland tributaries, and

[2] USGS StreamStats, 2022

[3] MassGIS 2016 Land Cover Data

priority habitat is not well protected in the watershed. A majority of the protected land in the watershed is located in the town of Hawley. In fact, 46% of the Hawley portion of the watershed is conserved, while less than 7% of the Buckland portion of the watershed is permanently protected.

The Clesson Brook Watershed includes a significant amount of BioMap Core Habitat and Critical Natural Landscape Block lands as defined by MassWildlife and the Nature Conservancy. These lands include critical areas for preserving biodiversity, protecting water supply, providing flood and carbon storage, and maintaining healthy natural ecosystems. Several areas in the watershed are estimated priority habitats of rare species, as mapped by the Natural Heritage & Endangered Species Program. These areas are located near the Hawks Brook Wildlife Management Area, Bear Swamp Reservation, and along the Clesson Brook main stem.

Description of the Problem

Clesson Brook is a healthy watershed and is not included in the Massachusetts Integrated List of Waters for the Clean Water Act 2022 Reporting Cycle. However, the fluvial geomorphic assessment of the Clesson Brook Watershed completed as a part of Buckland's 2022 Municipal Vulnerability Preparedness (MVP) Action Grant revealed severe sediment loading issues in an unstable channel system following Tropical Storm Irene. On August 28, 2011, three to 10 inches of rain fell on already saturated ground following several significant rain events in the preceding week. Tropical Storm Irene was approximately a 200-year recurrence interval flood, and the impact of this flood event can still be seen along Clesson Brook and its tributaries.

Long sections of Clesson Brook Road were rebuilt after Tropical Storm Irene, as in some areas the entire road grade had been eroded. The sections of the road that were reconstructed are armored extensively with boulder riprap, gabion baskets, stacked boulders, and concrete retaining walls. In some areas this armor constricts the stream channel, potentially increasing the risk of future fluvial erosion. In other areas the riprap has started to be undermined by migrating headcuts, which represent vertical instability in the stream bed.

Sediment from Clesson Brook and other tributaries deposited in the Deerfield River contributes to the formation of large gravel bars and represents increased hazards to bridges, roads, and other infrastructure. A major source of the sediment loading in Clesson Brook are the numerous mass failures along the channel. The fluvial geomorphic assessment identified 28 mass failures, the largest being 180 feet long and 40 feet high. Additionally, bank mapping completed as a part of the assessment determined 20% of the banks along the Clesson Brook are eroding, and 15% of the banks are armored.

Community Concerns

Individuals in the watershed are concerned about the incidence of future erosion, sedimentation, and inland flooding in the watershed. Although Tropical Storm Irene moved through the watershed over 10 years ago, many community members are still dealing with the effects from the storm and are worried about the damage the next storm system will bring.

Community members expressed concerns related to the impacts of climate change – especially with regard to increased precipitation. One participant in a community meeting held during the production of this WBP noted precipitation (including snowmelt) has increased from approximately 56 inches per year to 59-60 inches over the past 20 years. Other community concerns included aging and undersized drainage and road infrastructure (culverts and bridges), beaver dams, straightened sections of the river, and existing roads and buildings in the floodplain.

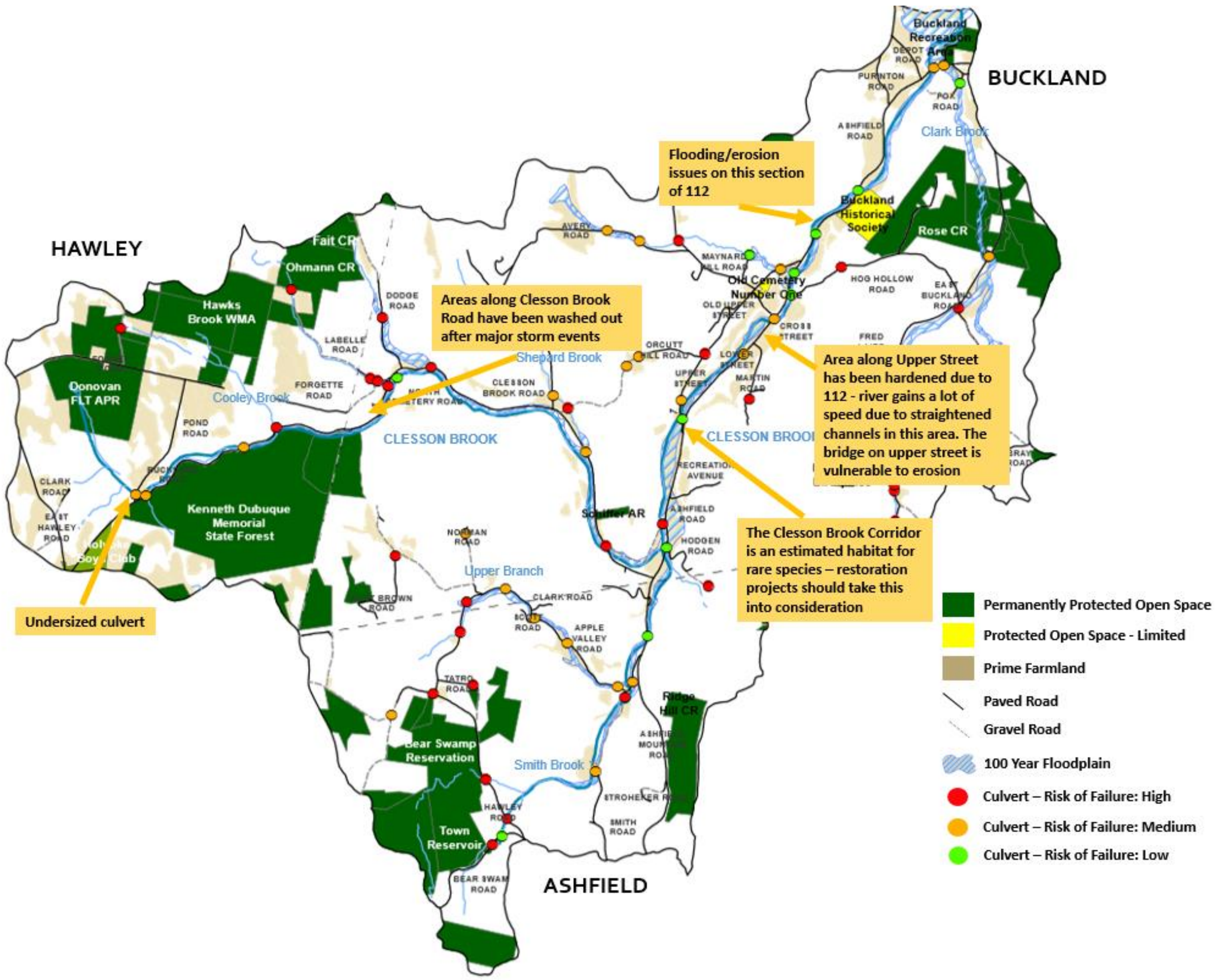


Figure 2: Example of concerns expressed by community members during the Clesson Brook Watershed Open House held in January 2022. A PDF with all comments is included as Appendix A.

Summary of Completed Work

The Town of Buckland received an Action Grant award from the EEA's MVP program to complete several studies that informed the development of this WBP, which are briefly described below. GZA GeoEnvironmental Inc. and Field Geology services performed all of the assessments.

Fluvial Geomorphic Assessment of Clesson Brook

Fluvial geomorphic assessments evaluate how the natural setting and history of human land use in a watershed affect river channel processes and form (i.e., channel dimensions and shape). The specific objectives of the Clesson Brook watershed fluvial geomorphic assessment were to: 1) characterize past and current channel conditions; 2) determine past and current human land uses that have resulted in ongoing channel adjustments;

and 3) identify natural watershed conditions that control the character and rates of channel adjustment. The fluvial geomorphic assessment found Clesson Brook and its tributaries have been adjusting to lower discharges (relative to Tropical Storm Irene) and a higher sediment load, one that includes a significant suspended load of clay and silt as well as bedload gravel, cobbles and boulders. Thirty-five percent of stream banks that were mapped as a part of the assessment are either eroding or armored, representing the lateral instability in the system. The full report is included as Appendix B.

Hydrologic and Hydraulic Model of the Clesson Brook Watershed

The objective of the hydrologic analysis was to develop peak flow rates for the Clesson Brook watershed to be used in hydraulic modeling. The analysis includes the 10-year, 50-year, 100- year, and 500-year peak flow rates for the present day, as well as taking into consideration late- century potential climate change scenarios. The objective of the existing conditions hydraulic analysis was to evaluate flood and seasonal flow water surface elevations, velocities, and inundation extents under present and projected future conditions considering climate change. This model was used to analyze proposed restoration conditions in the Clesson Brook Watershed.

Comprehensive assessment of road-stream crossings along the Clesson Brook and its main tributaries

GZA GeoEnvironmental Inc. developed a comprehensive database of assessed and unassessed road-stream crossings within the Clesson Brook watershed, which was used for prioritization of crossings for replacement. Based on the scoring system that was developed for the assessment, there are 13 priority risk road-crossing rankings identified for the 152 road-stream crossings in the Clesson Brook watershed. The full report is included as Appendix C.

Identification and mapping of vulnerable Clesson Brook Watershed segments & prioritization of parcels within the Clesson Brook Watershed for conservation

GZA, in partnership with Field Geology Services, compiled the results of the Fluvial Geomorphic Assessment, Hydrologic and Hydraulic Analysis, and Prioritized Road-Stream Crossing Replacement Assessment to identify segments of the Clesson Brook Watershed that are exposed to vulnerabilities from climate change. Segments of Clesson Brook and lower Smith Brook were identified as high priority based on fluvial erosion and/or inundation hazards and/or otherwise a priority for conservation.

Based on those segments identified as high priority, parcels to be prioritized for conservation were selected along Clesson Brook and lower Smith Brook. Parcels along upland tributaries were selected based on the presence of crossings identified for replacement and where large expanses of privately-owned open space were observed along upland tributaries, as detailed fluvial erosion and/or inundation hazards were not examined along the upland tributaries. Based on the evaluation, there are 58 parcels identified for potential conservation in the Clesson Brook watershed. This report is included as Appendix D. Conserving these parcels over time and protecting them from development will make the Clesson Brook Watershed more resilient to the effects of climate change by providing benefits such as habitat, carbon sequestration, and storage for floodwaters and associated sediment.

Identification of potential restoration projects and development of conceptual designs

The most common categories of impacts observed along Clesson Brook include fluvial erosion, flooding, channel straightening and lack of large woody debris, undersized culverts and bridges, and disconnection of the channel from its floodplain. GZA GeoEnvironmental Inc. and Field Geology Services identified restoration options best suited to address the impacts to the impaired segments and to work towards bringing Clesson Brook back to geomorphic equilibrium and make the watershed more resilient to the impacts of climate change. There are 12 restoration projects that were identified for potential future implementation in the Clesson Brook watershed. Conceptual designs for four of these restoration projects were then developed. The restoration projects and conceptual designs are included in the Appendix of the Fluvial Geomorphic Assessment, which is included as Appendix B.

Watershed Based Plan Development

Project Partners and Stakeholder Input

This WBP was developed by the Franklin Regional Council of Governments (FRCOG) with input and collaboration from the Town of Buckland and MassDEP and with technical assistance from GZA GeoEnvironmental Inc. and Field Geology Services. This WBP was developed using funds from the MassDEP's 604(b) Water Quality Management Planning Grant Program and the EEA's Municipal Vulnerability Preparedness Action Grant Program.

Core project stakeholders and their points of contact include:

- Town of Buckland
  - Heather Butler, *Town Administrator*
  - Anthony Gutierrez, *Highway Foreman*
- Consultant Team
  - Rosalie Starvish, *Senior Project Manager / Water Resources Engineer, GZA GeoEnvironmental Inc.*
  - Nic Miller, *Fluvial Geomorphologist, Field Geology Services*
- MassDEP:
  - Padmini Das, Ph.D., *Nonpoint Source Pollution Section Chief*
  - Malcolm Harper, *319 Grant Coordinator*
  - Judith Rondeau, *Nonpoint Source Pollution Watershed Specialist and Outreach Coordinator*
  - Meghan Selby, *604b Grant Coordinator*
  - Matthew Reardon, *TMDL Section Chief*

While the FRCOG worked with the aforementioned core stakeholders on the drafting of the plan, the FRCOG engaged a broad range of stakeholders during public education and outreach and the public review period for this WBP, including residents from Buckland, Hawley, and Ashfield, town staff from all three watershed towns, and the Franklin Regional Planning Board.[4] Buckland will want to continue broader outreach and input into the plan and implementation in the future to ensure the support of public and private landowners.

Data Sources

This WBP was developed using the framework and data sources provided by MassDEP's WBP Tool and supplemented by data from additional studies and a watershed field investigation.

[4] Recordings of some of the presentations completed as a part of public education and outreach are included under the "Events" tab of the *Building Climate Resiliency in the Clesson Brook Watershed* StoryMap: https://storymaps.arcgis.com/stories/c6bde5f5a342459bbb1df1a07a04182a

Element A: Identify Causes of Impairment & Pollution Sources

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

General watershed information:

Water Quality Impairments

The MassDEP 2022 Massachusetts Integrated List of Waters does not list any impairments for the Clesson Brook Watershed. However, the fluvial geomorphic assessment confirmed Clesson Brook suffers from instability following excessive sediment mobilization and deposition during Tropical Storm Irene. In the 13 years since Tropical Storm Irene, Clesson Brook and its tributaries have been adjusting to lower discharges, and a higher sediment load. As previously noted, 20% of the banks along the assessed reaches of Clesson Brook and lower Smith Brook were mapped as eroding. In addition, 15% of the banks were armored. In total, 35% of the total length of the stream banks were classified as unstable. Sedimentation and fluvial geomorphic instabilities are impairments in this Healthy Watershed. All streams are designated as Coldwater Fish Resources (CFRs); sedimentation and those impairments negatively affect sensitive habitats.[5] Stabilizing streambanks, reducing erosion, improving riparian buffers, and addressing fluvial geomorphic impairments will help to maintain Clesson Brook's status as a Healthy Watershed.

Water Quality Goals

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

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

b.) For **water bodies without a TMDL for total phosphorus** (TP), a default water quality goal for TP is based on target concentrations established in the Quality Criteria for Water (USEPA, 1986) (also known as the "Gold Book"). The Gold Book states that TP should not exceed 50 ug/L in any stream at the point where it enters any lake or reservoir, nor 25 ug/L within a lake or reservoir. For the purposes of developing WBPs,

[5] A Coldwater Fish Resource (CFR) is a waterbody (stream, river, or tributary thereto) used by reproducing coldwater fish to meet one or more of their life history requirements. CFRs are particularly sensitive habitats. https://www.mass.gov/info-details/coldwater-fish-resources

MassDEP has adopted 50 ug/L as the TP target for all streams at their downstream discharge point, regardless of which type of water body the stream discharges to.

c.) Massachusetts Surface Water Quality Standards (314 CMR 4.00, 2013) prescribe the minimum water quality criteria required to sustain a waterbody's designated uses. This watershed is a Class 'B' waterbody. The water quality goal for fecal coliform bacteria is based on the Massachusetts Surface Water Quality Standards.

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

Assessment Unit ID	Waterbody	Class
MA33-116	Unnamed Tributary	B
MA33-15	Clesson Brook	B
MA33-26	Smith Brook	B
MA33-45	Cooley Brook	B
MA33-79	Ruddock Brook	B

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

Table A-5: Water Quality Goals

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

Pollutant	Goal	Source
	of samples from most recent 6 months shall not exceed 33 colonies/100 ml, and no single sample shall exceed 61 colonies/100 ml.	

Note: *There may be more than one water quality goal for bacteria due to different Massachusetts Surface Water Quality Standards Classes for different Assessment Units within the watershed.*

MassDEP Water Quality Assessment Report and TMDL Review

The following reports are available:

- Deerfield River Watershed 2000 Water Quality Assessment Report

The section below summarizes the findings of any available Water Quality Assessment Report and/or TMDL that relate to water quality and water quality impairments. Select excerpts from these documents relating to the water quality in the watershed are included below (note: relevant information is included directly from these documents for informational purposes and has not been modified).

Deerfield River Watershed 2000 Water Quality Assessment Report (MA33-26 - Smith Brook)
AQUATIC LIFE Habitat and Flow Smith Brook was sampled by DWM biologists downstream from the confluence with Upper Branch in Ashfield (Station VP04SMI) in September 1996 as part of the MA DEP Biocriteria Development Project. At the time of the survey the brook was roughly 10 m wide with depths ranging from 0.25 m to 0.5 m. The substrates were comprised primarily of cobble, sand and boulders. The overall habitat score was 147 (MA DEP 1996b). The instream habitat was limited most by the channel flow status, the riparian vegetative zone width and bank vegetative cover. Biology Smith Brook was sampled by DWM downstream from the confluence with Upper Branch in Ashfield (Station VP04SMI) in September 1996 as part of the DWM Biocriteria Development Project (Appendix C). Fish species captured in order of abundance included slimy sculpin (Cottus cognatus), rainbow trout (Onchorynchus mykiss), longnose dace (Rhinichthys cataractae), blacknose dace (Rhinichthys atratulus), and brook trout (Salvelinus fontinalis) (MA DEP 1996b). Multiple age classes of both rainbow and brook trout were present. All fish species collected in this brook are fluvial specialists/dependants. The presence of multiple age classes of brook and rainbow trout, multiple intolerant species, and the absence of macrohabitat generalists indicated excellent habitat and water quality conditions as well as stable flow regimes. Chemistry-water In-situ measurements (DO, %saturation, pH, temperature, conductivity, and turbidity) in Smith Brook were taken downstream from the confluence with Upper Branch in Ashfield (Station VP04SMI) on 24 September 1996 and near the confluence with Clesson Brook in Buckland (Four Corners) and Upper Branch (Station UB01) on 27 September 1995 (Appendix G, Table G3). No recent data are available so the Aquatic Life Use is not assessed. PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS DWM collected one fecal coliform bacteria sample each from Smith Brook near the confluence with Clesson Brook in Buckland (Four Corners) and from Upper Branch (Station UB01) on 27 September 1995 (Appendix G, Table G4). With the exception of a sewage odor noted in the upper area of the stream reach sampled by DWM biologists in Smith Brook in September 1996, no other objectionable deposits, or conditions were noted (MA DEP 1996b).

Deerfield River Watershed 2000 Water Quality Assessment Report (MA33-26 - Smith Brook)

No recent data are available to assess the Recreational and Aesthetic uses, so they are not assessed.

The drainage area of this segment is approximately 5.77 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):
Forest 80.8%
Agriculture 7.5%
Open Land 6.8%

MA DFWELE has recommended that Smith Brook and its tributary Upper Branch be protected as cold water fishery habitat (MassWildlife 2001).

Landfills
The Deerfield River Watershed Landfill Assessment Study (Fuss and O'Neill 2003) identified one historic landfill in this segment; the Ashfield Landfill/Demolition /Wood Waste Landfill. The Ashfield Landfill/Demolition/Wood Waste Landfill is over 25 years old and is capped and lined. The site contains municipal waste and wood waste, is within one-half mile of private water supplies, 0.9 miles from of a community wellhead protection area, and approximately 2000 feet from Smith Brook. In 2002, MA DEP required the Town of Ashfield to prepare an Initial Site Assessment including test borings, monitoring wells, and soil and water sampling. Since this sampling is planned, Fuss and O'Neill did not recommend that screening level sampling be performed at this site under their study.

Report Recommendations:
• Conduct water quality and biological monitoring in this segment during the next monitoring year cycle (2005) to assess the status of designated uses.
• Smith Brook and its tributary Upper Branch should be protected as cold-water fishery habitat as recommended by MA DFWELE.
• The Town of Ashfield should participate in the Deerfield River Watershed Regional Open Space Planning Projects, which were funded by the Massachusetts Watershed Initiative/Deerfield River Watershed Team and conducted by the Franklin Regional Council of Governments and Dodson Associates. Through these projects the town can work cooperatively with other watershed communities to prioritize regional open space and recreational land acquisitions and protection goals, including water resources.
• In order to prevent degradation of water quality in the Smith Brook subwatershed it is recommended that land use planning techniques be applied to direct development, preserve sensitive areas, and maintain or reduce the impervious cover. The Town of Ashfield should support recommendations of the recently developed individual municipal open space plan and/or Community Development Plan to protect important open space and maintain their community's rural character.
• The rural roads that cross over and/or are in close proximity to watercourses should be identified. Field reconnaissance should be performed to evaluate their potential for impacting the water and habitat quality of these adjacent watercourses. Implementation of best management practices, as described in Unpaved Roads BMP Manual (BRPC 2001), should then be encouraged, as appropriate.

Deerfield River Watershed 2000 Water Quality Assessment Report (MA33-15 - Clesson Brook)

AQUATIC LIFE
Habitat and Flow
DWM biologists sampled one stream reach in Clesson Brook in September 1996 (Appendix G, Tables G3 and G4). The reach was located downstream from Hog Hollow Road off of the east side of Route 112 in Buckland (Station VP10CLE) and was surveyed as part of the MA DEP Biocriteria Development Project. The left side of Clesson Brook is channelized and riprapped due to the adjacent Route 112. Periphyton was very abundant and covered approximately 50% of the reach (Appendix D). Instream cover was suboptimal. A horse farm was located on the right bank and impacted the riparian zone. Habitat quality was limited because of the minimal riparian zone width and vegetative cover and the limited channel flow status. The total habitat assessment score was 149.

Biology
As part of the MA DEP Biocriteria Development Project benthic macroinvertebrate samples were collected by DWM biologists from Clesson Brook at Station VP10CLE (described above) on 5 September 1996. DWM also conducted fish population sampling on 26 September 1996 in Clesson Brook. Fish collected in order of abundance included: blacknose dace (Rhinichthys atratulus), longnose dace (Rhinichthys cataractae), white sucker (Catostomus commersoni), slimy sculpin (Cottus cognatus), and creek chub (Semotilus atromaculatus). One of the species collected is considered intolerant of pollution. All fish species collected in this brook are fluvial specialists/dependants. The absence of macrohabitat generalists and the presence of slimy sculpin (intolerant) are indicative of generally good habitat and water quality conditions and stable flow regimes.

Chemistry - Water
In-situ measurements (DO, %saturation, pH, temperature, conductivity, and turbidity) of Clesson Brook downstream from Hog Hollow Road off the east side of Route 112 in Buckland (Station VP10CLE) were made on 26 September 1996 as part of the MA DEP Biocriteria Development Project (Appendix G, Table G3). DWM also collected water quality samples from Clesson Brook at Route 112 bridge northeast of Depot Road in Buckland (Station CL) between September 1995 and June 1996 (n = 9) and two upstream locations (Stations CL02 and SH01) as part of the 1995/1996 Deerfield River Watershed monitoring survey (Appendix G, Tables G3 and G4).

Water quality samples were collected from Clesson Brook at three stations on as many as six occasions between August and November 2000 by ESS (ESS 2002):
- Station DW21 at the confluence of Sheperd Brook and Clesson Brook, Buckland Four Corners;
- Station DW20 adjacent to the intersection of Route 112 and Charlemont Road, upstream of agricultural areas, midway to Smith Brook, Buckland; and
- Station DW19 near the confluence with the Deerfield River, Buckland.

DO and % saturation
Although not representative of worst-case (pre-dawn) conditions the instream DOs were not less than 11.5 mg/L or 90.6% saturation. Saturation was as high as 105.2%.

Temperature
The maximum instream temperature was 17.1°C.

pH
The pH ranged from 7.0 to 7.3 SU at all three locations.

Turbidity
Turbidity ranged from 0.08 to 1.92 NTU.

Conductivity
Specific conductivity measurements ranged from 13.2 to 132.6 µS/cm.

The Aquatic Life Use for Clesson Brook is assessed as support based on the limited water quality data and best professional judgment. It is noteworthy that although temperature and oxygen levels met cold water fishery standards, salmonids were not collected during sampling of this proposed cold water fishery. This use is, therefore, identified with an “Alert Status” because of the absence of salmonids in the fish population sample and because the habitat assessment identified a number of potential concerns that may be impacting the habitat.

Deerfield River Watershed 2000 Water Quality Assessment Report (MA33-15 - Clesson Brook)

PRIMARY AND SECONDARY CONTACT RECREATION AND AESTHETICS
DWM collected fecal coliform bacteria samples from Clesson Brook at Route 112 bridge northeast of Depot Road in Buckland (Station CL) between September 1995 and June 1996 (n = 8) and several upstream locations (Stations SH01, CL02, CL03, and UB01) as part of the 1995/1996 Deerfield River Watershed monitoring survey (Appendix G, Table G4).
Fecal coliform bacteria samples were collected from Clesson Brook at three stations on six occasions representing both wet and dry weather sampling between August and November 2000 by ESS (ESS 2002). Four of the sampling events were conducted during the Primary Contact Recreational season of April 15 through October 15. Results were:
- Station DW21 at the confluence of Sheperd Brook and Clesson Brook, Buckland Four Corners - fecal coliform bacteria counts ranged from 6 to 70 col/100 mL;
- DW20 adjacent to the intersection of Route 112 and Charlemont Road, upstream of agricultural areas, midway to Smith Brook, Buckland - fecal coliform bacteria counts ranged from 6 to 100 col/100 mL; and
- DW19 near the confluence with the Deerfield River, Buckland - fecal coliform bacteria counts ranged from 8 to 60 col/100 mL.

With the exception of some decomposing algae and associated strong odors no other objectionable deposits, sheens or conditions were noted during the biological monitoring survey conducted by DWM biologists in Clesson Brook in September 1995 (Appendix C).

The Recreational and Aesthetics uses are assessed as support for Clesson Brook based on the low fecal coliform bacteria counts and the habitat quality information.

The drainage area of this segment is approximately 21.24 square miles. Land-use estimates (top three) for the subwatershed (map inset, gray shaded area):
Forest 81.4%
Agriculture 9.6%
Open Land 4.7%

NRCS provided best management practice guidance to selected land owners in the Clesson Brook subwatershed following DWM's 1995/1996 Deerfield River Watershed monitoring survey. Several agricultural BMPs were implemented in this subwatershed (Leone 1999).

The Natural Heritage and Endangered Species Program has certified five vernal pools in this subwatershed (MassGIS 1999).

MA DFWELE has recommended that Clesson Brook and several tributaries in its subwatershed - Cooley, Ruddock, and Sheperd brooks - be protected as cold water fishery habitat (MassWildlife 2001).

Landfills
The Deerfield River Watershed Landfill Assessment Study (Fuss and O'Neill 2003) identified one historic landfill in this segment; the Buckland Landfill. The Buckland Landfill is over 25 years old and received municipal, demolition, and industrial waste as well as sludge from Shelburne Falls WWTP. Fly ash and bottom ash were used as daily cover material. The landfill underwent MA DEP closure and capping in the late 1990s, but is not lined. Environmental monitoring has been conducted at this site since 1991, including an Initial Site Assessment, a Comprehensive Site Assessment, and post-closure monitoring. Since this site is already being monitored it was not recommended for screening level sampling by Fuss and O'Neill (2003).

Report Recommendations:
• Water quality monitoring in Clesson Brook should be conducted during the next monitoring year cycle (2005) to assess whether or not nutrient enrichment is occurring in this subwatershed from nonpoint sources of pollution, including agricultural inputs. In addition, fish population sampling should be conducted in Clesson Brook to document the presence of salmonids.
• Between the 1995 and 2000 year surveys on this stream NRCS worked with several landowners to implement agricultural BMPs in this subwatershed. These activities may have contributed to the drop in coliform bacteria measured in the stream below the agricultural areas. It is recommended that NRCS and DFA continue to work with landowners to maintain and expand the use of BMPS to protect riparian areas and prevent agricultural runoff and streambank erosion.
• Based on MA DFWELE recommendations, Clesson Brook and several tributaries in its subwatershed - Cooley, Ruddock, and Sheperd brooks - should be protected as cold water fishery habitat.
• The Towns of Ashfield, Buckland and Hawley should participate in the Deerfield River Watershed Regional Open Space

Deerfield River Watershed 2000 Water Quality Assessment Report (MA33-15 - Clesson Brook)
Planning Projects, which were funded by the Massachusetts Watershed Initiative/Deerfield River Watershed Team and conducted by the Franklin Regional Council of Governments and Dodson Associates. Through these projects these towns can work cooperatively with other watershed communities to prioritize regional open space and recreational land acquisitions and protection goals, including water resources. • In order to prevent degradation of water quality in the Clesson Brook subwatershed it is recommended that land use planning techniques be applied to direct development, preserve sensitive areas, and maintain or reduce the levels of impervious cover. The Towns of Ashfield, Buckland and Hawley should support recommendations of their recently developed individual municipal open space plans and/or Community Development Plans to protect important open space and maintain their communities' rural character. • The rural roads that cross over and/or are in close proximity to watercourses should be identified. Field reconnaissance should be performed to evaluate their potential for impacting the water and habitat quality of these adjacent watercourses. Implementation of best management practices, as described in Unpaved Roads BMP Manual (BRPC 2001), should then be encouraged, as appropriate. • The volunteer monitoring surveys to locate and map Japanese knotweed infestations conducted in 2003 by the DRWA as part of a Massachusetts Watershed Initiative/Deerfield River Watershed Team workplan project in the Clesson Brook subwatershed identified and mapped extensive patches of this plant growing between Buckland Four Corners and Clesson Brook's confluence with the Deerfield River. Results of this study should be consulted and local efforts to help manage current and future infestations of this invasive plant should be encouraged (Serrentino 2003).

Historical and current Technical Memoranda (TM) produced by the MassDEP Watershed Planning Program (WPP) are available here: Water Quality Technical Memoranda | Mass.gov and are organized my major watersheds in Massachusetts. Most of these TMs present the water chemistry and biological sampling results of WPP monitoring surveys. The TMs pertaining primarily to biological information (e.g., benthic macroinvertebrates, periphyton, fish populations) contain biological data and metrics that are currently not reported elsewhere. The data contained in the water quality TMs are also provided on the "Data" page (Water Quality Monitoring Program Data | Mass.gov). Many of these TMs have helped inform Clean Water Act 305(b) assessment and 303(d) listing decisions.

Water Quality Data

Deerfield River Watershed Association (DRWA) Water Quality & Monitoring[6]

The DRWA intermittently documents water quality in the main stem of the Deerfield River and its tributaries. From 2017 to 2019, the organization had funding to test Clesson Brook for total nitrogen and total phosphorus. No other sampling data for these nutrients are available. The DRWA routinely tests Clesson Brook for E. coli and that testing will continue, as long as they have funding.

[6] All reports can be found on DWRA's website: https://deerfieldriver.org/water-quality

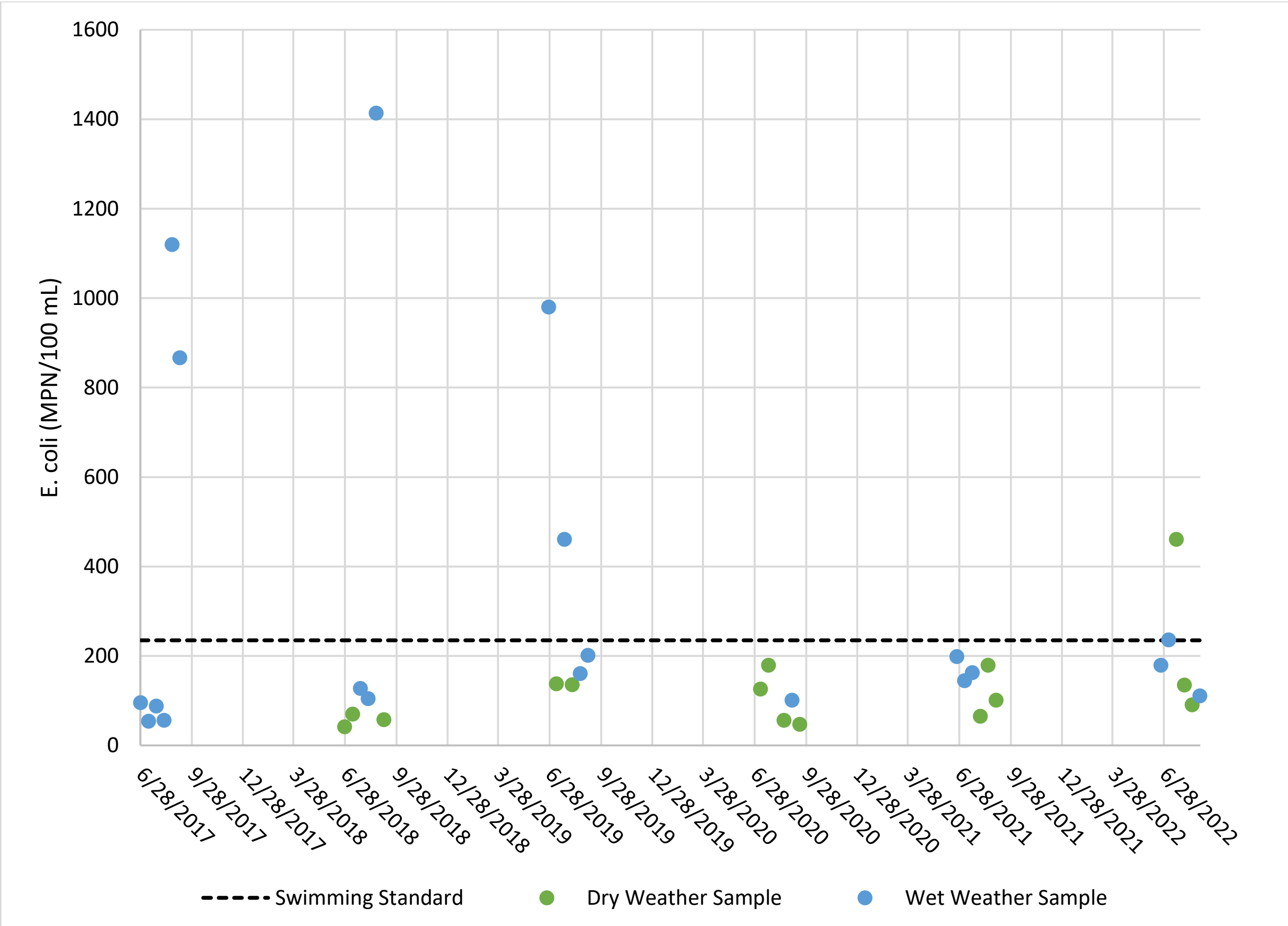


Figure A-1: E.coli in the Clesson Brook 2017-2022.

Source: Deerfield River Watershed Association/Connecticut River Conservancy

Note: Samples taken during wet weather indicate there was >.1" rain in 24 hours prior to sampling.

From 2019 to 2022, E. coli levels in Clesson Brook only exceeded the VT & EPA suitability for swimming standard during one test following dry weather. The other exceedances followed a period of heavy rain, which routinely leads to elevated levels of E. coli.

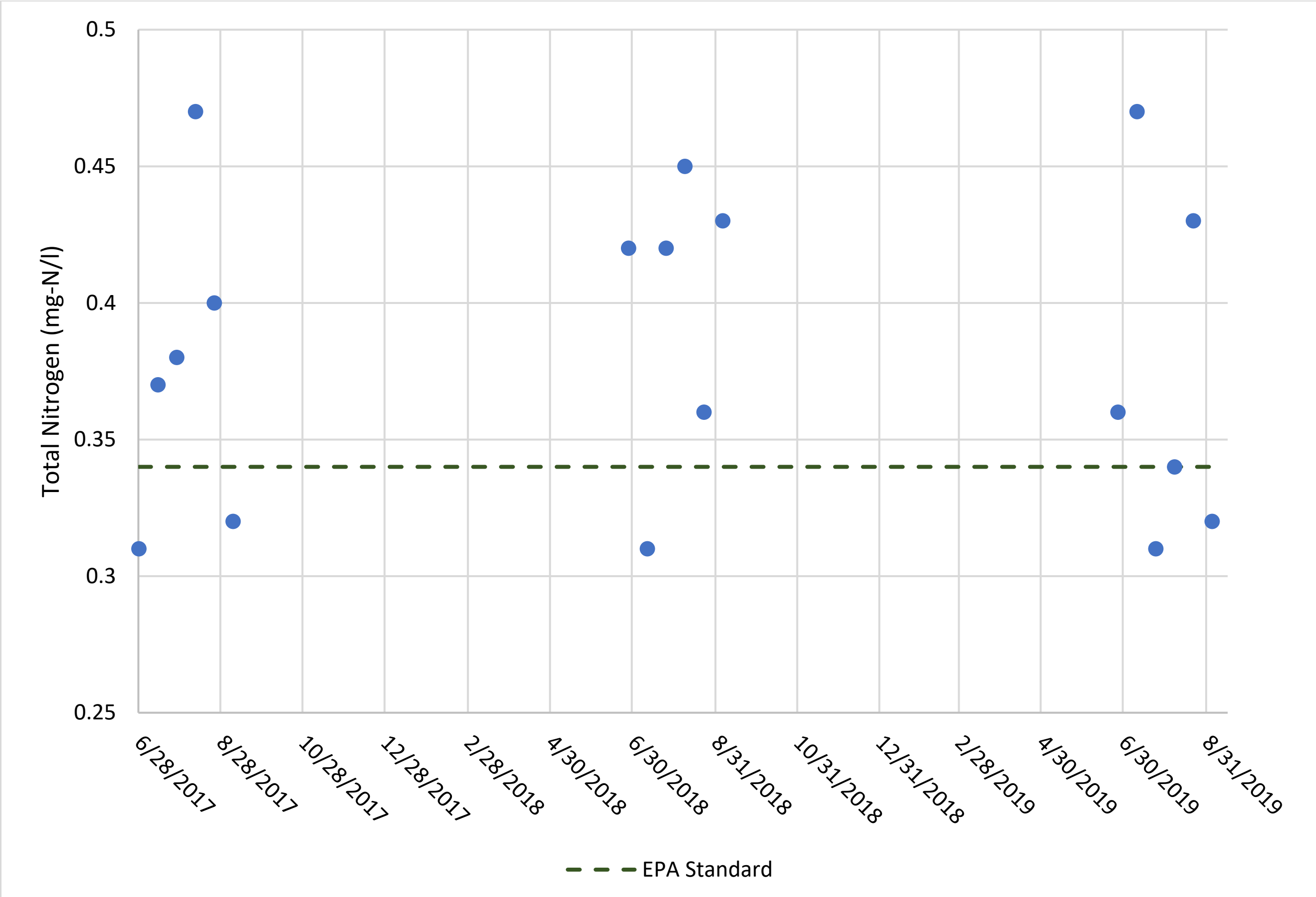


Figure A-2: Total Nitrogen levels in the Clesson Brook 2017-2019

Source: Deerfield River Watershed Association/Connecticut River Conservancy

There is no numerical state standard for nitrogen in Massachusetts and the standard in Vermont is 5.0 mg-N/L of water. For waters entering Long Island Sound, the EPA currently recommends a limit of 0.34 mg-N/L based on literature values.[7] This criteria is used as a comparative standard in this WBP, as the waters of the Clesson Brook ultimately travel to the Long Island Sound. Nitrogen levels in the Clesson Brook frequently exceeded the EPA suggestion of 0.34 mg-N/L from 2017 to 2019. Elevated levels of nitrogen are typically due to agricultural soil erosion and runoff, wastewater, or failing septic systems. There is a link between nitrogen levels and sediment loading.

[7] O'Donnell 2019

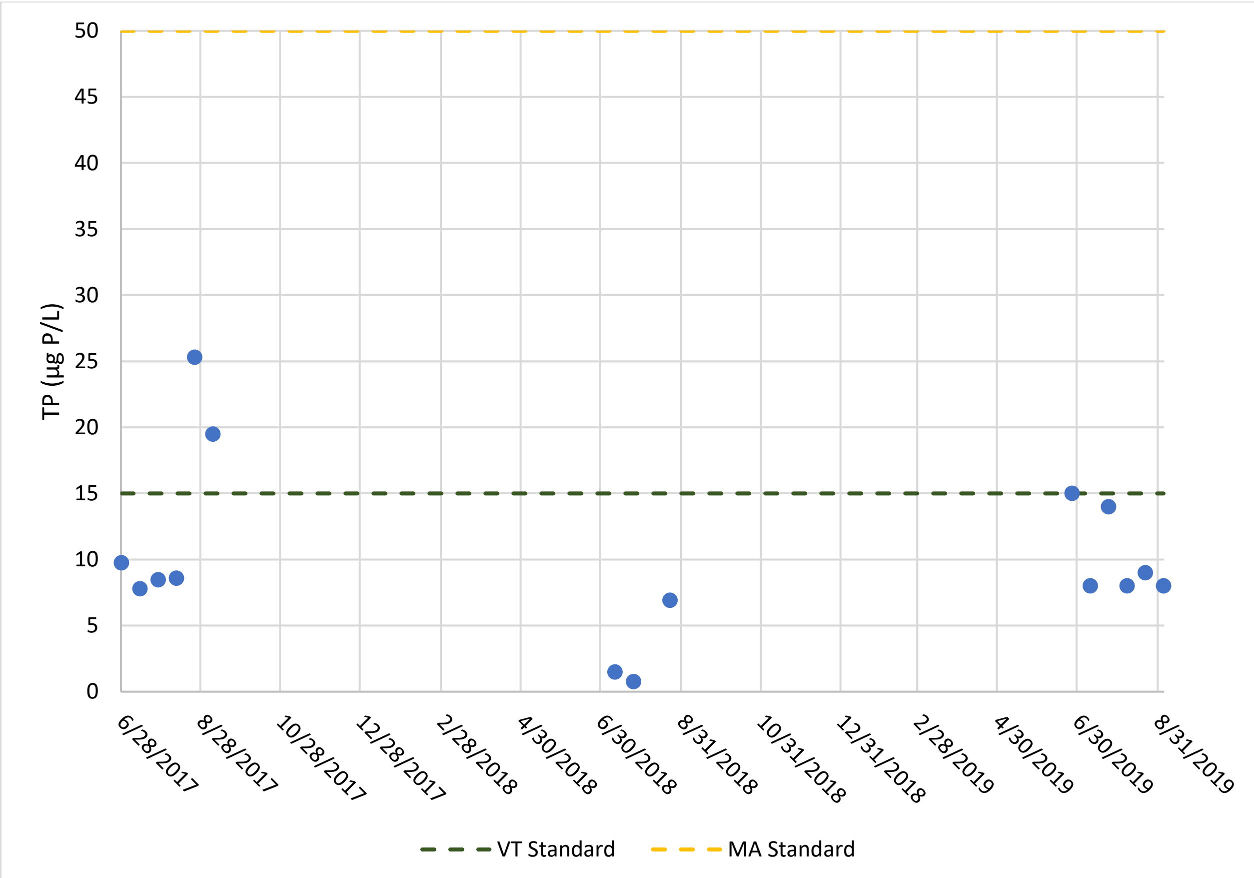


Figure A-3: Total Phosphorus levels in the Clesson Brook 2017-2019
Source: Deerfield River Watershed Association/Connecticut River Conservancy

Average total phosphorus levels in Clesson Brook remained well under the Massachusetts standard of 50 µg P/L, and were typically below the Vermont standard of 15 µg P/L. Similar to nitrogen, elevated levels of phosphorus can occur from agricultural soil erosion and runoff, wastewater, and failing septic systems.

Land Use and Impervious Cover Information

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

Watershed Land Uses

Table A-6: Watershed Land Uses

Land Use	Area (acres)	% of Watershed
Agriculture	1192.46	10.3
Commercial	5.32	0
Forest	9815.21	84.6
High Density Residential	0.91	0

Land Use	Area (acres)	% of Watershed
Highway	0	0
Industrial	30.18	0.3
Low Density Residential	346.21	3
Medium Density Residential	1.72	0
Open Land	181.71	1.6
Water	31.29	0.3

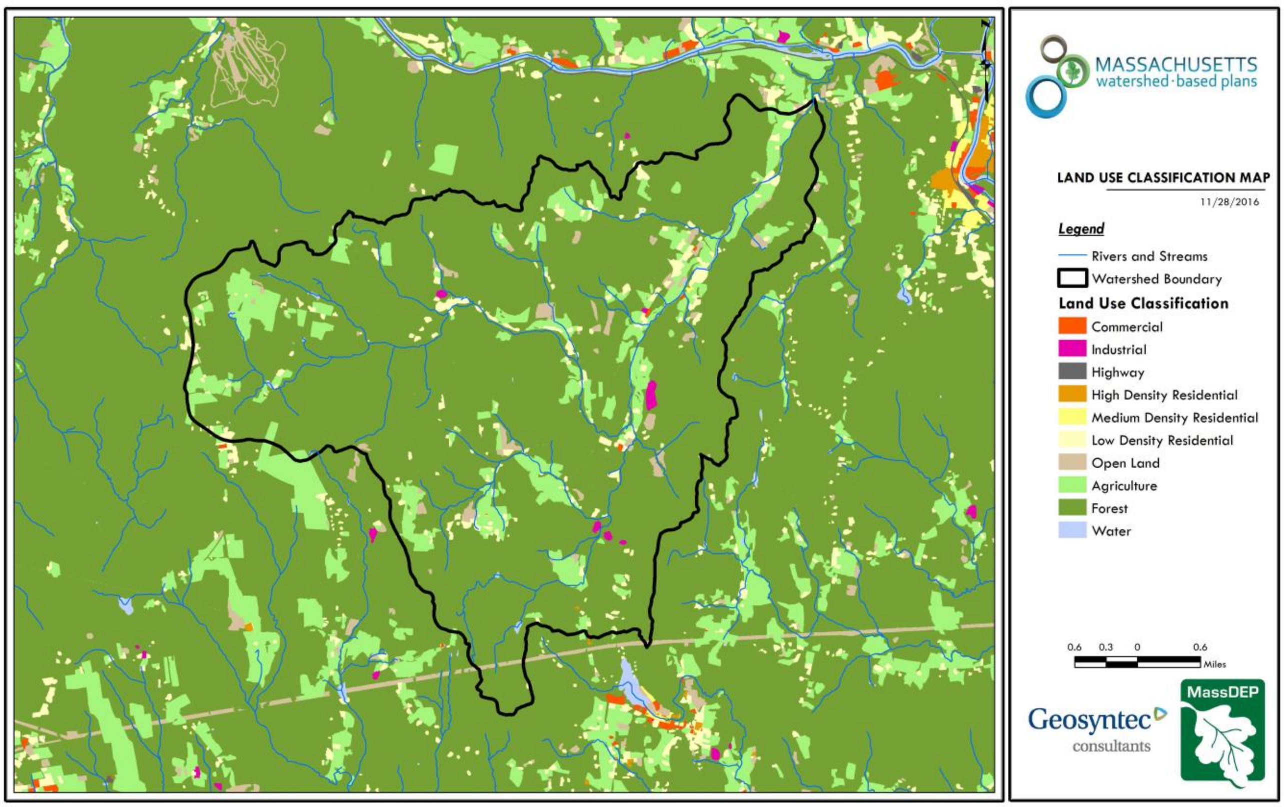


Figure A-4: Watershed Land Use Map (MassGIS, 2007; MassGIS, 2009b; MassGIS, 1999; MassGIS, 2001; USGS, 2016)

Watershed Impervious Cover

There is a strong link between impervious land cover and stream water quality. Impervious cover includes land surfaces that prevent the infiltration of water into the ground, such as paved roads and parking lots, roofs, basketball courts, etc.

Impervious areas that are directly connected (DCIA) to receiving waters (via storm sewers, gutters, or other impervious drainage pathways) produce higher runoff volumes and transport stormwater pollutants with greater efficiency than disconnected impervious cover areas which are surrounded by vegetated, pervious land.

Runoff volumes from disconnected impervious cover areas are reduced as stormwater infiltrates when it flows across adjacent pervious surfaces.

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

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

	Estimated TIA (%)	Estimated DCIA (%)
Watershed	1.7	1.4

The relationship between TIA and water quality can generally be categorized as shown in **Table A-8** (Schueler et al. 2009):

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

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

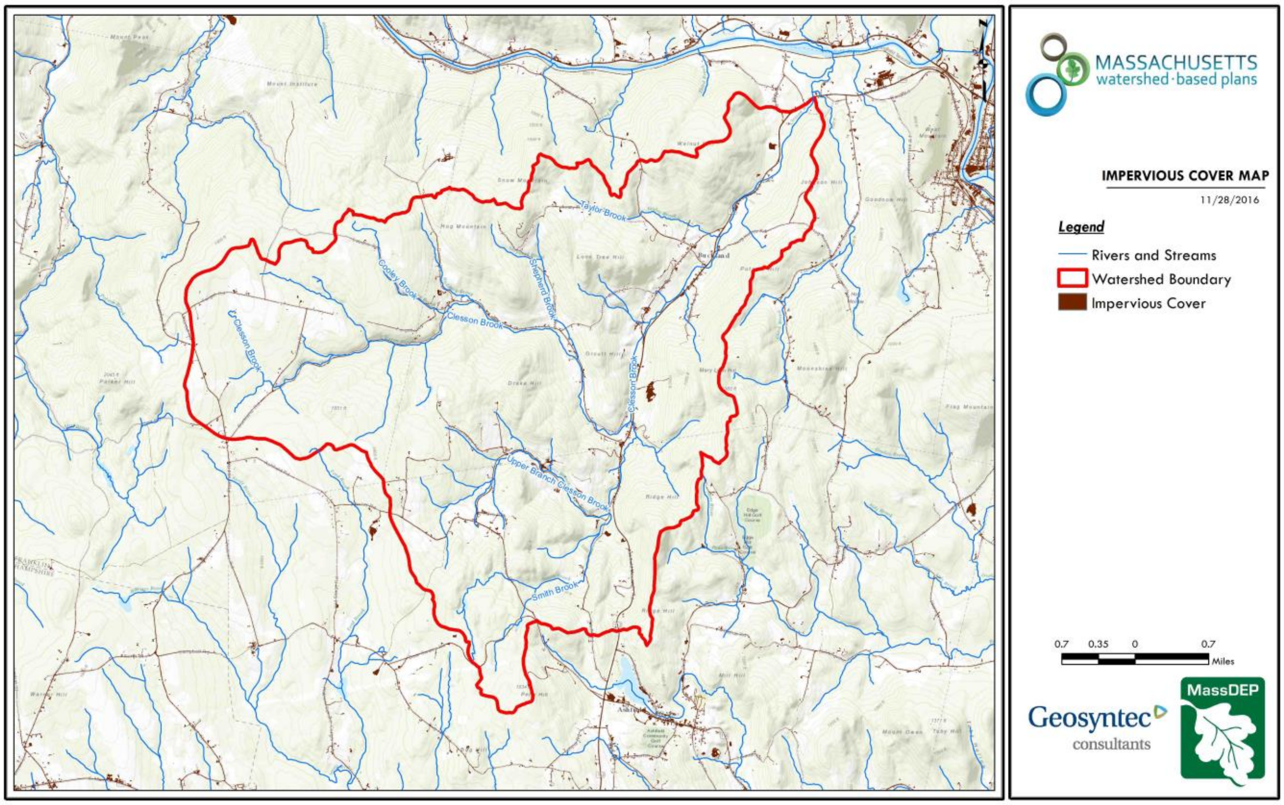


Figure A-5: Watershed Impervious Surface Map (MassGIS, 2007; MassGIS, 2009b; MassGIS, 1999; MassGIS, 2001; USGS, 2016)

Pollution Sources

Fluvial Erosion[8]

Table A-9 and field observation indicate channel erosion is the primary contributor of sediment loading in the watershed. In the 13 years since the flooding from Tropical Storm Irene, Clesson Brook and its tributaries have been adjusting to lower discharges and a higher sediment load, which includes a significant suspended load of clay, silt, bedload gravel, cobbles, and boulders. One of the responses to these changes has been the initiation of headcuts, or knickpoints, in the stream channel. Headcuts represent a vertical instability in the stream bed, in this case one that was initiated in the aftermath of Tropical Storm Irene. Eighty-seven (87) headcuts were mapped along the length of Clesson Brook. In reaches with coarser substrates composed of larger boulders these headcuts still appear steep and hydraulicly rough after 11 years, whereas in reaches with coarse gravel and cobble beds it is often difficult to identify these features as the bed morphology transitions back to one more in equilibrium with the current flow conditions.

[8] The section on fluvial erosion is adapted from the Fluvial Geomorphic Assessment of the Clesson Brook Watershed, prepared by Nicolas Miller of Field Geology Services with funding from an EEA Municipal Vulnerability Preparedness Action Grant.

The headcuts and vertical instabilities as previously described often correspond to lateral instabilities in the form of eroding banks (and formerly eroding armored banks). The vertical incision, or channel-downcutting, following upstream knickpoint migration leaves a deeper channel with higher steam banks. This is part of a well-documented channel evolution model where channel incision is followed by bank erosion and channel widening as more water is contained within the channel before spreading out onto the floodplain. There is a tendency for banks to become destabilized and erode following knickpoint migration, and this tendency was observed along the length of Clesson Brook.

Twenty percent of the banks along the assessed reaches of Clesson Brook and lower Smith Brook were mapped as eroding. In addition, 15% of the banks were armored. Together, 35% of the total length of the stream banks were classified as unstable. Bank erosion was not spread evenly throughout the mapped study area; there are many stream segments with little or no mapped bank erosion. Five segments along Clesson Brook all had eroding banks for more than 40% of their length.

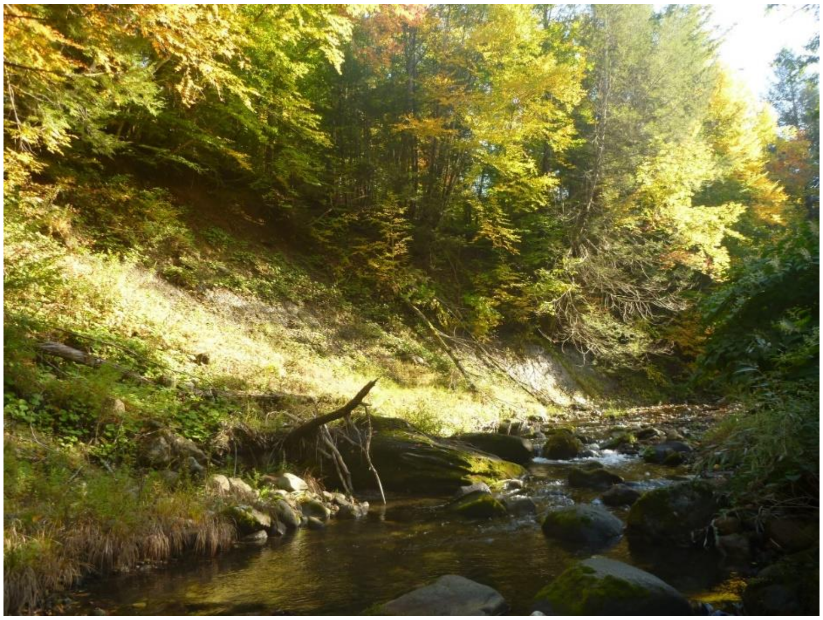
Rebuilding efforts following the flood from Tropical Storm Irene included extensive windrowing, as gravel and cobbles were excavated from the channel and piled as berms along Clesson Brook and its tributaries. Long sections of Clesson Brook Road were rebuilt after Tropical Storm Irene, as in some areas the entire road grade had been eroded. The sections of the road that were reconstructed are armored extensively with boulder riprap, gabion baskets, stacked boulder, and concrete retaining walls. In some areas, this armor constricts the stream channel, potentially increasing the risk of future fluvial erosion. In other areas, the riprap has started to be undermined by migrating headcuts.

***Left**: Emergency work completed in the months following Tropical Storm Irene included extensive windrowing, as gravel and cobbles were excavated from the channel and piled as berms along Clesson Brook. Photo by Andrea Donlon. **Right**: Headcuts, or knickpoints, migrating upstream during high flow events represents vertical instabilities in the streambed initiated in the aftermath of Tropical Storm Irene. Photo by Nic Miller.*

Mass Failures

Streambank mapping completed for the Fluvial Geomorphic Assessment identified mass failures as a major source of sediment loading in the Clesson Brook Watershed. Twenty-eight landslides were mapped along the length of Clesson Brook; the largest mass failure was 180 feet long and 40 feet high. Mass failures represent significant sources of coarse sediment adding to enlarged channel bars, and fine sediments contributing to suspended sediment loads and water quality impacts.

A significant mass failure is located near the Route 112 Bridge, and coupled with the undersized crossing, represents a fluvial erosion hazard.



Mass failures along the Clesson Brook. Photos by Nic Miller of Field Geology Services.

Agriculture

According to Table A-9, agricultural activities are one of the primary contributors of TN and TP in the watershed. As previously noted, agriculture is an important part of the watershed's economy. Many farms are located along the floodplain in the lower portion of the watershed (Figure A-6). These areas are wide and flat, which provide better conditions for farming than the hilly areas of the watershed outside of the floodplain. During site visits on farms throughout the watershed, bank erosion and a lack of riparian buffers were observed.

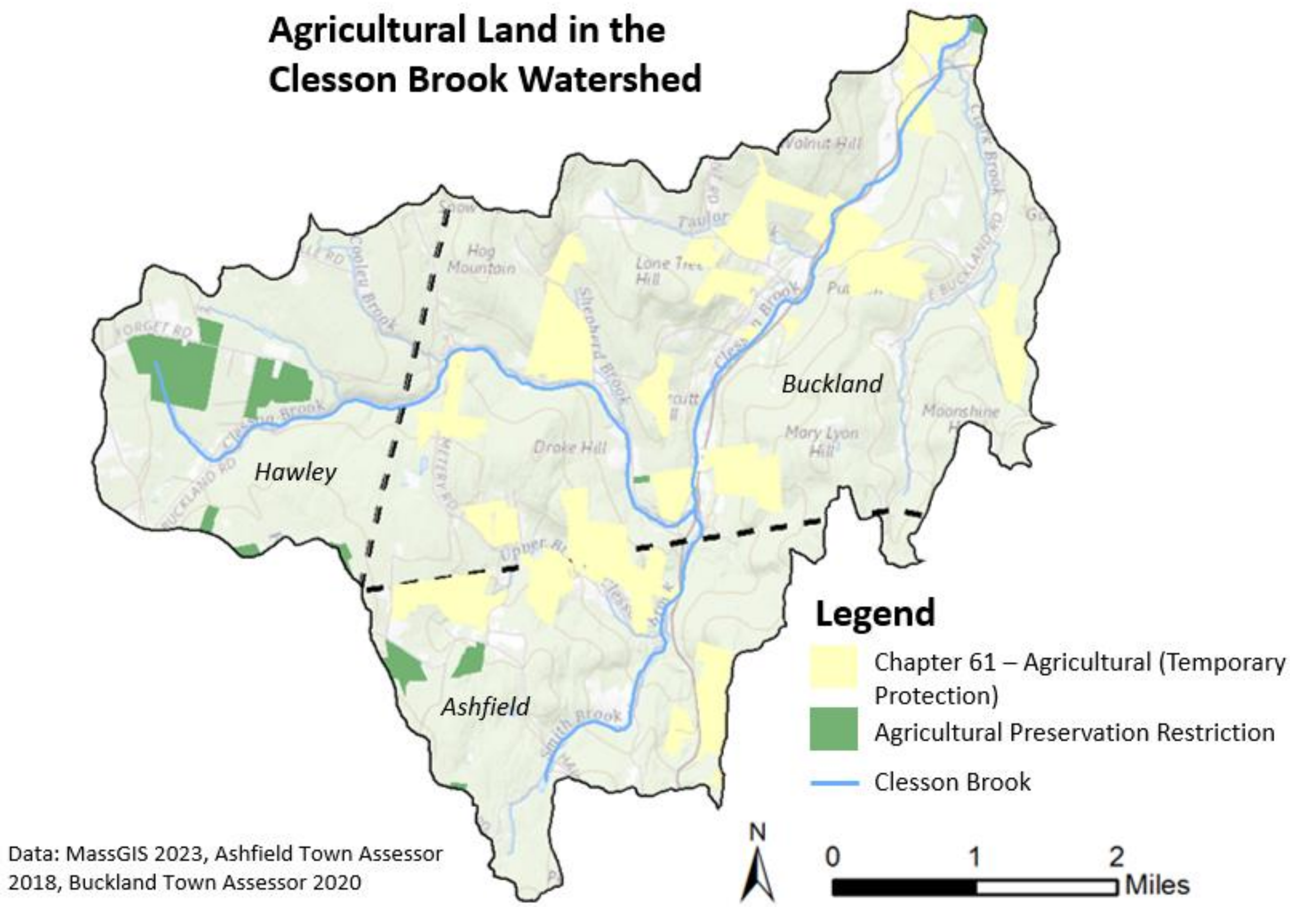


Figure A-6: Protected Agricultural Land in the Clesson Brook Watershed. *Note: Parcels enrolled in the Chapter 61A program in Hawley were not available at the time of map production.*

Forests

Forests are identified in Table A-9 as one of the primary contributors of TN and TP in the watershed, and the third highest contributor of sediment to the watershed. Forests are a natural source of phosphorus and not generally considered a problem. Human-caused sources of phosphorus, such as untreated stormwater runoff from developed land, are where pollutants can best be mitigated. However, implementing climate smart forest management plans may be a useful tool for reducing TN and TP in the Clesson Brook Watershed. Between Buckland and Ashfield, 1,785 acres are enrolled in the Chapter 61 Forest Tax Program, which requires the development of an approved forest management plan.

Another strategy that could be implemented to reduce TN and TP loading in the watershed is chop and drop (also known as wood addition) projects. Adding more wood to the upland areas of the Clesson Brook Watershed will slow and spread stormwater, recharge the aquifer, and help protect downstream infrastructure (roads, culverts, etc.) from excessive amounts of stormwater runoff, sediment loading, and flooding. Successfully implementing chop and drop projects will require agreements with interested landowners.

Roads

As noted in the fluvial geomorphic assessment, the majority of the sedimentation in the Clesson Brook is due to in-stream fluvial erosion. However, during site visits with landowners in the watershed, some areas were noted to be other likely sources. The Clesson Brook Watershed is hilly, with many steep slopes, and current stormwater infrastructure may not accommodate heavier stream flows. During Tropical Storm Irene in 2011, Shepard Brook carried sediment down towards Clesson Brook and overwhelmed the available storm drains.

***Left:** Shepard Brook carried a significant amount of sediment down Shepard Brook Road to Clesson Brook during Tropical Storm Irene in 2011. **Right**: A clogged storm drain on Clesson Brook Road due to Tropical Storm Irene. Photos by Sandra Brown.*

Septic

All houses in Ashfield, Buckland, and Hawley use on-site septic systems for wastewater disposal. Presently, there is no evidence that septic failure is contributing bacteria, nitrogen, or phosphorus to the Clesson Brook. As noted above, E. coli levels were only found to exceed acceptable levels following heavy rain events. E. coli from human wastewater is not the only source of this bacteria; it can also come from warm blooded animals, beaver activity, and other sources.

Underground Storage Tanks (USTs)

There were previously USTs installed near Route 112/Hodgen Road, but they have been removed. No other USTs are currently present in the Clesson Brook Watershed.

Pollutant Loading

As a part of the Watershed-Based Plan to Maintain the Health and Improve the Resiliency of the Deerfield River Watershed (15-04/319) project, a pollutant-loading model was used to estimate annual pollutant loads from the Clesson Brook Watershed. Fuss & O'Neill used the Watershed Treatment Model (WTM), developed by the Center for Watershed Protection. The WTM is a screening-level model that can be used to estimate the loading of various pollutants to a waterbody based on land use and other activities within a watershed and how the implementation of restoration projects and best management practices can reduce pollutant loads.

Based on user-specified input describing characteristics of the watershed, the WTM estimates total phosphorous (TP), total nitrogen (TN), total suspended solids (TSS), and fecal coliform bacteria (FC) loads from various land uses and activities. Modeled pollutant loads for Clesson Brook are shown in Table A-9 and the Pollutant Loading Model Technical Memorandum is included in Appendix E.

Table A-9: Modeled Pollutant Loads for the Clesson Brook Watershed, 2019[9]

Existing Loads to Surface Waters					
	TN (lb/year)	TP (lb/year)	TSS (lb/year)	Fecal Coliform (billion/year)	Runoff Volume (acre-feet/year)
Urban Land[10]	7,654	1,339.72	64,539	21,644	888
Active Construction	-	-	-	-	-
Sanitary Sewer Overflows	-	-	-	-	-
Combined Sewer Overflows	-	-	-	-	-
Channel Erosion	97	97	3,240,424	-	-
Road Sanding	-	-	186,060	-	-
Forest	28,293	2,263	1,131,733	135,808	1,319
Rural Land[11]	16,871	1,453	2,389,651	19,242	1,328
Livestock	-	-	-	-	-
Illicit Connections	-	-	-	-	-
Point Source Discharges	-	-	-	-	-
OSDS	1,157	193	7,710	78,187	-

[9] Appendix E includes a description of each pollutant source.

[10] Urban land uses include the following categories from MassGIS 2015 Land Use Classification: Low Density Residential, Very Low Density Residential, Medium Density Residential, Multi-Family Residential, High Density Residential, Commercial, Transportation, Industrial, Urban Public/Institutional, Mining, Golf Course, Cemetery, Transitional, Participation Recreation, Spectator Recreation, Water-Based Recreation, Waste Disposal

[11] Rural land uses include the following categories from MassGIS 2015 Land Use Classification: Forest, Forested Wetland, Non-Forested Wetland, Open Land, Brushland/Successional, Pasture, Powerline/Utility, Cropland, Nursery, Orchard, Water

Existing Loads to Surface Waters					
	TN (lb/year)	TP (lb/year)	TSS (lb/year)	Fecal Coliform (billion/year)	Runoff Volume (acre-feet/year)
Open Water	447	17	5,411	-	-
Total Storm Load	**30,780**	**4,056**	**6,665,680**	**176,695**	**3,535**
Total Non-Storm Load	**23,739**	**1,308**	**359,849**	**78,187**	**-**
Total Load to Surface Waters	**54,519**	**5,363**	**7,025,529**	**254,882**	**3,535**

Source: *A Watershed-Based Plan to Maintain the Health and Improve the Resiliency of the Deerfield River Watershed*

The WTM estimates prepared for Clesson Brook did not include nutrient loads from livestock. The consultant noted that the model intends to estimate pollutant loads for animals that are confined (e.g. feedlots), which is less relevant for the Clesson Brook Watershed because most of the livestock in the watershed are associated with hobby farms and small commercial farming operations. Additionally, the model assumes that loading rates for pastured animals are reflected by pasture land use loading rates.

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

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

Estimated Pollutant Loads

Estimated pollutant loads for TP (5,363 lbs/year), TN (54,519 lbs/year), and TSS (7,025,529 lbs/year) were previously presented in Table A-9 of this WBP.

Water Quality Goals

The goal of this healthy WBP is to design and implement a set of preventative and restorative measures, which will reduce sediment and nutrient loading to Clesson Brook. This is increasingly important as stormwater runoff and fluvial erosion are exacerbated by more frequent and intense storms due to climate change. Management measures will focus on restoring riparian buffers to reduce nutrient loading, and remediating fluvial erosion hazards. Specific load reductions for TN and TP were not set, as any reduction in nutrient loading will be beneficial to the watershed.

An annual long-term sediment load reduction goal was calculated using the pre-development land cover (100% forested watershed) load as a target.[12] Sediment load reduction is expected to aid with bacteria and nutrient load reduction. A description of criteria for each water quality goal is described by Table B-1.

The following adaptive sequence is recommended to establish and track water quality goals specific to the Clesson Brook Watershed:

1. Implement management measures as outlined in the Fluvial Geomorphic Assessment, Road-Stream Crossing Assessment, Conservation Prioritization, and Restoration Designs prepared by GZA GeoEnvironmental and Field Geology Services as a part of the FY22 MVP Action Grant.
2. Evaluate success of any implemented management measures in reducing fluvial erosion, TSS loading, and nutrient loading.

[12] The Pollutant Load Export Rates (PLERs) included in Appendix F were used to calculate the pre-development sediment loading rate.

3. Establish an interim goal to reduce sediment loading by 546 tons per year over the next 5 years (estimated annual pollutant removal based on bank stabilization) and any reduction in phosphorus and nitrogen loading achievable with the installation of management measures.[13]
4. Establish further goals to meet the long-term sediment load reduction goal of 3,146 tons per year.

Table B-1: Pollutant Load Reductions Needed

Pollutant	Existing Estimated Total Load	Water Quality Goal	Required Load Reduction
Total Phosphorus	5,363 lbs/year	--	Any reduction is desirable in order to protect existing high-quality waters.
Total Nitrogen	54,519 lbs/year	--	Any reduction is desirable in order to protect existing high-quality waters.
Total Suspended Solids	3,512 tons/year	366 tons/year	3,146 tons/year (Estimated existing load of 3,512 tons minus estimated pre-development load of 366 tons)

[13] The fluvial geomorphic assessment assessed that 9,841 feet of riverbank are eroding along Clesson Brook. Assuming an average height of 3 feet and a rate of erosion of .5 feet/year, arresting erosion along the banks would eliminate 1,092,000 pounds/year (546 tons/year) of dry sediment entering the Clesson Brook. This estimate is used as a short term goal for a reduction in TSS loading.

Element C: Describe management measures that will be implemented to achieve water quality goals

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

Recent field visits, past studies, and this WBP's loading model suggest that stormwater runoff and sediment from forests, farm fields, roads, and in-stream fluvial erosion, are likely the largest contributors of nutrient and sediment loading to Clesson Brook. Management measures in the watershed could therefore be selected and designed to slow stormwater flow and capture sediment.

Opportunities for Management Measures

The following section outlines general site characteristics and a general proposal for management measures for the Clesson Brook Watershed. Recommendations fall into the categories of watershed management/capacity building, structural BMPs, and nonstructural BMPs. Structural BMPs are designed to remove pollutants from stormwater runoff or reduce the volume of stormwater runoff. Nonstructural BMPs are focused on pollutant reduction, management of pollutants, and preservation of natural features thru management and maintenance practices. Further studies and non-structural BMPs will be essential to solving water quality challenges in this watershed.

Structural BMPs

With funding from an EEA MVP Action Grant, GZA GeoEnvironmental and Field Geology Services prepared a prioritized list of restoration projects best suited to address fluvial geomorphic instabilities and sedimentation to Clesson Brook. The 12 projects are summarized below and the full report with photos for each project is included in Appendix B. Conceptual designs for the first four projects listed below were developed and are included in Appendix B.

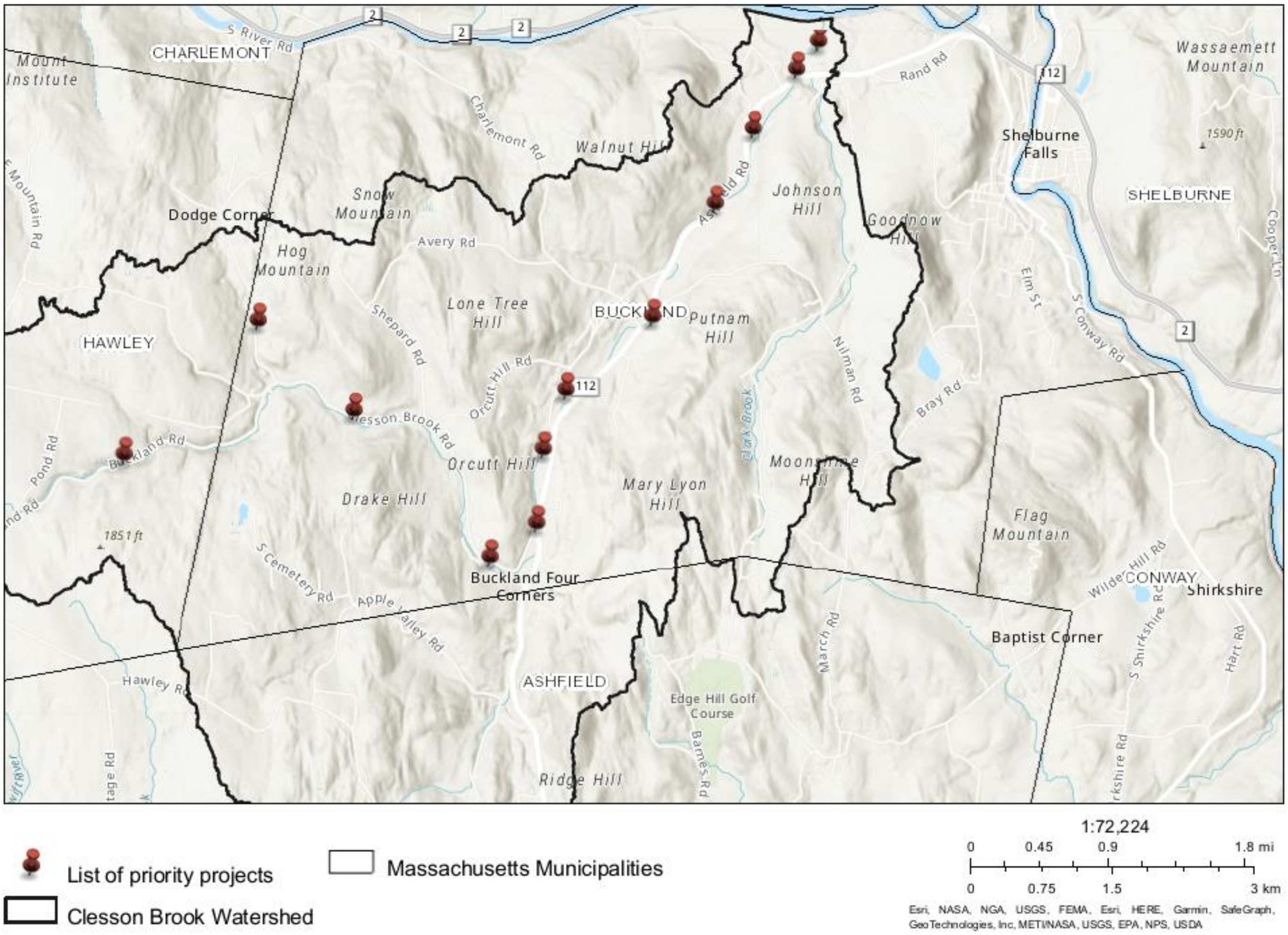


Figure C-1: Locations of proposed restoration projects in the Clesson Brook Watershed.
Source: Clesson Brook Watershed Crossing App developed by GZA GeoEnvironmental, 2023.

Clessons River Farm

Bank erosion, exacerbated by Tropical Storm Irene, threatens land and infrastructure along the Clesson Brook corridor. At Clessons River Farm, the large cornfield along the right bank is threatened by continued bank erosion. Engineered log jams are proposed to deflect flow away from the eroding bank. The log jams and toe wood are designed to stabilize the streambank using natural materials and allow the riparian buffer to become established leading to longer-term stability. A proposed 35-foot wide buffer of native trees and shrubs provides many habitat values as well as limiting the input of sediment and nutrients from the agricultural fields.

Straightened Reaches of Clesson Brook

Wood is often lacking and aquatic habitat is impaired along the artificially straightened reaches of Clesson Brook. In Reach CLE05 the stream has been straightened along the left side of the valley, where Route 112 encroaches along its length. Proposed wood and boulder additions provide cover while increasing flow complexity and sediment sorting.

Floodplain Reconnection
Vertical instability along Clesson Brook following excessive sediment mobilization and deposition during Tropical Storm Irene was observed in the form of headcuts (knickpoints). Headcuts migrate upstream during higher flow events leaving a deeper channel, potentially increasing erosion hazards and reducing the connection between the channel and its floodplain. Headcuts can lead to lateral instability (bank erosion) and potential undermining of infrastructure. Segment CLE15B includes six mapped headcuts and a windrow (berm) blocking a portion of the right bank floodplain. Boulder-supported log jams and isolated logs encourage sediment sorting and deposition while enhancing habitat. These treatments are designed to slow flow velocities, encourage aggradation, and divert flows onto the right bank floodplain. Breaching the berm would further help restore floodplain connection along this artificially straightened stream segment.

Route 112 Bridge Enhancement
The Route 112 bridge (MassDOT Bridge #B28004), located about ½ mile upstream from the Clesson's Brook confluence with the Deerfield River, is vulnerable to overtopping by floods having a 10-year recurrence interval frequency and larger, based on hydraulic modeling conducted in support of this project. The modeling indicates that a 600± feet length of Route 112 in the vicinity of the bridge is also vulnerable to flooding. Potential flooding along Route 112, accompanied by fluvial (river bank) erosion, may be reduced by enlarging the Route 112 bridge to meet the Massachusetts Stream Crossing Standards and improve hydraulic capacity. This project would also include the installation of additional relief culverts across Route 112 within the floodplain of Clesson Brook, raising and reinforcement of the roadway in flood prone areas and stabilization of the mass failure located immediately upstream of the Route 112 bridge. The stabilization of the mass failure would be achieved by reducing the steepness of the upper portion of the slope (approximately 20 feet in height) and stabilizing the lower portion of the slope, below the 10-year water surface elevation. Stabilization design will include bioengineered and nature-based treatment options such as rootwad revetments, log, and boulder deflectors, with consideration for techniques that will provide habitat benefits. The upper portion of the slope would be graded back and stabilized with nature-based treatments such as brush mattresses and willow fascines. The slope will be planted with quick-growing native species well-suited for slope stabilization with an eye toward incorporating species adapted to changing climate conditions to maximize resiliency.

Road Crossing Upgrade/Replacement in Hawley
Box culvert installed post-Irene is an extreme fluvial erosion hazard with high likelihood of failure. Located at valley slope break downstream of an artificially straightened channel. Modeling shows overtopping at 10-year recurrence interval event. No aquatic organism passage. Replace culvert with a bridge or bottomless arch, may include habitat structures upstream and downstream.

Road Crossing Upgrade/Replacement and Mass Failure Stabilization
Undersized MassDOT bridge (#B28004) is extreme fluvial erosion hazard with risk of clogging with sediment from adjacent and upstream mass failures. Located downstream of artificially straightened channel and at angle to stream channel. Sediment deposition inside structure and along left abutment limits hydraulic capacity. Significant scour at right bank abutment. Significant rust on steel span. Low clearance at upstream opening. Modeling shows overtopping at 10-year R.I. event. Replace bridge with increased span and increased clearance, add floodplain culverts, and stabilize mass failure.

Road crossing upgrade/replacement in Buckland

Culvert on Dodge Rd has failed multiple times washing out large portions of Dodge Rd (according to local residents) and continues to represent an extreme fluvial erosion hazard with a high likelihood of failure. Located at valley slope break with an extensive beaver pond complex upstream. Landowner has installed beaver deceiver devices to reduce likelihood of beavers clogging culvert inlet. Upgrade culvert to meet State stream crossing standards with bottomless arch, may include floodplain relief culverts.

Headcut stabilization/grade control installation and mass failure stabilization in Buckland

A series of headcuts (knickpoints) in the channel bed migrating upstream threaten infrastructure including Route 112 bridge. This vertical instability leads to lateral instability resulting in increased bank erosion and undermining of large mass failures at the site. The largest is approximately 180 feet long and 40 feet high; this eroding glacial bank of sand, silt, and clay represents a significant sediment source, and contributes to water quality impacts. Stabilize the streambed by installing boulder weirs and/or log sills to arrest headcuts. Stabilize the toe of high bank using nature-based solutions and stabilize upper bank with vegetation.

Headcut stabilization, floodplain connection, and instream habitat structures in Buckland

Vertical instability along Clesson Brook following excessive sediment mobilization and deposition during Tropical Storm Irene has resulted in a deeper channel with impaired floodplain connection and increased erosion hazards. Segment CLE15B includes six mapped headcuts and a windrow (berm) blocking a portion of the right bank floodplain. Install log sills to help arrest headcut migration and stabilize the bed. Boulder-supported log jams and other instream habitat structures encourage sediment sorting and deposition while enhancing habitat. These treatments are designed to slow flow velocities, encourage aggradation, and divert flows onto the right bank floodplain. Breaching the berm would further improve floodplain connection along this artificially straightened stream segment.

Headcut stabilization/grade control installation and instream habitat structures in Buckland

Several large headcuts downstream of the intersection of Clesson Brook Rd and Old Hawley Rd are migrating upstream as the stream adjusts following Tropical Storm Irene. The channel bed has already incised along the riprap-armored slope and may eventually impact the Clesson Brook Rd bridge upstream. Stabilize the streambed by installing boulder weirs and/or log sills to arrest headcuts. Install boulder-supported log jams and other instream habitat structures to encourage sediment sorting and deposition while enhancing aquatic habitat.

Mass failure stabilization, flow deflectors, bank cutting/flow diversion in Buckland

This dynamic reach, just upstream of the confluence with the Deerfield River, flows along the Buckland Recreation Area. Erosion of glacial banks threatens the recreation paths and high school running trails. The largest mass failure is approximately 20 feet high and 225 feet long and contributes a significant volume of sediment to lower Clesson Brook and the Deerfield River. Stabilize the toe of high bank using nature-based solutions and slope upper bank, before stabilizing with vegetation. Engineered log jams or log sills may be used to deflect flow away from the eroding bank. Side channel flow could be increased through bank cutting/flow diversion, which would divert flow into a low left bank channel and away from the mass failures. If permitting allows, the mainstem channel could be diverted through more aggressive treatments.

Riparian buffer enhancement in Buckland

Impaired riparian buffer along Route 112 across from the Wilder Homestead Museum leads to lack of channel shading and elevated water temperatures. Mature riparian buffers reduce sediment and nutrient loading and increase bank stability. While impaired buffers are widespread along Clesson Brook, this site has space to accommodate the planting of native trees and shrubs, whereas many other sites do not. Buffer planting may be paired with invasive species mitigation.

Nonstructural BMPs

Land conservation will be an important strategy in reducing nutrient and sediment loading to Clesson Brook. GZA, in partnership with Field Geology Services, compiled the results of the Fluvial Geomorphic Assessment, Hydrologic and Hydraulic Analysis, and Prioritized Road-Stream Crossing Replacement Assessment to identify segments of the Clesson Brook Watershed that are exposed to vulnerabilities from climate change. Segments of Clesson Brook and lower Smith Brook were identified as high priority based on fluvial erosion and/or inundation hazards and/or otherwise a priority for conservation.

Parcels along upland tributaries were selected based on the presence of crossings identified for replacement and where large expanses of privately-owned open space were observed along upland tributaries, as detailed fluvial erosion and/or inundation hazards were not examined along the upland tributaries. Based on the evaluation, there are 58 parcels identified for potential conservation in the Clesson Brook Watershed. The selected parcels are shown in Figures C-2, C-3, and C-4, and C-5. The full report, *Prioritized Parcels within the Clesson Brook Watershed for Conservation*, is included as Appendix D.

Conserved parcels can serve as attenuation assesses that will provide room for the Clesson Brook to form meanders and store sediment. Depending on where parcels are conserved along the brook, attenuation assets can be protected in perpetuity by a conservation restriction or river corridor easement, or by a group such as a land trust purchasing the land outright from willing landowners.[14]

[14] For more information on attenuation assets and river corridor easements, please see the FRCOG's River Corridor Management Toolkit. https://frcog.org/publications/river-corridor-toolkit/

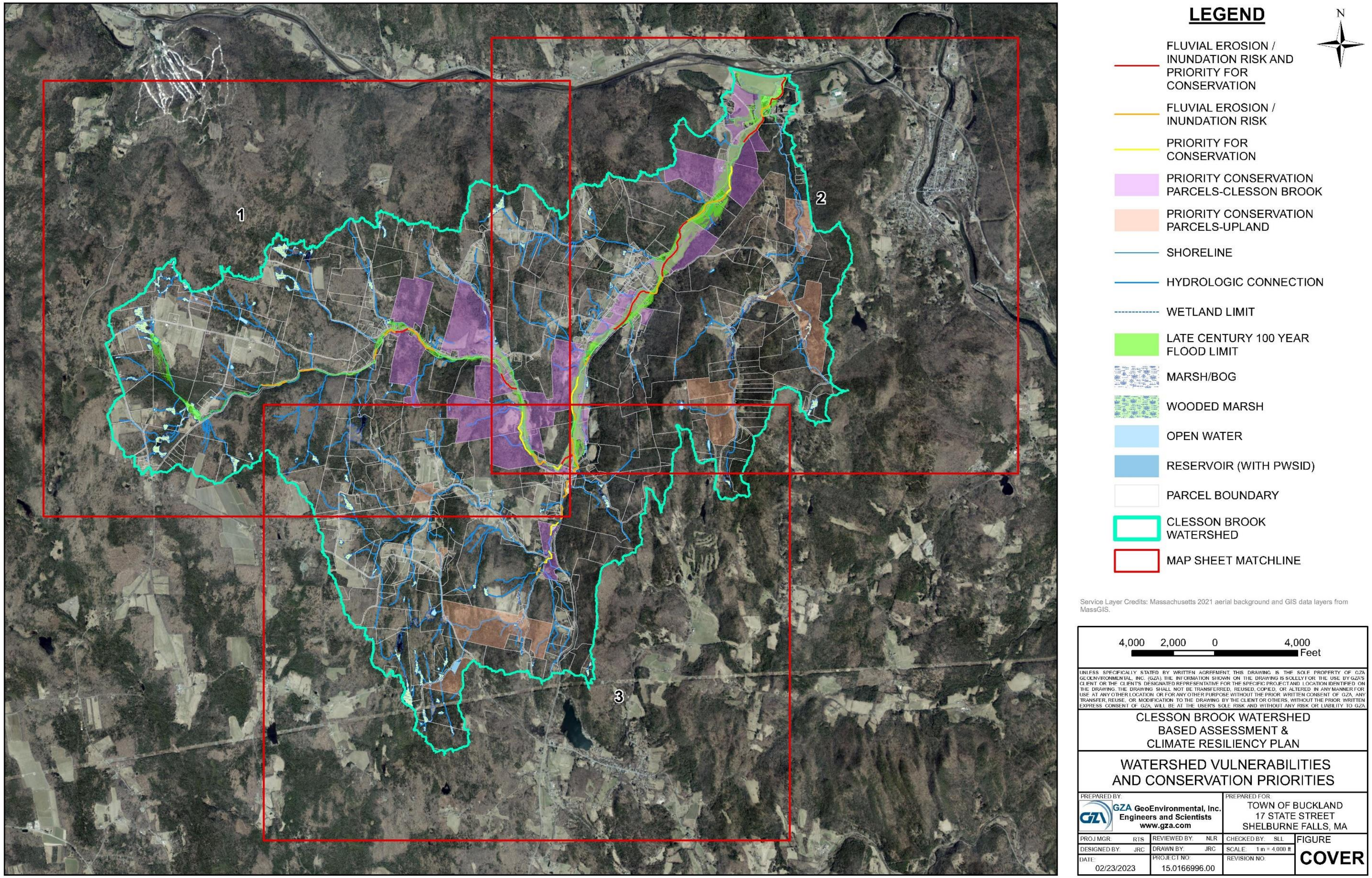


Figure C-2: Watershed Vulnerabilities and Conservation Priorities in the Clesson Brook Watershed.

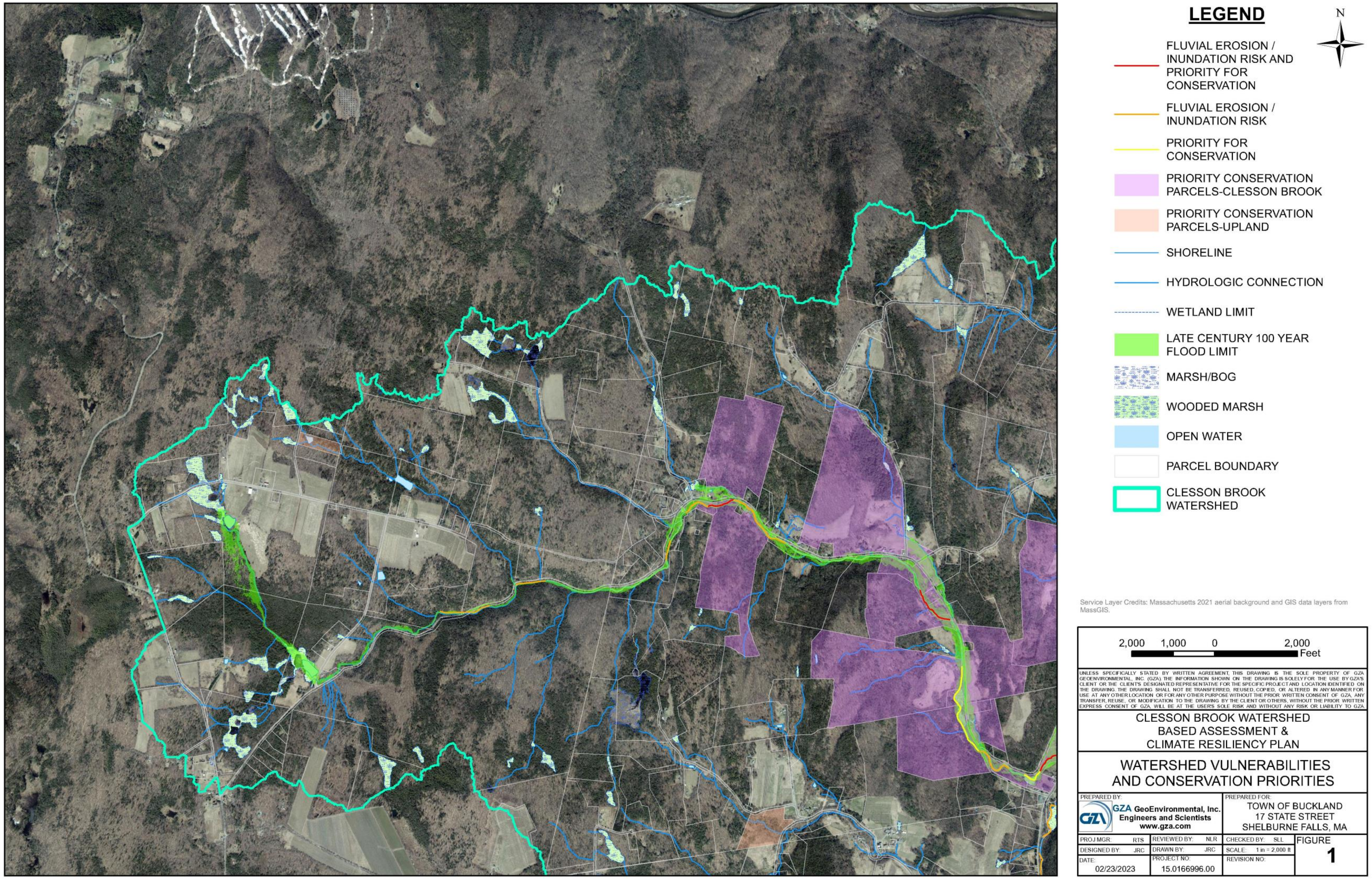


Figure C-3: Watershed Vulnerabilities and Conservation Priorities in the Clesson Brook Watershed, Map Sheet 1.

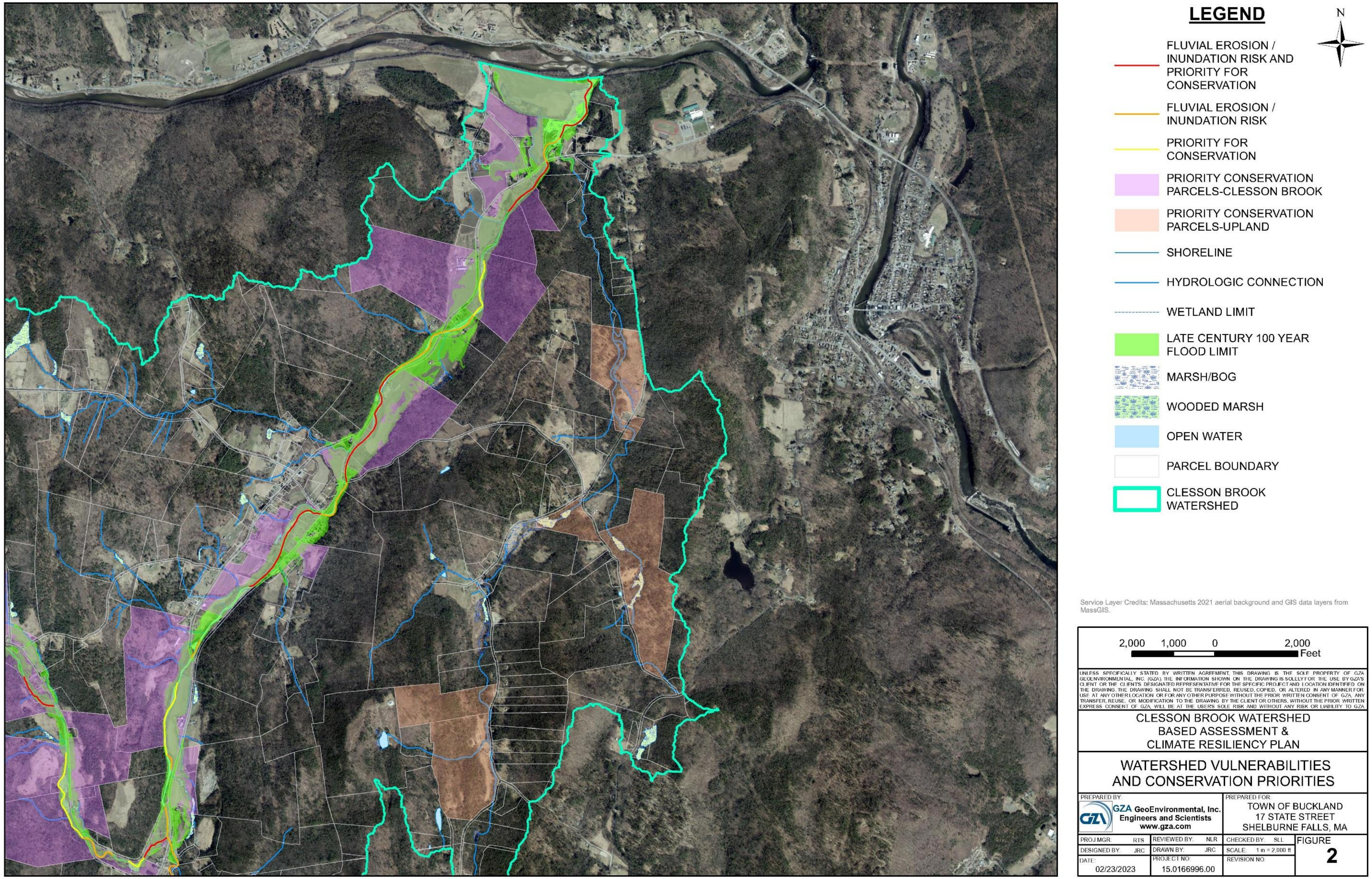


Figure C-4: Watershed Vulnerabilities and Conservation Priorities in the Clesson Brook Watershed, Map Sheet 2.

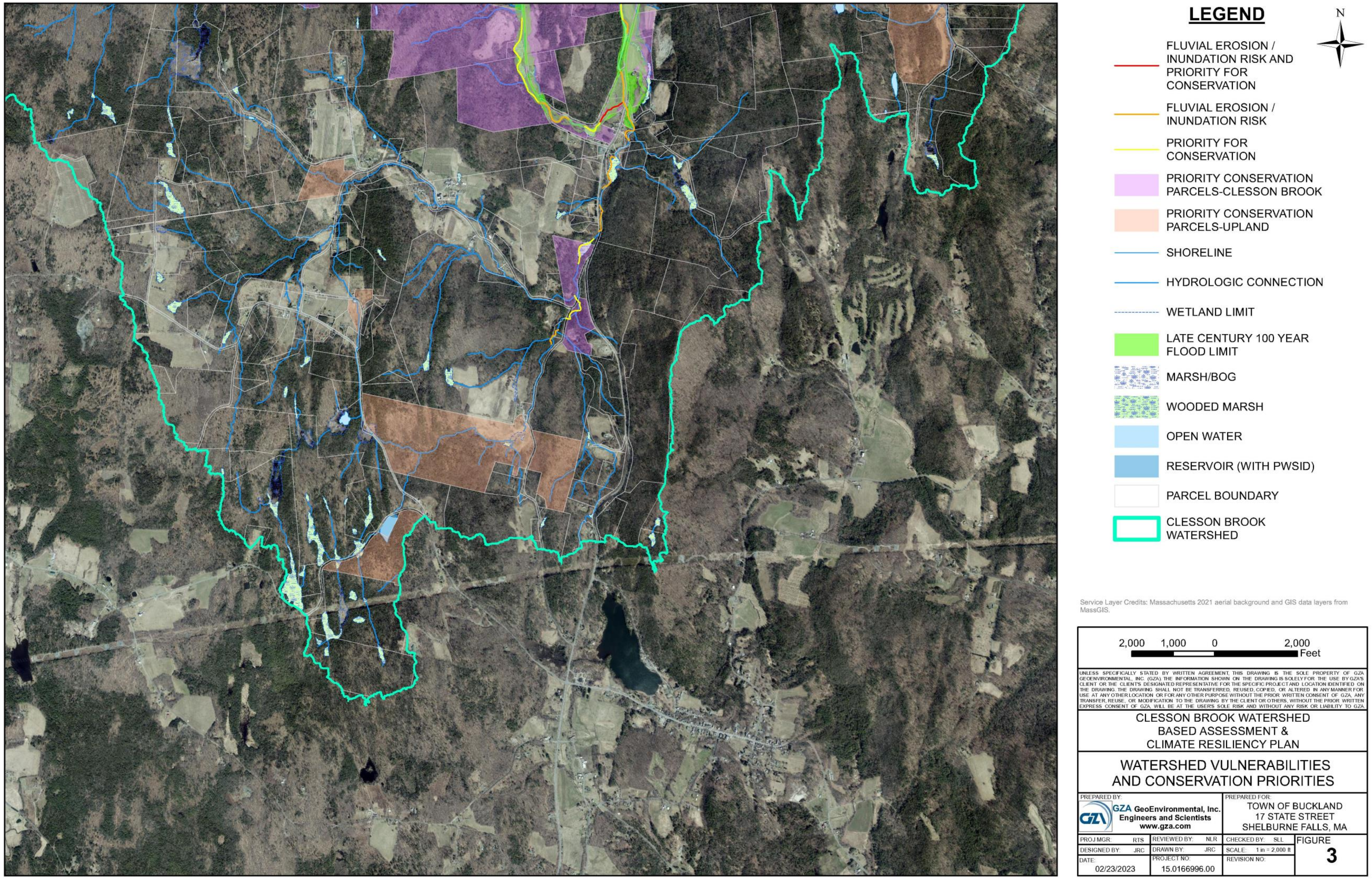


Figure C-3: Watershed Vulnerabilities and Conservation Priorities in the Clesson Brook Watershed, Map Sheet 3.

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

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

Table D-1 presents the funding needed to implement the management measures presented in this watershed plan. The table includes costs for structural and non-structural BMPs, operation and maintenance activities, information/education measures, and monitoring/evaluation activities.

During the writing of this WBP, the Town of Buckland received funding for a second MVP Action Grant for $160,000. The MVP Action Grant will help to build landowner support for climate resiliency projects on private land, complete river corridor mapping, and provide 25% conceptual designs for the Route 112 resiliency project and the Clessons River Farm bank stabilization projects. The extra assessments included in this WBP helped to secure the additional funding.

Table D-1: Summary of Funding Needed to Implement the Watershed Plan.

Management Measures	Location	Capital Costs	Operation & Maintenance Costs	Relevant Authorities[15]	Technical Assistance Needed	Funding Needed[16,17]	Notes
Structural and Non-Structural BMPs (from Element C)							
Streambank stabilization	Clessons River Farm	Not applicable	To be determined	Town of Buckland	Engineering consultant	To be determined	Field Geology Services prepared a conceptual design for this project as a

[15] Many of these projects will be installed on private property. Ongoing outreach for this WBP will focus on securing the cooperation of these landowners.
[16] The MVP funded project did not include estimates of probable costs. This table will need to be included in future grant applications.
[17] Where there are cost estimates, it should be noted that, because the estimates of funding needed were prepared based on limited data and assumptions, the actual cost for design and construction of the projects may be higher or lower than the estimates provided. As such, the estimates of funding needed should be considered "order of magnitude" and for general planning purposes only.

Management Measures	Location	Capital Costs	Operation & Maintenance Costs	Relevant Authorities[15]	Technical Assistance Needed	Funding Needed[16],[17]	Notes
							part of Buckland's MVP Action Grant.
Wood and boulder additions	Straightened reaches of Clesson Brook	Not applicable	To be determined	Town of Buckland	Engineering consultant	To be determined	Field Geology Services prepared a conceptual design for this project (Reach CLE05) as a part of Buckland's MVP Action Grant.
Floodplain reconnection	Clesson Brook segment CLE15B	Not applicable	To be determined	Town of Buckland	Engineering consultant	To be determined	Field Geology Services prepared a conceptual design for this project (Reach CLE15B) as a part of Buckland's MVP Action Grant.
Headcut stabilization and instream habitat structures	Clesson Brook segment CLE15B	Not applicable	To be determined	Town of Buckland	Engineering consultant	To be determined	
Route 112 Bridge Enhancement	MassDOT Bridge #B28004	To be determined	To be determined	Town of Buckland, MassDOT, GZA	Engineering consultant	$1,000,000 to $5,000,000	Project to be completed in conjunction with mass failure stabilization. Field Geology

Management Measures	Location	Capital Costs	Operation & Maintenance Costs	Relevant Authorities[15]	Technical Assistance Needed	Funding Needed[16],[17]	Notes
							Services prepared a conceptual design for this project as a part of Buckland's MVP Action Grant. Funding from a FY24-FY25 MVP Action Grant will provide funding to complete a 25% conceptual design with project drawings and a cost opinion.
Mass failure stabilization	MassDOT Bridge #B28004	Not applicable	To be determined	Town of Buckland, MassDOT	Engineering consultant	To be determined	Project to be completed in conjunction with bridge enhancement to meet MA Stream Crossing Standards.
Headcut stabilization/grade control installation	Near MassDOT Bridge #B28004	Not applicable	To be determined	Town of Buckland, MassDOT	Engineering consultant	To be determined	Project to be completed in conjunction with the two other MassDOT Bridge #B28004 projects

Management Measures	Location	Capital Costs	Operation & Maintenance Costs	Relevant Authorities[15]	Technical Assistance Needed	Funding Needed[16,17]	Notes
Road crossing upgrades	3 marked locations in Buckland and Hawley	To be determined	To be determined	Town of Buckland, Town of Hawley	Engineering consultant	$500,000 to $1,500,000 per culvert (includes design and permitting)	All 3 culvert replacements will need to meet MA Stream Crossing Standards.
Headcut stabilization/grade control and instream habitat structures installation	Clesson Brook Road and Old Hawley Road	Not applicable	To be determined	Town of Buckland	Engineering consultant	To be determined	
Mass failure stabilization, flow deflectors, bank cutting/flow diversion	Near the Buckland Recreation Area	Not applicable	To be determined	Town of Buckland	Engineering consultant	To be determined	
Riparian buffer enhancement	Route 112/Wilder Homestead Museum	Not applicable	To be determined	Town of Buckland	Engineering consultant	To be determined	
Land conservation	Priority parcels	Not applicable	To be determined	Town of Buckland, landowners in Buckland, Hawley, and Ashfield	Engineering consultant, Franklin Land Trust	To be determined	
Wood addition projects in the upper watershed	Priority parcels	Not appliciable	To be determined	Towns of Buckland, Hawley, and Ashfield, landowners in each town	Field Geology Services	To be determined	

Management Measures	Location	Capital Costs	Operation & Maintenance Costs	Relevant Authorities[15]	Technical Assistance Needed	Funding Needed[16],[17]	Notes
Information/Education (see Element E)							
Educational materials for landowners of priority parcels and landowner engagement	N/A	$22,000	N/A	Town of Buckland	Consultant, FRCOG	$22,000	
Educational materials for watershed residents	N/A	$12,000	N/A	Town of Buckland	Consultant, FRCOG	$12,000	
Public education site visits to demonstration projects	N/A	$1,500	N/A	Town of Buckland	Consultant, FRCOG	$1,500	
Project updates (websites and online StoryMaps)	N/A	$1,000	N/A	Town of Buckland	Consultant, FRCOG	$1,000	
Monitoring and Evaluation (see Element H/I)							
Annual water quality sampling	TBD	Not applicable	TBD	Connecticut River Conservancy, MA Department of Environmental Protection	$10,000	Extent of sampling program TBD, this is placeholder estimate	
					Total Funding Needed:	To be determined	
Funding Sources:							
Potential Funding Sources: • 604b Water Quality Management Planning Grant Program • Section 319 Nonpoint Source Competitive Grant Program							

<table>
<tr><th>Management Measures</th><th>Location</th><th>Capital Costs</th><th>Operation & Maintenance Costs</th><th>Relevant Authorities[15]</th><th>Technical Assistance Needed</th><th>Funding Needed[16],[17]</th><th>Notes</th></tr>
<tr><td colspan="7">
Municipal Vulnerability Preparedness (MVP) Action Grant Program (only the Town is eligible to apply)
Long Island Sound Futures Fund (LISFF) through the National Fish and Wildlife Foundation (NFWF)
Town Ch. 90 funds
Town Capital Funds
Town Wetland Funds (i.e., filing fees to enforce Massachusetts Wetlands Protection Act)
Massachusetts Environmental Trust
FEMA Hazard Mitigation Grant
Volunteer time for public outreach and monitoring
</td><td></td></tr>
</table>

Element E: Public Information and Education

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

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

Step 1: Goals and Objectives

1. Educate watershed residents and Town staff about the health of Clesson Brook, including the potential sources of nonpoint source pollution and causes of fluvial erosion.
2. Educate watershed residents and Town staff about the importance of undertaking climate resiliency projects in the Clesson Brook Watershed.
3. Build working relationships in the watershed by conducting outreach to landowners whose parcels were identified as priorities for conservation as a part of the FY22 MVP Action Grant.
4. Contact the owners of the land included in the conceptual designs to review the findings of the FY22 MVP Action Grant study and how the designs would address flooding and erosion, gauge their interest in the project, and see if there are related concerns that the landowners have that could inform the next phase of design.
5. Incorporate water quality and stormwater management principles and practices into local school curriculum.

Step 2: Target Audience

1. Town of Buckland, Hawley, and Ashfield staff
2. Clesson Brook Watershed residents in Buckland, Hawley, and Ashfield
3. Mohawk Trail Regional School District students and staff
4. Local watershed organizations such as the Deerfield River Watershed Association and the Connecticut River Conservancy

Step 3: Outreach Products and Distribution

1. Provide general information about nonpoint source pollution, sources, and mitigation in Franklin County via promotion of the Franklin County Healthy and Climate Resilient Rivers online StoryMap.

2. Continue to update the Building Climate Resiliency in the Clesson Brook Watershed online StoryMap.

3. Prepare a packet detailing the 12 climate resiliency projects to gain support from interested landowners.

4. Prepare outreach materials on resilient land management for different areas – riparian and river corridor; upland watershed areas; forested lands, agricultural lands; land adjacent to vulnerable infrastructure (culverts, bridges) for landowners who own priority watershed parcels.

5. When completed, provide the Town of Buckland, Hawley, and Ashfield Highway Departments with the FRCOG's Dirt Roads Toolkit to inform good dirt road maintenance and stormwater management.

6. Host community open houses and other public events to keep watershed residents up to date on the progress of implementing the Clesson Brook WBP.

Step 4: Evaluate Information/Education Program

1. Track the number of educational materials distributed in hardcopy or by email.

2. Attach a counter to websites and other social media to evaluate visits and download of materials.

3. Track the number of attendees at educational presentations.

4. Track the number of site visits conducted and attendees.

5. Track the number of private landowners who move forward with implementing climate resilient projects on their property.

Elements F & G: Implementation Schedule and Measurable Milestones

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

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

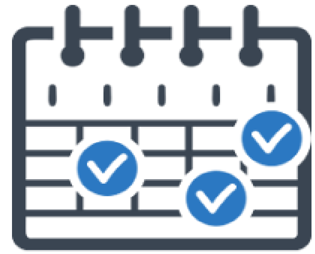


Table FG-1 provides a preliminary schedule for implementation of recommendations provided by this WBP. It is expected that the WBP will be re-evaluated and updated at least once every three (3) years, or as needed, based on ongoing monitoring results and other ongoing efforts.

Table FG-1: Implementation Schedule and Interim Measurable Milestones

Category	Action	Estimated Cost	Year(s)
Monitoring /Evaluation	Document estimated pollutant removals from existing BMPs in the watershed	TBD	Annual
Structural BMPs	Obtain funding for and implement at least 2 of the 12 restoration projects	TBD	2026 – 2028
Nonstructural BMPs	Conservation of priority parcels in the watershed	TBD	2025 and ongoing
Public Education and Outreach *(See Element E)*	Project updates (website posts)	N/A	Ongoing
	Landowner outreach and educational materials for priority conservation areas	$22,000	Ongoing
	Educational Materials and/or presentation	$12,000	Annual
	Site visits to demonstration projects	TBD	2028 and ongoing
	Road management best practices training to private and public road maintenance staff	TBD	2025 – 2026
Adaptive Management and Plan Updates	Charge a group with establishing a working group comprised of stakeholders and other interested parties to implement recommendations and track progress. Meet at least twice per year.	Volunteer	2024
	Re-evaluate Watershed-Based Plan at least once every three (3) years and adjust goals and plan, as needed, based on monitoring results and other observations and experiences.	**TBD**	**Every 3 years from beginning of WBP implementation**

Elements H & I: Progress Evaluation Criteria and Monitoring

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

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

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

Project-Specific Indicators

Anticipated pollutant load reductions from existing, ongoing (i.e., under construction), and future BMPs will be tracked as BMPs are installed.

Direct Measurements

There are currently no monitoring programs for Total Phosphorus and Total Nitrogen in the Clesson Brook. The DWRA/CRC's funding for such monitoring expired in 2020. If the DWRA were to obtain funding to restart a monitoring program, those samples would be used to monitor the success of any BMPs that are implemented.

Indirect Indicators of Load Reduction

Potential load reductions from non-structural BMPs, such as land conservation projects can be estimated by indirect indicators such as: how many landowners are contacted through outreach campaigns, how many landowners agreed to implement climate resilient projects on their land, and how many climate smart forestry management plans are created for forested tracts in the watershed.

Adaptive Management

Long-term goals will be re-evaluated at least once every three years and adaptively adjusted based on additional monitoring results and other indirect indicators.

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Appendices

Appendix A: Cleson Brook Watershed Community Concerns
Appendix B: Fluvial Geomorphic Assessment of the Clesson Brook Watershed, MA
Appendix C: Prioritized Road-Stream Crossings for Replacement
Appendix D: Prioritized Parcels within the Clesson Brook Watershed for Conservation
Appendix E: Pollutant Loading Model Technical Memorandum for the Deerfield River Watershed
Appendix F: Pollutant Load Export Rates (PLERs)
Appendix G: Hydrologic and Hydraulic Analysis

Due to file size, all appendices are available for viewing online:

https://drive.google.com/file/d/1s8161kyAeXxp-VM-CAOINzphArKfaOYb/view?usp=sharing

or

https://frcog.org/publications/#climate-resilience-land-use by searching “Clesson Brook Watershed Based Plan”