BUTTERNUT CREEK WATERSHED MANAGEMENT PLAN (DRAFT 08.31.21)

DEPARTMENT OF ENVIRONMENTAL CONSERVATION • NEW YORK STATE •

OTSEGO LAND TRUST

OTSEGO COUNTY NEW YORK

BUTTERNUT VALLEY ALLIANCE

OTSEGO COUNTY SOIL AND WATER CONSERVATION DISTRICT

OCCA OTSEGO COUNTY CONSERVATION ASSOCIATION

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1 Executive Summary

Protecting water quality and, by extension, protecting watershed health has been and will continue to be one of the highest priorities when it comes to improving the resilience of Otsego County's communities. Healthy watersheds protect against flooding, improve agricultural productivity, enhance biodiversity, improve water storage and filtration capabilities, and improve our resilience against natural disasters as well as the effects of climate change. The 2021 Butternut Creek Watershed Management Plan will guide both county and local-level policymaking and serve as a reference for government agencies, community organizations, residents of the Butternut Creek Watershed, and environmental organizations as they work toward protecting the Butternut Creek Watershed for generations to come.

The Butternut Creek Watershed Management Plan is one of the first plans of its kind in Otsego County. Given its location in the Chesapeake Bay Watershed, the Butternut Creek Watershed Management Plan was created to coordinate local-level activities related to watershed protection with the overarching water quality protection targets established by the 2010 Chesapeake Bay Total Maximum Daily Load (TMDL) and state-level planning efforts like the 2020 New York State Phase III Watershed Implementation Plan.

Despite its location in a rural county, with limited technical capacity to achieve watershed protection outcomes, there is a considerable amount of attention dedicated to watershed protection. In 2020, the Otsego County Soil and Water Conservation District (SWCD) in partnership with SUNY Oneonta, the Butternut Valley Alliance (BVA), and the Otsego County Conservation Association (OCCA) completed a Background Assessment of the entire watershed which evaluated the physical condition of the entire watershed while gathering important information about its ecological characteristics. Organizations such as the Upper Susquehanna Coalition (USC), the Otsego Land Trust (OLT), the Wetlands Trust (TWT), and SUNY Oneonta, are working on habitat restoration projects for sensitive species like the American eel (*Anguilla rostrata)* and the eastern hellbender (*Cryptobranchus aleghaniensis alleghaniensis)*

Despite the high levels of ongoing research in the Butternut Creek Watershed, there are substantial challenges facing the watershed moving forward. None of the communities in the watershed have a full-time professional on staff focused on watershed protection. Moreover, these communities lack the budgetary capacity to tackle large-scale watershed protection activities. Local agencies such as SWCD and Otsego County cover a large service area and have limited resources to dedicate to water quality projects in the Butternut Creek Watershed. Physical infrastructure in the watershed need to be upgraded to withstand severe precipitation events. 56% of the watershed's culverts have a significant or severe barrier that restricts waterflow—substantially increasing the risk of significant flood damage during a heavy rain event. The Butternut Creek Watershed Management Plan establishes an achievable pathway to addressing these challenges.

1.1 2021 Butternut Creek Watershed Management Plan: Highlights

The 2021 Butternut Creek Watershed Management Plan provides a 30,000-foot view of the current conditions and challenges regarding water quality in the Butternut Creek Watershed. The planning process was coordinated by OCCA, SWCD, the New York State Department of Environmental Conservation (DEC), and BVA with assistance from several local agencies and organizations. Funding for the plan came in the form of a $25,000 grant from DEC. OCCA convened a Stakeholder Committee comprised of state and local agencies, environmental nonprofits, and community organizations. The Committee gathered community and stakeholder input through two public workshops, 11 public presentations, and hundreds of hours of primary and secondary research expended by Committee members. The 2020 Butternut Creek Watershed Background Report prepared by SWCD provided foundational information for this document. The 2021 Butternut Creek Watershed Management Plan is based on this broad range of data.

The Butternut Creek Watershed experienced substantial declines in nutrient loading between 1985 and 2019. Utilizing the Chesapeake Assessment Scenario Tool (CAST), Edge of Stream (EOS) Nitrogen Loading in the watershed declined by 33.8%, EOS Phosphorous Loading declined by 54.7%, and EOS Sediment Loading declined by 30.3% between 1985 and 2019. These declines can be explained, in part, by the consolidation of the local agricultural industry. However, it is clear that substantial advances have been made in water quality protection efforts over the past three decades.

At the same time, several challenges persist. Communities in the Butternut Creek Watershed have limited technical capacity to implement, monitor, and evaluate the installation of new Best Management Practices (BMPs). Existing annualized maintenance costs for the BMPs currently in place exceed $200,000 thus creating a challenging policy environment for local leaders tasked with planning for and installing new BMPs. While there are numerous funding opportunities to install BMPs and pursue other watershed protection activities, limited coordination between local governments, combined with the limited staff capacity of local governments and area nonprofits, these funding opportunities are often not taken advantage of.

The Stakeholder Committee prioritized the development of a plan that is realistic and achievable. The plan provides a vision for the Butternut Creek going forward, and then identifies 11 Priority Projects and 38 action steps along with strategies for implementation.

1.2 2021 Butternut Creek Watershed Management Plan Priority Projects

The 2021 Butternut Creek Watershed Management Plan **identified 11 Priority Projects** that will help achieve the Stakeholder Committee’s vision of sustained watershed resilience. The Projects are listed below:

- Develop the capacity to implement the Butternut Creek Watershed Management Plan
- Develop a County-Wide Stream Restoration Program
- Right-Size High Priority Culverts in the Butternut Creek Watershed
- Create and implement a Riparian Buffer Survivability Program
- Identify high-priority bridges for repair and replacement using best available technology to protect water quality

- Create a One-Stop Shop for Data in Butternut Creek Watershed
- Increase the Number of Certified Nutrient Management Planners Serving Otsego County
- Increase Attendance and Stakeholder Participation at the SWCD Highway Superintendent Training Programs
- Increase and Conserve Existing Public Access to the Butternut Creek
- Increase capacity of the Otsego County Conservation Association’s Citizen Science Monitoring Program
- Identify and secure funding to implement key habitat restoration projects throughout the Butternut Creek Watershed

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2 Introduction

2.1 What is a watershed?

A watershed or catchment is defined as an area of land that drains into a single point on a stream or river determined by surrounding topography or the drainage divide (Naiman et al. 2005). The characteristics of a watershed influence the physical, chemical, and biological conditions of the stream which describe the water quality of the stream (Welch et al. 1998). Fluvial processes (those produced by the river) that include the supply, storage, and movement of water, sediment, and wood through the stream system are also influenced by the watershed characteristics (Naiman and Bilby 1998). As described by Naiman and Bilby (1998),

> "Activities within a watershed, whether natural or anthropogenic (human-induced), influence the most basic aspects of the hydrological cycle. Vegetation absorbs and transpires water to the atmosphere; roads channelize water to streams; urbanization and certain types of agriculture decrease soil permeability, causing an increase in erosional sheetflow; and impoundments alter the timing, frequency, and intensity of peak flows. All of these alterations, singly and in combination, directly impact the habitat distributions, the trophic structure, the physical, chemical, and biological processes (such as sediment transport, nitrogen cycling, and primary production), and demography of the biological communities."

A watershed is constantly being reshaped by the transport of dissolved and particulate material by river flow (Naiman et al. 2005). The streambed and or banks are scoured in one place and sediment is deposited in another. Stream alteration that causes any change in the stability, pattern or profile of the channel can lead to detrimental ecological effects such as extensive erosion of stream banks and channel bed and sediment deposition (aggradation) in other areas that exceed the stability of the channel. The changes can affect the streams transport capacity or the ability to move the sediment load (Montgomery and Buffington 1998). In addition to being the conduit for water and sediment through the watershed, streams, rivers and other waterways provide essential aquatic habitat and water distribution.

2.2 Planning Process

In 2019, OCCA received $25,000 in funding from the New York State Department of Environmental Conservation (DEC). OCCA worked with the DEC, local government agencies, and nonprofit organizations to create a steering committee tasked with overseeing the development of the plan. Agencies participating on the steering committee included:

- Otsego County Conservation Association (OCCA)
- Otsego Land Trust (OLT)
- Otsego County Planning and Solid Waste Department (OPD)
- Otsego County Soil and Water Conservation District (SWCD)
- Butternut Valley Alliance (BVA)
- New York State Department of Environmental Conservation (DEC)

The Steering Committee met several times through the plan development period from 2019-2021, in addition to conducting various activities to solicit public input and feedback.

The planning process involved:

- Identifying the stakeholders who needed to be involved in the preparation of the plan, establishing open lines of communication, and bringing them together in various formats to provide valuable input;
- Reviewing state and local-level planning documents such as the New York State Phase III Watershed Implementation Plan (WIP) and the Otsego County Strategic Prioritization Plan to ensure the Plan's consistency with existing planning targets, goals, and objectives;
- Preparing and conducting stakeholder interviews with individuals and organizations throughout the Butternut Creek Valley;
- Working with SWCD to review the 2020 Butternut Creek Watershed Background Report;
- Researching demographic conditions of municipalities that lay within the Butternut Creek Watershed's boundaries;
- Evaluating current land-use patterns, water quality conditions, and other environmental factors;
- Conducting numerous public presentations to municipal officials, higher education institutions, and public organizations to obtain input on possible plan recommendations;
- Using the Chesapeake Assessment Scenario Tool (CAST) to identify best management practices that balance water quality protection with economic feasibility;
- Organizing all information and data obtained through steering committee meetings, desktop research, and stakeholder interviews to prepare goals, objectives, and action items that are realistic and achievable; and
- Identifying the impacts of climate change on water quality conditions in the Butternut Creek Watershed

2.2.1 Public Engagement

Since the passage of the 1972 Clean Water Act, there has been a dramatic improvement in water quality throughout the entire United States. The Clean Water Act contains an impressive array of rules, regulations, and resources for improving water quality in general. However, even though billions of dollars have been spent on improving old and creating new water treatment plants, permitting systems, and inspections, 40% of the waters in the United States are still too polluted for swimming (U.S. EPA, 2015). Compounding this issue is an underlying need to educate the public about water quality. In its *Getting in Step Guide (2010)* the U.S. EPA cites a report prepared by the National Environmental Education and Training Foundation which states that 47% of respondents still believe that the most common source of water pollution is from factories.

Watersheds do not adhere to societal boundaries. The Butternut Creek Watershed, for example, traverses eight towns and two villages. Coordinating management efforts across many jurisdictions requires constant feedback, information, and stakeholder empowerment.

- **Feedback**: helps state and local agencies, planners, elected officials, business owners, citizens, and visitors visualize the strengths and weaknesses of a particular watershed. As watershed management plans are developed, feedback is critical to ensure that proposed water quality improvement measures actually work without unduly impacting the economic viability of the area in need of protection.

- **Information:** can be used to motivate water quality managers, business owners, cooperating agencies, elected officials, bad actors, and the public. Effective public engagement can yield information that is traditionally missed from desktop analyses (i.e. focus groups, one-on-one stakeholder interviews, etc.)
- **Stakeholder Empowerment:** involves sharing data with the public in a transparent and equitable manner so that citizens can make informed management decisions about their watershed. This principle is based on Arnstein's (1969) "*Ladder of Citizen Participation*." Following Arnstein's example, effective outreach can lead to citizens being allocated increasing levels of control over planning decisions in their respective watershed.

Public engagement plays a critical role in watershed planning. New York is a home rule state meaning local governments (village, city, and/or town) have substantial powers to direct development within their jurisdictions. An informed public plays a critical balancing role in ensuring a harmonious relationship between the built and natural environment within a given watershed.

Residents across New York State have a strong connection to water resources. Rivers, streams, creeks, wetlands, and lakes, provide for outdoor recreation, food, drinking water, flood control, and a place to relax and enjoy the scenery. Public engagement and education can help individuals channel their connection to water resources into the creation of an overarching strategy to protect water quality.

2.2.1.1 Public Engagement Strategy

Butternut Creek Watershed Public Engagement Plan: In October 2019, the Steering Committee developed a Public Engagement Plan (PEP) (Appendix A) which guided public engagement activities in the Butternut Creek Watershed.
The purpose of the PEP is threefold in nature:

1) To empower communities to make watershed management decisions for themselves;
2) Increase the capacity and potential of communities in the Butternut Creek Valley to manage their watershed; and
3) To improve the relationships between local and state agencies, community organizations, municipalities and the public while advancing regional, state, and national goals for the public good.

The PEP governs the storage of plan-based information to ensure its accessibility to the public, messaging related to the plan, plan-based messaging, publication of materials, and data gathered from public engagement events. The PEP also establishes strategies such as stakeholder surveys, targeted landowner outreach, event-based outreach and stakeholder interviews to gather on-the-ground data that assists in the plan's development. The PEP encourages the building of relationships with higher education institutions such as Hartwick College and SUNY to identify data gaps in the watershed and outlines ways in which students can be engaged to address said gaps.

Public Meetings: In addition to the stakeholder interviews, the Steering Committee held 2 public meetings (Table 1). The meetings were held in central locations within the Butternut Creek Watershed to ensure accessibility for interested stakeholders.

The Steering Committee publicized the public meetings through announcements in local newspapers, organizational bulletins, and email. Initial meetings included an overview of the planning process, the agencies involved in the planning process, and opportunities for the public to provide input regarding key policy issues related to watershed management. Later meetings included an overview of current environmental, land-use, and demographic conditions in the watershed, an evaluation of the planning capacity of municipalities within the watershed, and outlined a series of best management practices that could be undertaken to improve water quality in the Butternut Creek Watershed.

Purpose	Date	Location	Attendees
Kickoff Meeting	July 2019	New Lisbon Town Hall	9
Outreach Strategy Session	August 2019	New Lisbon Town Hall	17

Table 1: Public meetings including date, purpose of meeting, location and number of participants.

Complementary Efforts: To supplement ongoing public engagement efforts, members of the Steering Committee conducted presentations in several venues in and outside of the Butternut Creek Watershed. These presentations gave members of the Steering Committee the ability to reach a strong cross-section of key local and regional stakeholders to raise awareness of the BCWMP. As stated above, the Steering Committee engaged local governments, higher education institutions, and local nonprofit organizations during the plan development process. Table 2 shows a list of outreach events conducted by the Steering Committee.

Purpose	Date	Location	Attendance
Laurens Town Board Meeting	August 2019	Laurens, NY	8
Morris Town Board Meeting	September 2019	Morris, NY	12
Pittsfield Town Board Meeting	September 2019	Pittsfield, NY	10
New Lisbon Town Board Meeting	September 2019	Garrattsville, NY	14

Butternuts Town Board Meeting	October 2019	Butternuts, NY	11
Burlington Town Board Meeting	February 2020	Burlington, NY	3
SUNY Binghamton Presentation	September 2019	Remote via Zoom	24
Hartwick College Water Symposium	November 2019	Oneonta, NY	45
Butternut Valley Alliance Board of Directors	July 2019	Gilbertsville, NY	8
Upper Susquehanna Conservation Alliance Meeting	February 2020	Cortland, NY	20

Table 2: Complementary outreach meetings.

Consultation with Key Agencies: Throughout the multi-year planning process, Steering Committee representatives met with agencies and organizations conducting watershed management activities throughout the Butternut Creek Watershed. These consultations allowed the Steering Committee to collect input from entities performing on-the-ground watershed management activities. Agencies and organizations consulted include:

- Susquehanna River Basin Commission
- Upper Susquehanna Conservation Alliance
- Butternut Valley Alliance

Review of Regional and Statewide Initiatives: As part of the planning process, the Steering Committee examined and, in some cases, incorporated recommendations from a wide range of regional and statewide plans, documents, and initiatives. This was done to ensure the plan's consistency with existing planning priorities. These included but are not limited to:

- 2019 New York State Phase III Watershed Implementation Plan
- 2018 4th National Climate Assessment
- 2014 New York State Energy Research and Development Authority ClimAID report
- 2014 Chesapeake Bay Watershed Agreement
- 2017 Otsego County Strategic Prioritization Plan
- 2019 Otsego County All Hazards Mitigation Plan

COVID-19 Pandemic

The spread of SARS-COV-2 in New York State and the subsequent restrictions on mass gatherings caused outreach activities related to the BCWMP to be canceled during the Spring and Summer of 2020 out of an abundance of caution for public safety. As of June 2020, New York State is in the midst of a phased reopening plan which is anticipated to extend through July 2020. The coronavirus pandemic could drastically change the way in which public engagement is conducted, with large gatherings potentially being replaced by virtual meetings on a temporary basis. This change has the potential to cause challenges related to equity and inclusion as several areas in the Butternut Creek Watershed do not have adequate internet access to participate in virtual meetings. Future outreach efforts related to the BCWMP will incorporate proper precautions to limit the risk of exposure to coronavirus.

2.3 Partners

The crux of any good stakeholder-based plan is a strong group of partners to help foster the planning process. With the Otsego County Conservation Association as the lead for this project, a team of local interested partners were assembled to provide input from all sectors of the community. These partners were chosen because of their interest in preserving the Butternut Creek watershed, their governance within the watershed, their expertise in natural resource conservation and environmental policy, and an overall interest in the Butternut Valley. Below is a description of the partner agencies, organizations and municipalities that have taken an active role in the planning process.

2.3.1 Otsego County Conservation Association (OCCA)

OCCA is a countywide environmental organization addressing a broad spectrum of basic environmental concerns. OCCA plays a key role in initiating and carrying out programs designed to improve or protect Otsego County's air, land, and water. Wide support from county residents enhances our ability to accomplish our mission. More information about OCCA can be found at: http://occainfo.org/

2.3.2 Otsego County Planning Department (OPD)

The department is responsible for a wide array of functions including administration of housing and transportation grants, managing solid waste and recycling, GIS services, and administering economic development initiatives. More information about OCPD can be found at: https://www.otsegocounty.com/departments/planning_department/index.php

2.3.3 Otsego County Soil and Water Conservation District (SWCD)

The staff at Otsego Soil and Water Conservation District works with landowners, land managers, local government agencies, and other local entities in addressing a broad spectrum of resource concerns: erosion control, flood prevention, water conservation and use, wetlands, ground water, water quality and quantity, non-point source pollution, forest land protection, wildlife, recreation, wastewater management and community development. More information about SWCD can be found at: https://www.otsegosoilandwater.com/.

2.3.4 New York State Department of Environmental Conservation (DEC)

The DEC's mission is to conserve, improve and protect New York's natural resources and environment and to prevent, abate and control water, land and air pollution. In order to enhance the health, safety and welfare of the people of the state and their overall economic and social well-being. More information about the DEC can be found at: http://www.dec.ny.gov/.

2.3.5 Otsego Land Trust (OLT)

Otsego Land Trust conserves our natural heritage of woodlands, farmlands, and waters that sustain rural communities, promote public health, support wildlife diversity, and inspire the human spirit. More information about OLT can be found at: http://www.otsegolandtrust.org/

2.3.6 Butternut Valley Alliance (BVA)

The Butternut Valley Alliance is a 501(c)(3) organization. Its mission is to protect and conserve the environmental qualities, farming, economic development and cultural heritage in the Butternut Creek watershed. More information about the BVA can be found at: https://butternutvalleyalliance.org/content.aspx?page_id=0&club_id=791986.

2.3.7 Committee Governance Structure

The Committee has elected to utilize a horizontal governance structure to ensure consensus-driven decision making during the planning process. A horizontal governance structure trades a traditional hierarchical management structure and replaces it with a flat management structure. Horizontal governance prioritizes collaboration, coordination, shared responsibility for decisions and outcomes, and a willingness to work through consensus.

2.4 Watershed Vision

The Vision Statement for the Butternut Creek Watershed Management Plan is intended to outline a broad statement of the values undergirding the development of the document along with current and future efforts to protect water quality in the watershed. In its current form, the Vision Statement reads as follows:

“We the residents of the Butternut Creek Watershed firmly believe that a healthy watershed is integral to our economic, social, and environmental wellbeing. We believe that a proactive approach to protecting water quality, in light of the current and anticipated effects of climate change, will be critical to maintaining the water quality of the Butternut Creek. We envision a future where communities throughout the Butternut Creek Valley work collaboratively to protect water quality. We envision a future where community leaders, citizens, community organizations, government agencies, and other interested parties are regularly invited to assist us with our efforts to protect water quality.”

3 Watershed Characterization

3.1 Size, Location, and Subwatersheds

Butternut Creek originates at the headwaters on Angel Hill in the Town of Burlington, Otsego County, NY (Figure 1) (Peterson 2017). Butternut Creek and its contributing tributaries flow through eight towns and two villages: Burlington, Pittsfield, New Lisbon, Exeter, Morris, Laurens, Butternuts, Unadilla, the Village of Morris, and the Village of Gilbertsville, before joining the Unadilla River in the Town of Butternuts near Mount Upton, Chenango County, NY. The course of the mainstem, or the primary downstream section of the river covers 43 miles. Butternut Creek is one of the headwater streams of the Upper Susquehanna watershed which is part of the larger Chesapeake Bay watershed. The Susquehanna River enters the Chesapeake Bay at Havre de Grace, Maryland (approximately 400 linear miles to the south).

The Butternut Creek watershed typifies the characteristics of Otsego County's landscape which are low-lying river valleys surrounded by rolling flat topped hills, with steep side slopes and ravines found adjacent to watercourses. The watershed is divided in three 12-digit sub watershed Hydrologic Unit Codes (HUC), the Lower (20501010910), Middle (20501010803), and Upper (20501010802) (Figure 1). The combined area of the three sub watersheds contributing to the entire Butternut Creek watershed is 130.17 mi^2 (83,331 acres). The size of the watershed has an effect on the volume of water entering the stream channel (Travis and Brown 2011). The sub-watersheds increase in size going from upstream to downstream (Table 3). The Upper Butternut watershed has a drainage area of 33.92 mi^2 (21,709 acres) and consists of mostly unnamed tributaries with a size range from 1 mi^2 to 3 mi^2 (Appendix A, Figure 1). The Middle Butternut watershed has a drainage area of 44.10 mi2 (28,222 acres) and consists of tributaries with a size range from 1 mi^2 to 5 mi^2, some of which are named (Appendix A, Figure 2). The Lower Butternut watershed is the largest of the three sub watersheds with a drainage area of 52.16 mi^2 (33,380 acres). The Lower Butternut has several small tributaries of 1 mi^2 but also several larger tributaries ranging in size from 2 mi^2 (Halbert Brook and Coye Brook) to 6 mi^2 (Cahoon Creek) (Appendix A, Figure 3).

Watershed	Area		HUC-12 Code
	Acres	mi^2	
Upper	21,709	33.92	20501010802
Middle	28,222	44.10	20501010803
Lower	33,380	52.16	20501010910
Total	83,311	130.18	

Table 3: Summary of Butternut sub watershed areas

The Butternut Creek originates as a 1st order foothill stream with a relatively high gradient of 75 ft/mile in the first five miles of its course. The stream classification system developed by Strahler (1957, 1964) assigns an order to a stream and river along a channel network based on the number of tributaries feeding them (Naiman et al. 2005). A 1st order stream has no tributary inputs. When two 1st order streams come together the confluence forms a 2nd order stream, at the confluence of a 2nd order stream a 3rd order stream is formed, and so on. The Butternut Creek evolves into a 3rd order stream, with a more moderate gradient of 12 ft/mile over its last 17 miles (Stensland 2002). The Butternut Creek is predominantly in the erosional stage of development. The presence of a small floodplain in the last few miles of the Butternut Creek indicates that it is considered to be transitional in terms of hydrology (Stensland 2002). The elevation difference between Angel Hill, 2087 feet, and the confluence with the

Unadilla, 1000 feet, is 1087 feet, with an average stream gradient of 25.3.9 ft/mile, and 89% of the watershed over 1198 feet elevation (USGS 2020a).

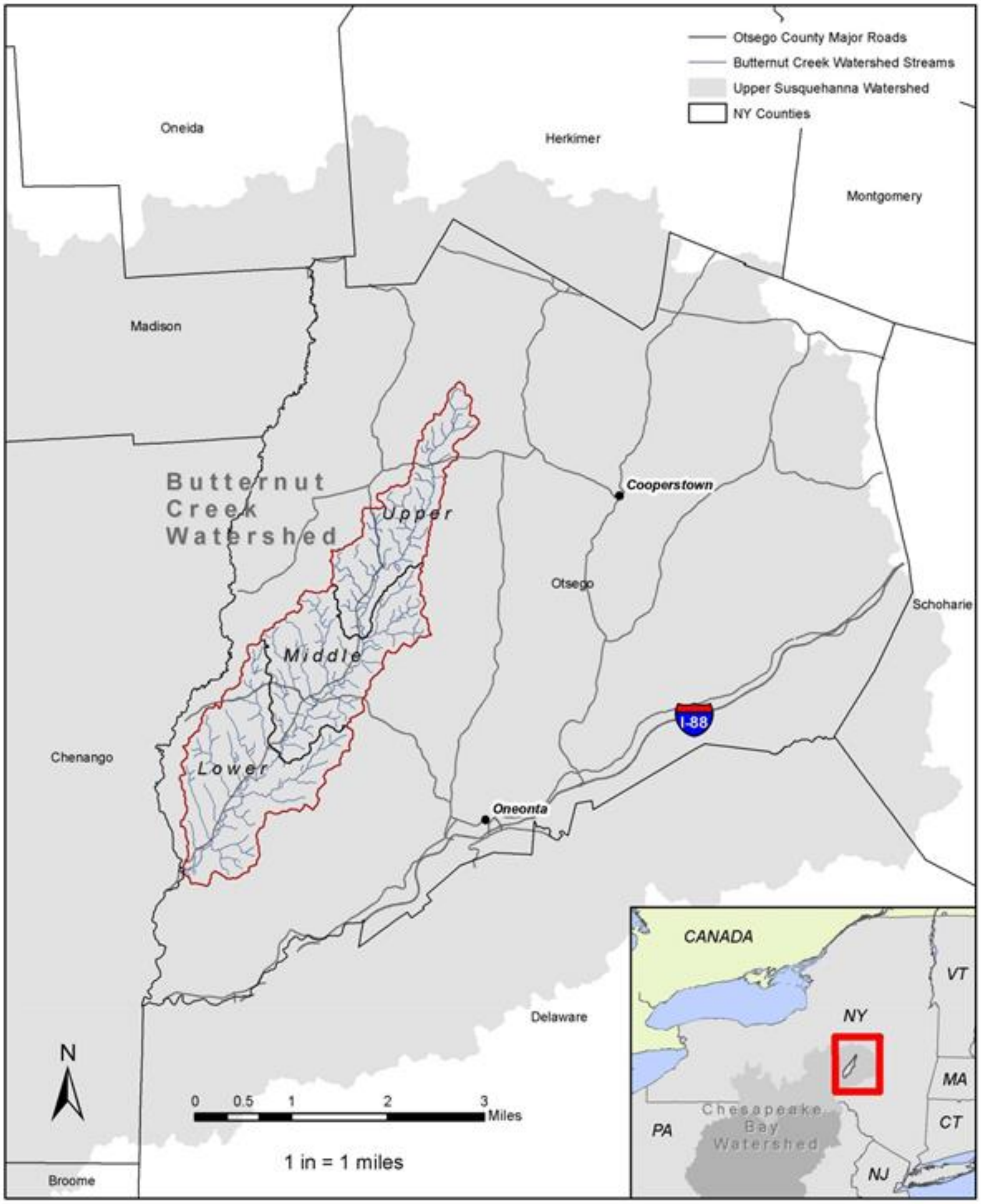

Figure 1. Overview of the Butternut Creek Watershed.

3.2 Sociological Characteristics

As part of the planning process, OCCA utilized data from the U.S. Census Bureau American Community Survey for the year 2018 to estimate the overall population of the watershed. In estimating the population of the Butternut Creek Watershed, OCCA utilized ArcGIS to merge the census tract boundaries with the boundaries of the watershed. Population was then estimated based on the proportion of each census tract that lay within the Butternut Creek Watershed. OCCA's analysis yielded an estimated population of 4,489 individuals living within the watershed. It should be noted that OCSWCD/Capuana (2021) conducted their own population estimate during the preparation of the *Butternut Creek Watershed Background Report* which indicated that an estimated 6,089 individuals resided within the watershed. For the purposes of comparison, the population of Otsego County in 2019 was 59,972 individuals (American Community Survey, 2019.)

The development pattern within the watershed can be characterized as relatively low-density and rural in nature, with about one housing unit for every 38 acres of land in the watershed's seven towns. The villages of Morris and Gilbertsville reflect a higher population density with an average density of one housing unit for every 2.8 acres of land. The Butternut Creek Watershed is approximately 14 miles from the City of Oneonta and 26 miles from the County seat of Cooperstown.

Understanding the sociological characteristics of a watershed can provide insight into the capacity and willingness of its population to finance watershed implementation efforts, support the adoption of watershed protection policies, and identify potential barriers to the adoption of watershed protection measures (Kreye, Adams & Kline, 2019). [1]The following section describes a series of sociological metrics in the Butternut Creek Watershed. It should be noted that these figures will likely need to be updated when the data from the 2020 U.S. Census are released. Data for this section were gathered from the U.S. Census Bureau website http://data.census.gov. Census data were gathered from the American Community Survey (ACS), with data from 2018 being used to reflect sociological conditions in the watershed.

3.2.1 Median Household Income

According to ACS data, the Butternut Creek Watershed's median household income was $54,263 per year in 2018.[2] This figure was slightly higher than Otsego County's median household income ($53,121) and approximately 20% lower than New York State's ($65,323). Among the individual municipalities, household median income was highest in the Village of Gilbertsville ($66,136) and lowest in the Village of Morris ($43,173). Per capita income in the Butternut Creek watershed was $28,012 in 2018 falling below New York State's per capita income of $38,884 but remaining slightly higher than Otsego County ($27,680). Per capita income was highest in the Town of New Lisbon ($33,905) and lowest in the Town of Burlington ($23,185). Figure 2 provides a breakdown of income levels in the Butternut Creek Watershed.

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[1] Kreye, M. M., Adams, D. C., & Kline, J. D. (2019). Gaining voter support for watershed protection. *Land Use Policy*, *89*, 104227.

[2] To calculate the sociological metrics for the entire Butternut Creek Watershed, metrics such as household median income were aggregated and averaged.

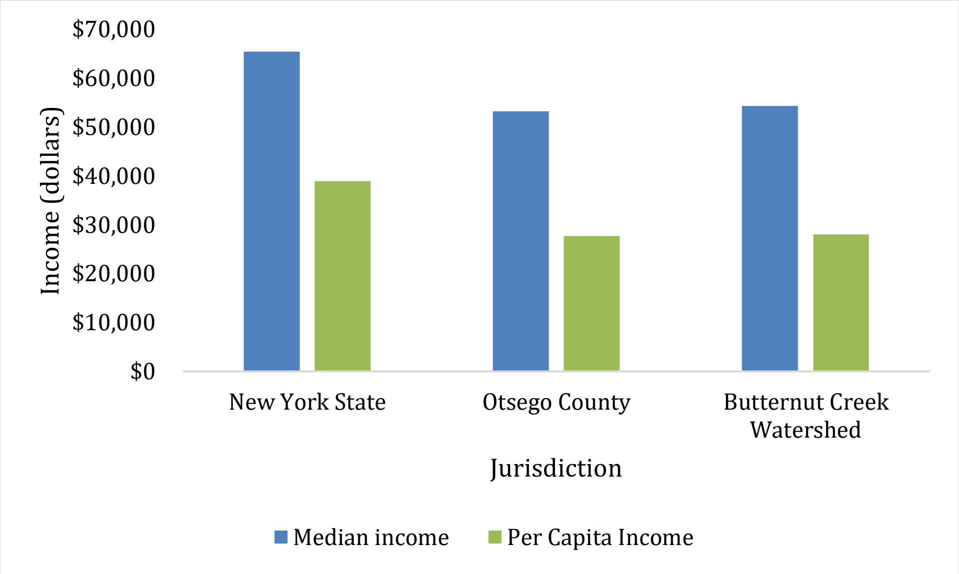


Figure 2. Household Median Income in the Butternut Creek Watershed

3.2.2 Age Distribution

Understanding the age distribution within the Butternut Creek Watershed is important as it can help local leaders identify future community needs and potential challenges including the provision of appropriate housing, recreational opportunities, public services, and transportation among others. As shown in Figure 3, approximately 28% of individuals in the Butternut Creek Watershed are over the age of 60. This figure is higher than Otsego County's level of 27% and 32% higher than the proportion of New York State residents over the age of 60.

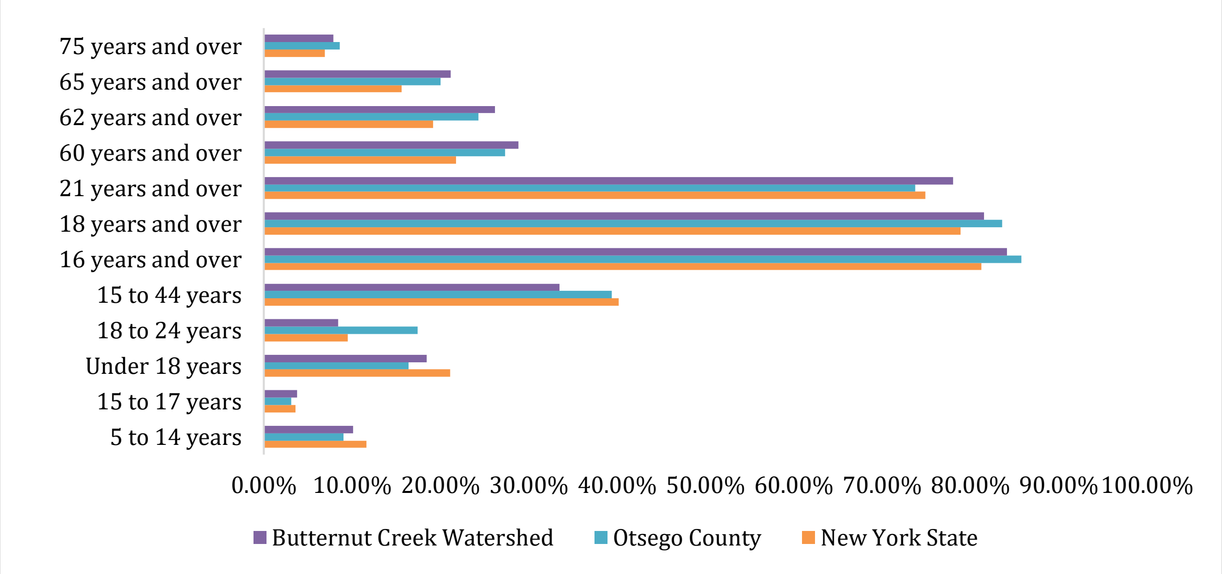


Figure 3. Age Distribution in the Butternut Creek Watershed (2018)

3.2.3 Housing

Understanding housing patterns can benefit a watershed management plan by providing insight into the level of development pressure facing the watershed, the economic resilience of its population, and information on the relative population density of the watershed. As stated above, the Butternut Creek Watershed has a relatively low population density, with the Village of Morris representing the watershed's densest community. As of 2018, there were a total of 8,434 housing units in the watershed (U.S. Census Bureau, 2018). Of the total number of housing units, approximately 11% (919) of the housing units were built after the year 2000. It should be noted that 77% of the housing units constructed in the Butternut Creek Watershed occurred before the Great Recession of 2008-09. Figure 4 provides an overview of the age of the watershed's housing stock compared to Otsego County and New York State.

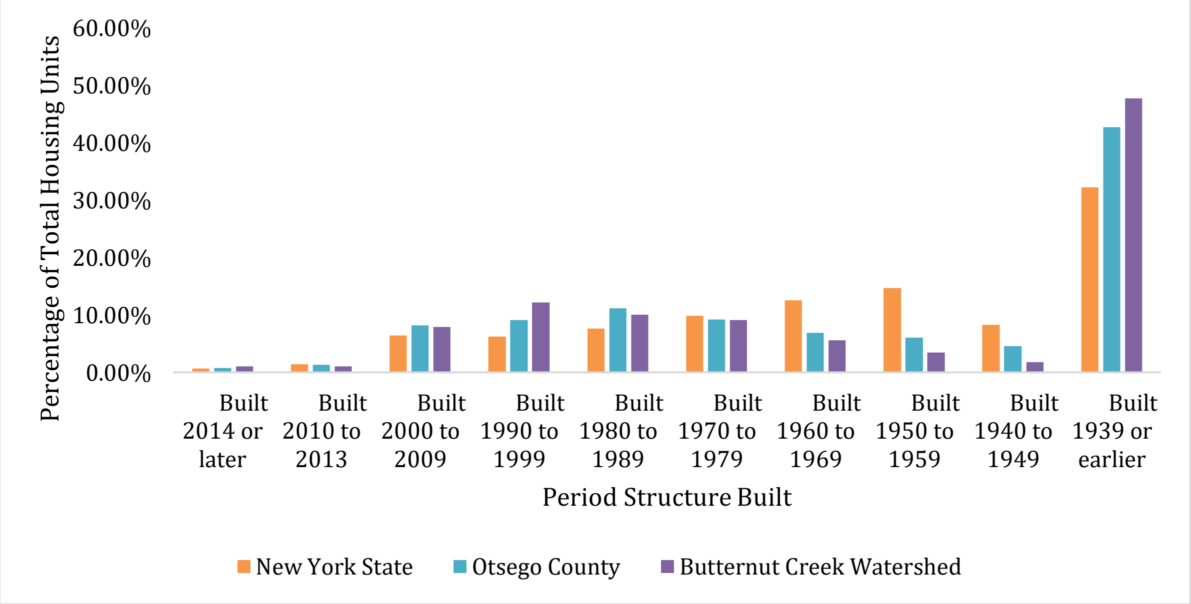


Figure 4. Age of Housing Stock in the Butternut Creek Watershed (2018)

As seen in Figure 4, approximately 47% of the housing units in the Butternut Creek Watershed were built in 1939 or earlier. This figure can help local officials assess the development potential of the watershed and the potential to utilize infill development techniques to offset the environmental impact of constructing new homes.

In addition to evaluating the age of the watershed's housing stock, it is also important to evaluate the affordability of the watershed's housing stock as well. The U.S. Census Bureau evaluates the "affordability" of housing by measuring the percentage of an individual's or family's income spent on housing costs. The U.S. Census Bureau indicates that housing expenditures equating to more than 30% of an individual's or family's income points to a housing affordability problem.

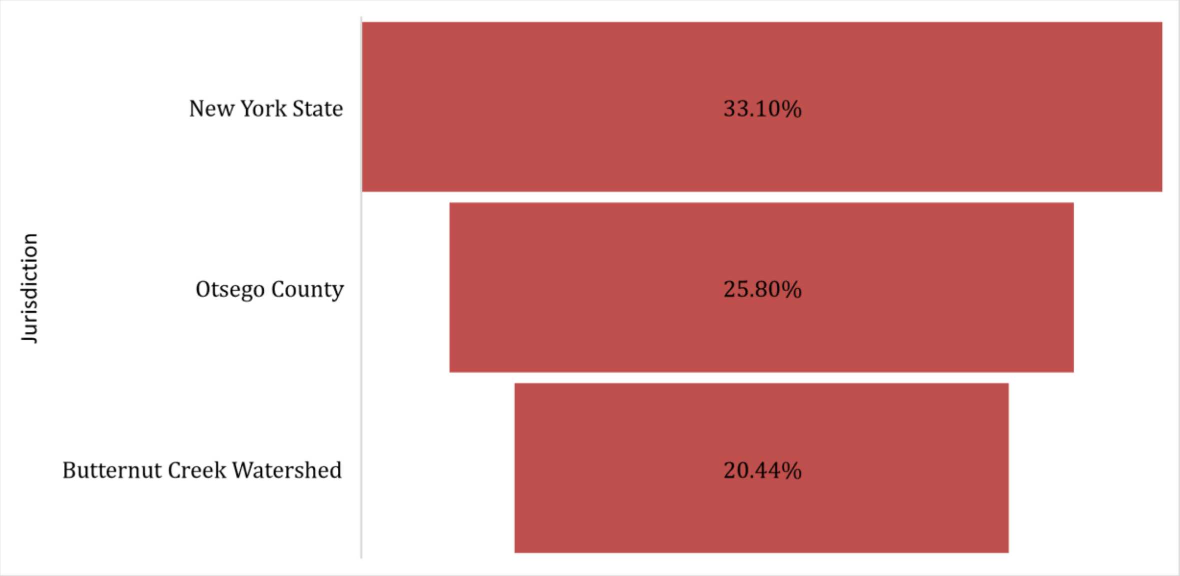


Figure 5. Percentage of Income Stressed Households in the Butternut Creek Watershed

As shown in Figure 5, 20.44% of households in the Butternut Creek Watershed are income stressed (spend more than 30% of their monthly income on housing costs). This figure is noticeably lower than both the Otsego County level of 25.80% and the New York State level of 33.10%.

3.2.4 Poverty Rate

According to the 2019 Opportunities for Otsego Head Start/Early Head Start Community Needs Assessment, the number of people living in poverty in Otsego County decreased between 2012 and 2017. In the Butternut Creek Watershed, the mean poverty rate for the year 2018 was 13.26%. This figure was lower than both Otsego County's poverty rate (15.40%) and New York State's poverty rate (14.60%). The Town of Pittsfield had the highest poverty rate in the watershed (17.70%) while the Village of Gilbertsville had the lowest at 6.80%. Figure 6 shows a comparison of poverty rates for the Butternut Creek Watershed, Otsego County, and New York State.

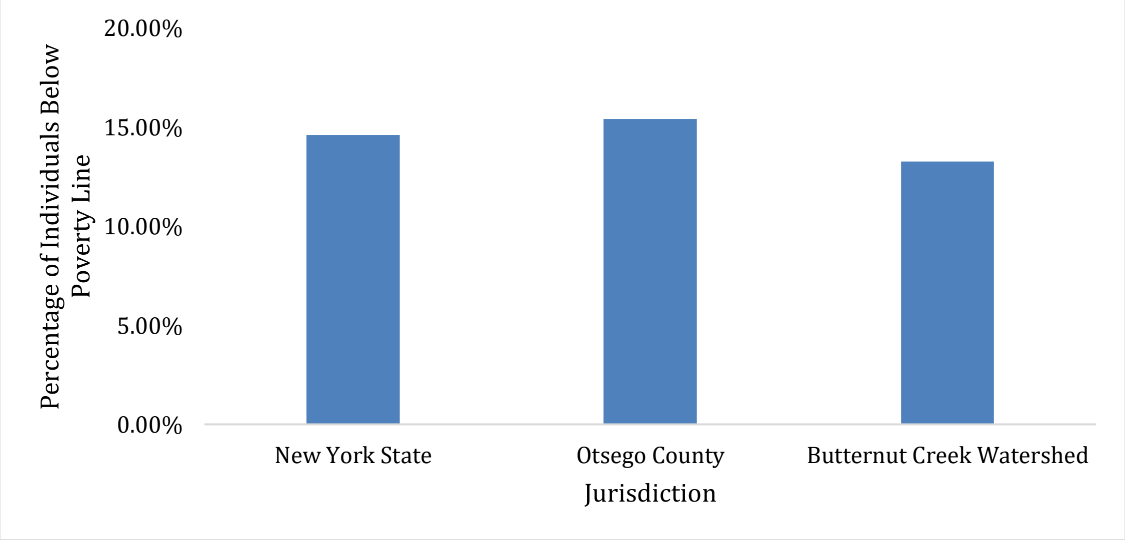


Figure 6. Poverty Rate in the Butternut Creek Watershed

3.2.5 Educational Attainment

Understanding the education levels in the Butternut Creek Watershed can provide insight into current and future income, poverty, and employment in the region. Education, particularly environmental education, has been positively correlated to increases in conservation behaviors among members of the public (Varela-Candamio, Novo-Corti & Garcia-Alvarez, 2018). Partnerships established with schools in the watershed can lead to the implementation of environmental education programs geared toward the conservation of the Butternut Creek Watershed. In 2020, OCCA was awarded a National Oceanic and Atmospheric Administration (NOAA) Bay Watershed Education and Training Grant (B-WET) to work with area teachers to design science curricula focusing on the protection of the Chesapeake Bay's water quality. Figure 7 provides an overview of educational attainment levels in the Butternut Creek compared to those of Otsego County and New York State as a whole.

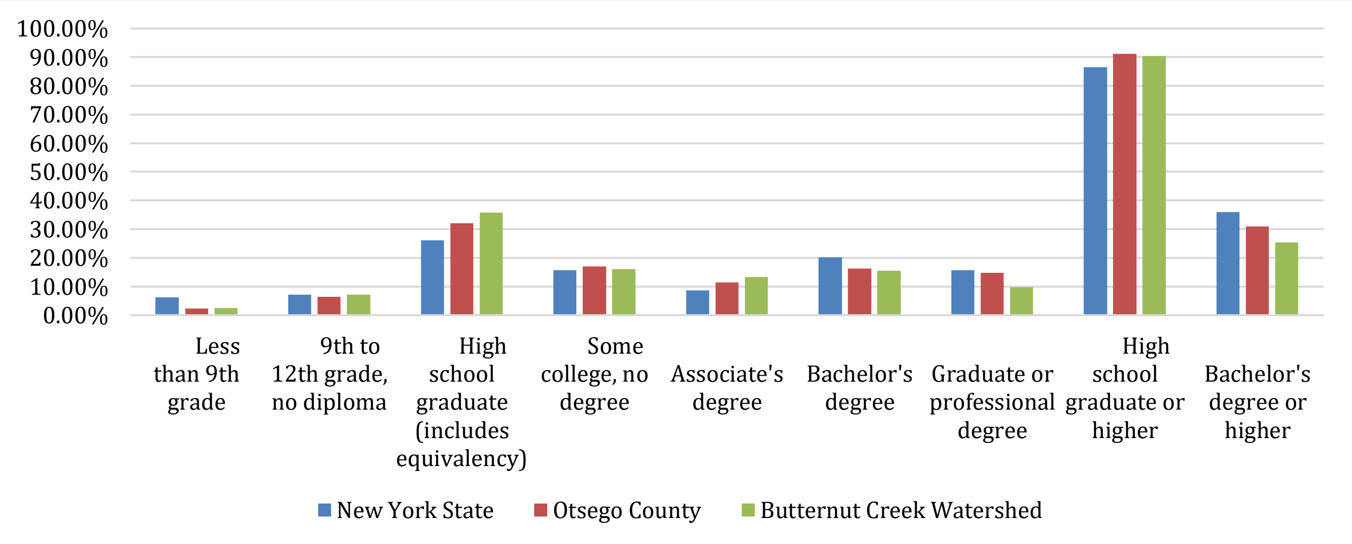


Figure 7: Butternut Creek Watershed Educational Attainment Levels

According to the data presented in Figure 7, approximately 90% of watershed residents graduated high school. This figure is slightly lower than that of Otsego County (91.20%) but a bit higher than the state figure of 86.50%. However, 25.30% of watershed residents received a Bachelor's Degree or higher. This number is lower than that of Otsego County (30.90%) and New York State (35.90%).

3.2.6 Job Breakdown by Sector

The viability of a community is often tied to having a diverse group of employers in a particular area. According to the 2018 ACS data, approximately 28% of watershed residents work in the educational services, healthcare, and/or social assistance sectors. This figure closely tracks that of Otsego County where 35% and New York State (28%). Manufacturing (13%) and retail trade (12%) represent the second and third largest sector employing the most watershed residents. It is worth noting that the percentage of residents working in the manufacturing sector is nearly twice that of Otsego County (7.9%) and more than doubles that of New York State (6.0 %). Figure 8 provides a breakdown of employment by sector in the Butternut Creek Watershed.

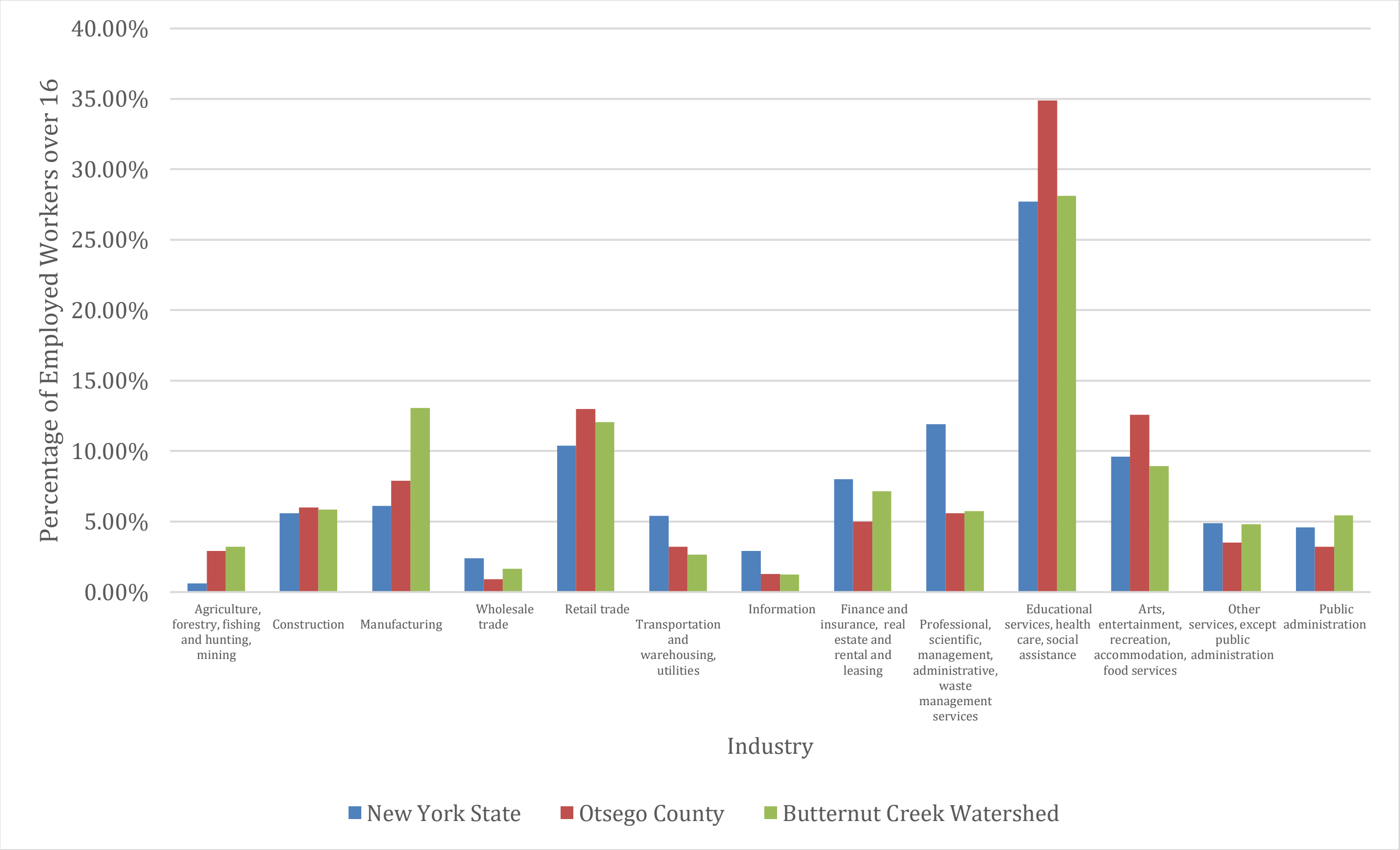


Figure 8. Breakdown of Employment by Sector in the Butternut Creek Watershed

3.3 Land Cover and Land Use

3.3.1 Land Cover

The Chesapeake Conservancy created a high-resolution (1-meter) land cover data set for the entire Chesapeake Bay Watershed based on 2013 or 2014 aerial imagery from USDA's National Agricultural Program (NAIP), available leaf-off imagery produced by state and county agencies and the latest LiDAR imagery (Chesapeake Conservancy 2016, CBP 2017). From the land cover data set a high-resolution (1-meter) land use dataset was developed that has been used to inform the Chesapeake Bay Program Phase 6 Watershed Model which guides water quality improvement efforts under the TMDL (CBP 2017). The Butternut Creek watershed is characterized by rolling hills covered by mixed deciduous/conifer forests and farmland with minimal development as identified by structures and impervious surfaces and roads (Table 4). Over half of the watershed is covered with forest as defined by tree canopy in the land cover classification followed by low vegetation (Table 4) (Chesapeake Conservancy 2016). Land cover characteristics are similar for each subwatershed (Table 4, Figure 9).

Land Cover	**Percent of Subwatershed**			**Total**
	Lower	**Middle**	**Upper**	
Water	0.72	0.84	0.83	0.79
Tree Canopy	65.60	66.33	60.24	64.45
Low Vegetation (includes cropland, pasture, turf grass, and mixed open)	31.78	30.74	37.11	32.82
Barren	0.02	0.02	0.03	0.02
Structures	0.16	0.23	0.14	0.18
Impervious Surfaces	0.12	0.13	0.07	0.11
Impervious Roads	1.17	1.34	1.16	1.22
Tree Canopy over Structures	0.01	0.02	0.01	0.02
Tree Canopy over Impervious Surfaces	0.01	0.01	0.00	0.01
Tree Canopy over Impervious Roads	0.40	0.33	0.41	0.38

Table 4. Land cover classification of the Butternut Creek Watershed from Chesapeake Conservancy high resolution 1 m land cover data (Chesapeake Conservancy 2016).

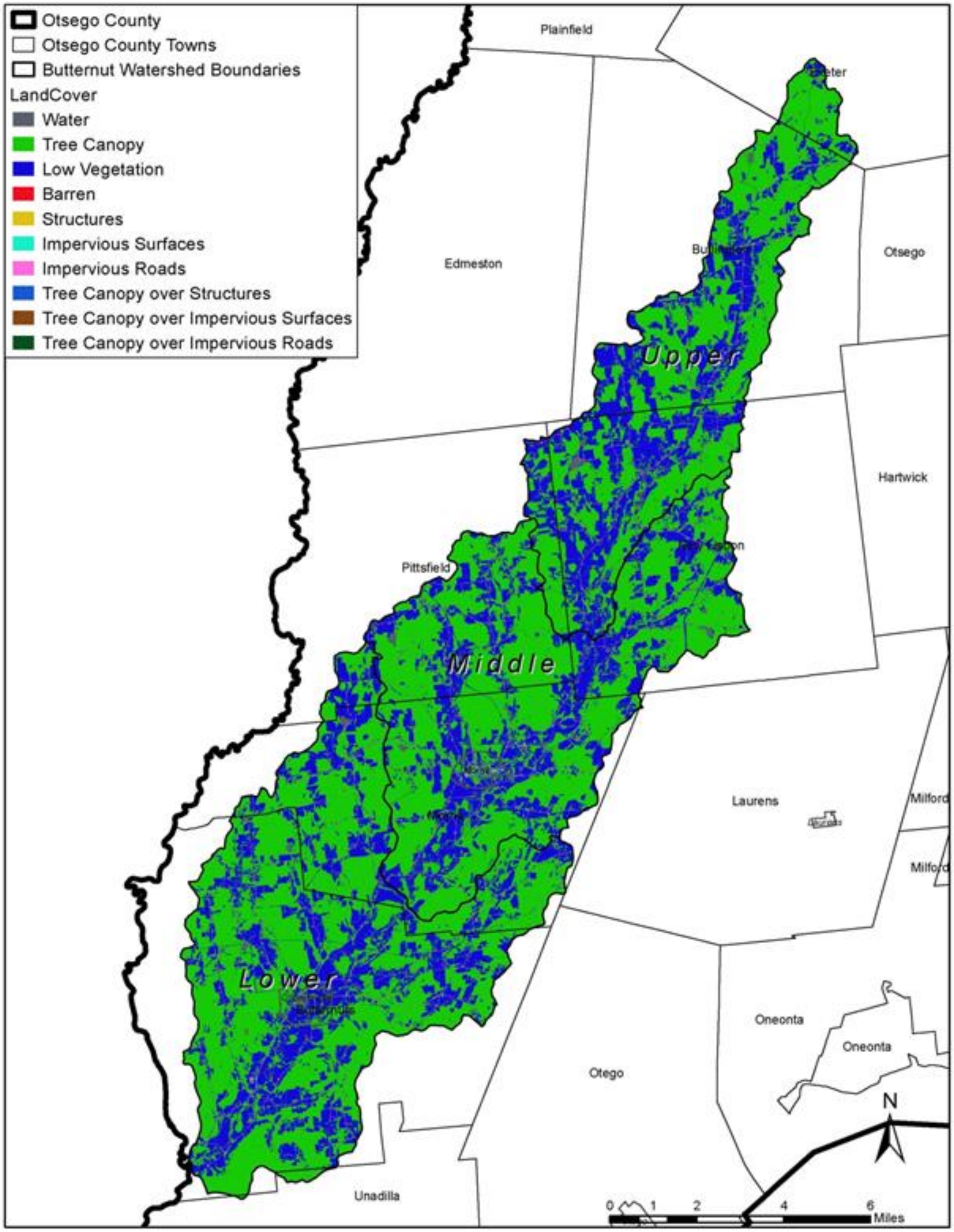


Figure 9. Land cover classification in the Butternut Creek Watershed (Chesapeake Conservancy 2016).

3.3.2 Land Use

The land use classification of the Butternut Creek watershed provides more detail on how the different land cover types are being used and incorporates wetland information. Floodplain wetlands make use 1.7% of the watershed and the Upper Butternut Creek watershed has the highest percentage of the watershed covered in floodplain wetlands and other wetlands compared to the other sub watersheds (Table 5, Figures 10 and 11). Forest is the dominant land use making up almost 60% of the watershed. The Lower Butternut Creek watershed has the highest percentage of forested land use among the sub watersheds followed by the Middle Butternut Creek watershed and then the Upper Butternut Creek watershed, 61.8%, 59.7%, and 53.3% respectively (Table 5, Figures 10 and 11, Appendix XX). Agriculture is the second largest land use in the watershed with 31.2 % of the watershed classified as agriculture. The Upper Butternut Creek watershed has the most land classified as agriculture and the Lower Butternut Creek and Middle Butternut Creek watershed both have the same percent of land use classified as agriculture (Table 5). The land use classification of agriculture includes pasture and cropland. Agricultural land use has decreased over the last century and large chunks of land have returned to forested conditions. A quantification of historical change is beyond the scope of this project. However, comparing aerial photography from 1937 to 2017 around the Village of Morris visually shows such changes over the past 80 years as well as changes in the meander pattern of Butternut Creek.

Land Use	Lower		Middle		Upper		Total	
	Area (acres)	% Watershed	Area (acres)	% Watershed	Area (acres)	% Watershed	Area (acres)	% Watershed
Impervious, Road	391.42	1.2%	383.37	1.4%	255.09	1.2%	1,029.88	1.2%
Impervious, Non-Road	94.00	0.3%	100.87	0.4%	44.49	0.2%	239.37	0.3%
Tree Canopy over Impervious	154.95	0.5%	120.44	0.4%	98.31	0.5%	373.69	0.4%
Water	286.47	0.9%	295.94	1.0%	200.21	0.9%	782.62	0.9%
Floodplain Wetlands	416.30	1.2%	500.55	1.8%	463.80	2.1%	1,380.65	1.7%
Other Wetlands	546.09	1.6%	581.70	2.1%	720.82	3.3%	1,848.61	2.2%
Forest	20,619.83	61.8%	16,859.18	59.7%	11,574.91	53.3%	49,053.92	58.9%
Tree Canopy over Turf	33.65	0.1%	37.04	0.1%	31.60	0.1%	102.29	0.1%
Mixed Open	431.45	1.3%	490.90	1.7%	345.68	1.6%	1,268.04	1.5%
Fractional Turf (small)	14.25	0.0%	2.50	0.0%	0.89	0.0%	17.64	0.0%

Fractional Turf (med)	57.68	0.2%	56.92	0.2%	22.59	0.1%	137.20	0.2%
Fractional Turf (large)	34.68	0.1%	16.65	0.1%	71.70	0.3%	123.03	0.1%
Turf Grass	370.34	1.1%	386.46	1.4%	246.47	1.1%	1,003.28	1.2%
Agriculture	9,929.91	29.7%	8,390.45	29.7%	7,633.27	35.2%	25,953.63	31.2%

Table 5. Land use classification of the Butternut Creek watershed from Chesapeake Conservancy high resolution 1 m land use data (Chesapeake Conservancy 2016).

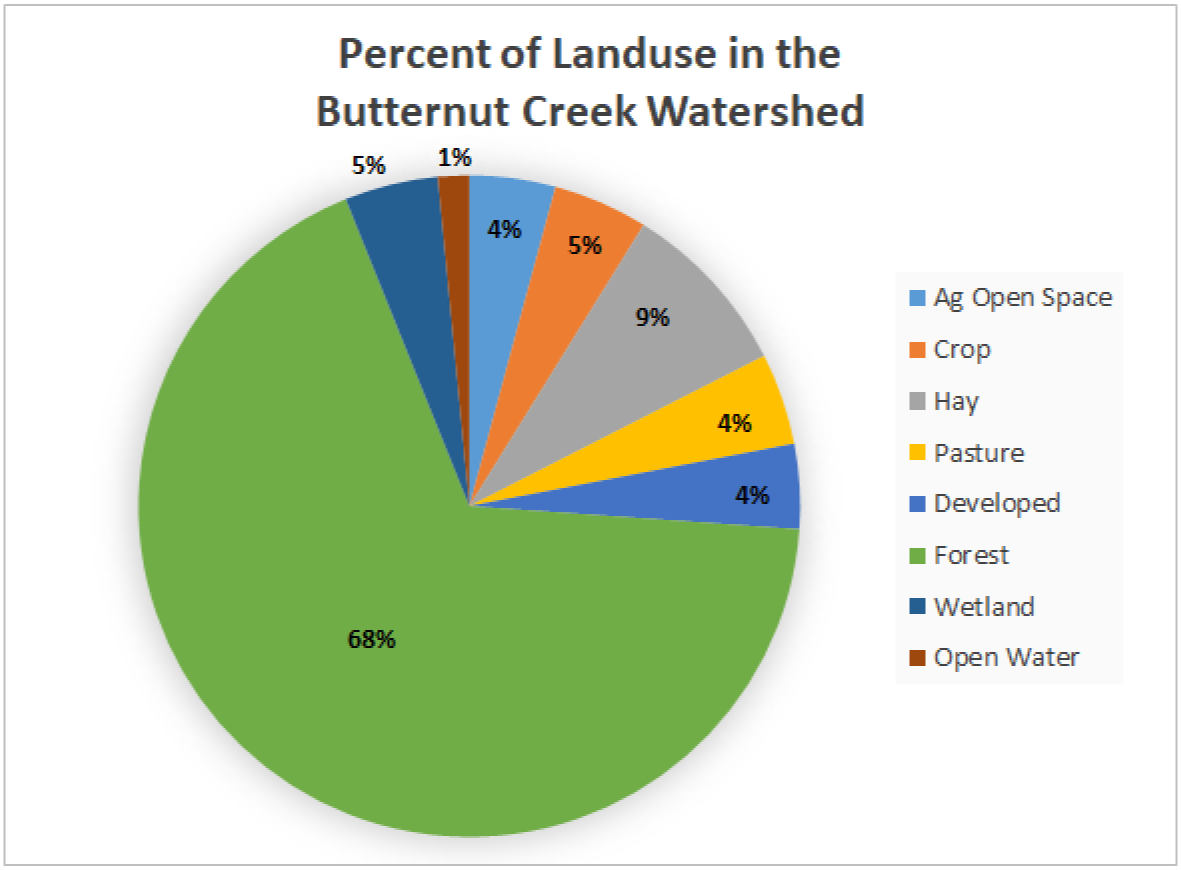


Figure 10. Percent of landuse in the Butternut Creek watershed (Chesapeake Conservancy 2016).

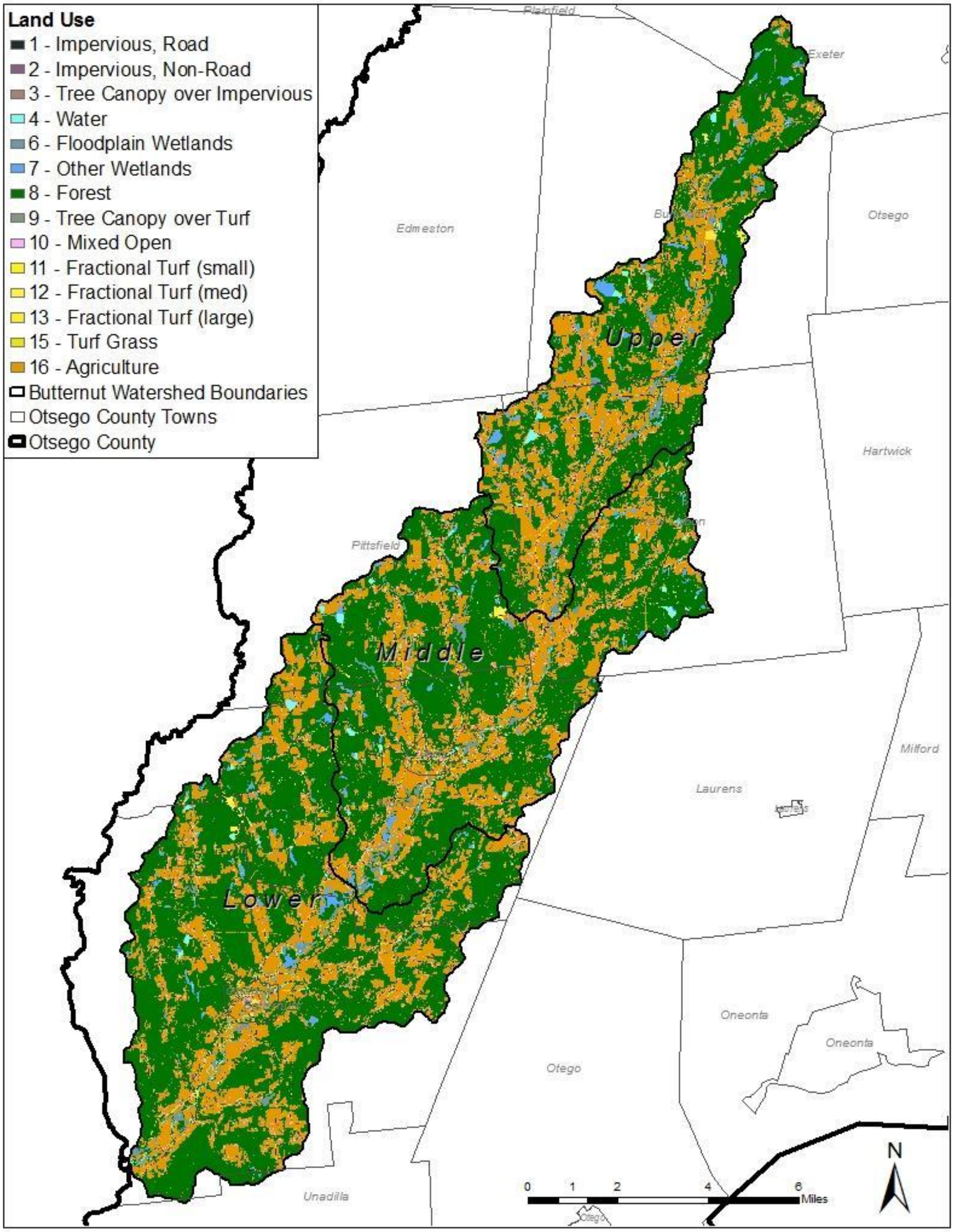
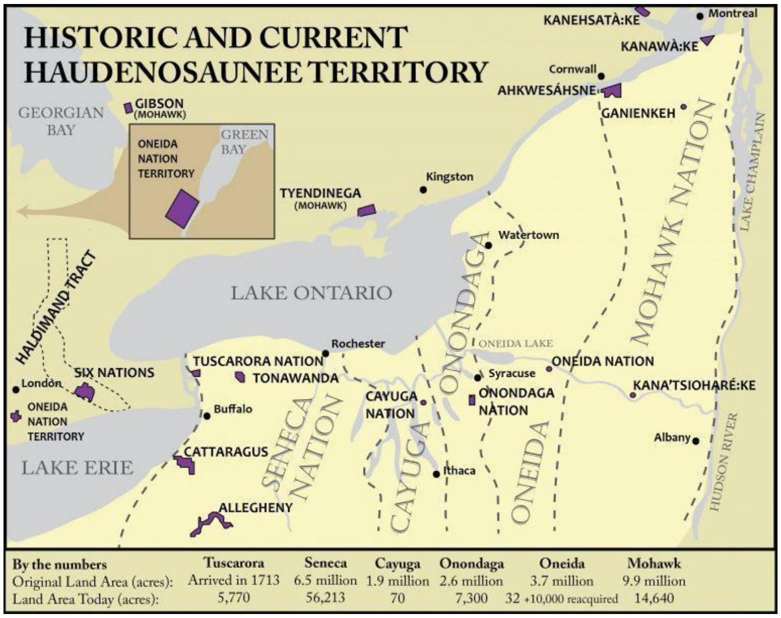


Figure 11. Land use in the Butternut Creek watershed (Data from Chesapeake Conservancy 2016).

3.3.2.1 Historical Land-Use

The land in the Butternut Creek watershed was historically occupied by the Oneida (Onʌyote'a:ka) Indian Nation and the Mohawk (Kanien'kehá) Tribe, both members of the Haudenosaunee (Öngweh'önweh) Confederacy also known as the Iroquois or Six Nations (OIN 2020). The confederacy includes six tribes: Mohawk (Kanien'kehá)– The People of the Flint, Oneida (Onʌyota'a:ka) – The People of the Upright Stone, Onondaga (Onoñda'gega') – The People of the Hills, Cayuga (Gayogo̱hó:nǫ')– The People of the Great Swamp, Seneca (Onöndowa'ga:' Gawë:nö')– The People of the Great Hills, and Tuscarora (Ska:rù:rę') – The Shirt Wearing People. The Oneida Nation ancestral lands originally covered approximately 6 million acres (Figure 35) (OIN 2020, NYS Language RBE-RN 2012, HTTR 2020). As first peoples living in the area, the Butternut Creek was an important lifeway for Oneidas and their ancestors. There is evidence of occupation and land use throughout the watershed dating back thousands of years (Bergevin 2020). The Mohawk territory included areas of the upper half of the Butternut Creek watershed (Figure 12). The ancestral land stretched from the northeast region of New York State including the Mohawk Valley extending into southern Canada and Vermont (SRMT 2020). Mohawk are also known as "Keepers of the Eastern Door" because they are the easternmost nation in the Haudenosaunee territory and were traditionally responsible for defending the eastern boundaries of the territory (NYS Language RBE-RN 2012). The Mohawks fought mostly with the British during the revolutionary war and started to leave the Mohawk Valley in the mid 1700's (SRMT 2020).



By the numbers	Tuscarora	Seneca	Cayuga	Onondaga	Oneida	Mohawk
Original Land Area (acres):	Arrived in 1713	6.5 million	1.9 million	2.6 million	3.7 million	9.9 million
Land Area Today (acres):	5,770	56,213	70	7,300	32 +10,000 reacquired	14,640

Figure 12. Historic and Current Haudenosaunee Territory (HTTR 2020).

Land use changed considerably in the Butternut Creek watershed after the Revolution War when forests were cleared by European Settlers for farmland and dams were installed on Butternut Creek and its tributaries to generate power for mills (Stensland 2002). By 1868 there were 38 mills operating at dam sites within the Butternut Valley (Beers et al.1868). There were 13 mills in the Upper Butternut Creek watershed, 14 mills in the Middle Butternut Creek watershed, and 11 in the Lower Butternut Creek watershed (Table 6). Throughout the region sawmills were the dominant type of mill, followed by grist and cider mills. Remnants of the mills can still be found on Butternut Creek and its tributaries such as the former cider mill on Aldrich Creek at the end of Burlingham Rd (Figure 13). While no longer functional dams, the remnants can continue to influence flow and function of these streams. Impacts to stream hydrology are evident at the former Bushnell's Dam location in Gilbertsville, NY where the former dam footers are still visible (Figure 14). A dam remains below Basswood pond to maintain the impoundment. A second dam in the watershed remained functioning until the mid-1990's in Morris before falling into disrepair (Stensland 2002). The dam diverted water to a millpond at the old Linn Tractor plant.

By the end of the 19th century dairy farms started to replace subsistence farms and would eventually become the main industry of the valley (Stensland 2002). Farms dominated the valley and the villages of Morris and Gilbertsville became population centers at this time. Dairy farms remain in the valley today but have increased in size or been subdivided. Many people travel out of the watershed to surrounding cities and towns for employment (Stensland 2002).

Type of Mill	**Lower**	**Middle**	**Upper**	**Total**
Cider	2	2		**4**
Cotton		1		**1**
Grist	2		2	**4**
Good Mill Site			1	**1**
Mill (Unknown)		1	1	**2**
Saw	7	7	6	**20**
Saw and Grist		1	1	**2**
Shingle			1	**1**
Weed			1	**1**
Wood		2		**2**
Total	**11**	**14**	**13**	**38**

Table 6. List of mills by type in the Butternut Creek Watershed from 1868 Atlas of Otsego County, NY (Beers et al. 1968).

Figure 13. Photos of dam remnants on Aldrich Creek at Burlingame Falls (listed as a Cider Mill in Beers et al. 1968. Photo on left date unknown, courtesy of Morris Historical Society Postcard Collection. Photo on right from same location October 4, 2017 (photo credits OCSWCD).

Figure 14. Bushnell's Dam/Bridge at Spring St in Gilbertsville, NY. Upper left date unknown (Bridgehunter 2018), Upper right – 2014 leaf off aerial imagery, Lower left – looking upstream from downstream of current Spring St bridge, Lower right – looking downstream from Spring St bridge (photo credits OCSWCD taken on 8/9/2017).

3.3.2.2 Protected Land

3.3.2.2.1 Forest

The Butternut Creek watershed is part of the Leatherstocking Unit Management Unit (NYSDEC 2000). In 1929, DEC purchased no longer in use farmlands with erosion and soil quality issues (Otsego County 2017). The state forests are managed for multiple uses including recreation, wildlife habitat, natural resource conservation, and timber harvest (Otsego County 2017). The Upper Butternut Creek watershed includes the Basswood Pond State Forest and sections of Texas School House State Forest (Appendix B, Figure 1). The Middle Butternut Creek watershed includes Calhoun Creek State Forest and Morris Reservoir (Appendix B, Figure 2). The Lower Butternut Creek watershed includes Wagner Farm State Forest and General Jacob Morris State Forest. State and county forest land make up 4.6% of the watershed (3832 acres) (Table 7). Private timber holdings are not included in this analysis.

Subwatershed	State forest (acres)	County forest (acres)	Total	Percent of Subwatershed
Lower	1,584.90	233.02	1,817.92	5.45%
Middle	1,250.70	379.04	1,629.74	5.77%
Upper	464.97	64.51	529.48	2.44%
Total	3,300.57	676.57	3,977.14	4.77%
Percent of Watershed	3.96%	0.81%	4.77%	

Table 7. Acres of NY State forest and Otsego county forest land in the Butternut Creek Watershed.

3.3.2.2.2 Recreational Parks

There are three main parks in the Butternut Creek watershed. A portion of Gilbert Lake State Park is located in the eastern portion of the Middle Butternut Creek watershed (Appendix C, Figure 2). Copes Corner County Recreation Park is located on Butternut Creek in the Lower Butternut Creek watershed (Appendix C, Figure 3). Centennial Park in the Village of Gilbertsville is also located in the Lower Butternut Creek watershed (Appendix C, Figure 3).

3.3.2.2.3 Conservation Easements

There are multiple conservation easements in the Butternut Creek watershed through USDA NRCS conservation programs as well as easements managed by the Otsego Land Trust (OLT). Conservation easements are privately owned land with voluntary legal agreements between a landowner and a land trust or government agency which permanently limits uses of the land to protect conservation values

(Otsego County 2017). As a government entity, NRCS assists farmers through the Agricultural Conservation Easement Program (ACEP). ACEP helps to conserve agricultural lands and protects and enhances wetlands through Agricultural Land Easements and Wetland Reserve Easements. The Otsego Land Trust is a non-profit organization with a mission to conserve the region's woodlands, farmlands, and waters. Land is conserved by OLT through direct ownership which usually includes public access or through conservation easements which remain privately owned and are not publicly accessible.

The Lower Butternut Creek watershed has the largest area preserved in Conservation Easements, followed by the Middle Butternut Creek watershed and the Upper Butternut Creek watershed (Table 8). There is considerably more land enrolled in Conservation Easements with OLT than with NRCS Conservation Easement programs, 1,495.09 acres compared to 195.10 acres (Table 8) (USDA-NRCS 2016, OLT 2020). The easements are distributed throughout the watershed and make up a small percentage of the watershed (Appendix C).

Watershed	Otsego Land Trust Conservation Easements	NRCS Conservation Easements	Total Acres in Conservation Easements	Percent of Watershed
Lower	783.86	33.55	817.40	2.4%
Middle	450.10	40.46	490.56	1.7%
Upper	261.13	121.10	382.23	1.8%
Total	1,495.09	195.10	1,690.19	2.0%

Table 8. Summary of land enrolled in conservation easements with Otsego Land Trust and NRCS in the Butternut Creek Watershed.

3.4 Physical Characteristics

3.4.1 Climate

Otsego County's climate is continental-humid with cold winters and mild summers, having precipitation throughout the year. The annual average temperature is 44°F with average precipitation being 41.7 inches (H2O Partners, 2013). The lowest recorded temperature was in 1934 at -34°F while the highest recorded temperature was 99°F between July 9 and 10, 1936.

3.4.2 Hydrology

Hydrology is the study of the distribution, occurrence, movement, and properties of water in a landscape and how those actions relate to the hydrologic cycle (USGS 2020). The water that flows in a stream is dependent upon precipitation in the form of rain and snow (Hynes 1970). However, only a portion of water that falls from rain or snow reaches a stream because other hydrologic processes divert the water such as evaporation, transpiration from vegetation, and captured by the soil which may slowly move underground and make its way into a stream (Hynes 1970, Leopold 1960). This storage of water provides flow during dry periods. In this way surface water and groundwater in river corridors are linked (Naiman et al. 2005).

Stream discharge or stream flow is measured by the volume of water running down a stream every second and is referred to as the unit, cubic feet per second (cfs). There is seasonal and inter-annual variability in stream flow that is influenced by the size and shape of a watershed as well as the local climate (Naiman et al. 2005). The way in which water flows forms the patterns of rivers, streams, and their beds and is fundamental in shaping instream and riparian habitats, flooding, and erosional events (Hynes 1970). There is frequently a link between changes in watershed processes such as erosion, sedimentation, wood debris dynamics, and heat transfer with changes in streamflow (Ziemer and Lisle 1998). An understanding of the Butternut Creek hydrology is important to developing an understanding of the watershed's characteristics.

Similar to other streams in Otsego County, the Butternut Creek runs northeast to southwest (NRCS 2006). The tributaries draining the slopes of the valleys are typically steep before reaching the broad valley bottom, and gain flow over their length until they cross the alluvial fan deposit. It is not uncommon for the streams to go subsurface before joining the mainstem during low flow periods (USDA-NRCS 2006). Over many years, the Butternut Creek has experienced deep cutting resulting in narrow floodplains and steep sides as shown in the images in Figure 5 (Otsego County 2017).

Stream flow data was collected on the Butternut Creek by the United States Geological Service (USGS) from June 19, 1938 to March 31, 1995 (USGS 01502000) in Morris, NY, with a 59.7 mi^2 drainage area. Over the 56-year sampling time frame, the minimum annual mean flow occurred in the "water year" (12-month period from October 1st, for any given year through September 30th) of 1965 at 47.68 ft^3/s while the maximum mean flow occurred in 1978 at 174.48 ft^3/s (Figure 15) (USGS 2020). The maximum average daily discharge for the time period of data collected occurred on 10/17/1977 at 3,700 ft^3/s and the minimum average daily discharge occurred on 9/4/1939 at 1.3 ft^3/s. The variation in surface flow over the period of available data can be seen in Appendix F. The closest stream gage currently operating near Butternut Creek is a gage located at the Flat Iron Bridge operated by the Susquehanna River Basin Commission (SRBC). The next closet gage operating near the Butternut Creek Watershed the Unadilla River in Rockdale, NY (USGS 01502500) which drains a larger basin of 520 mi^2. It is important to note that the data are only through 1995, and do not capture the more frequent flood events and now sometimes flashy nature of the creek due to climate change.

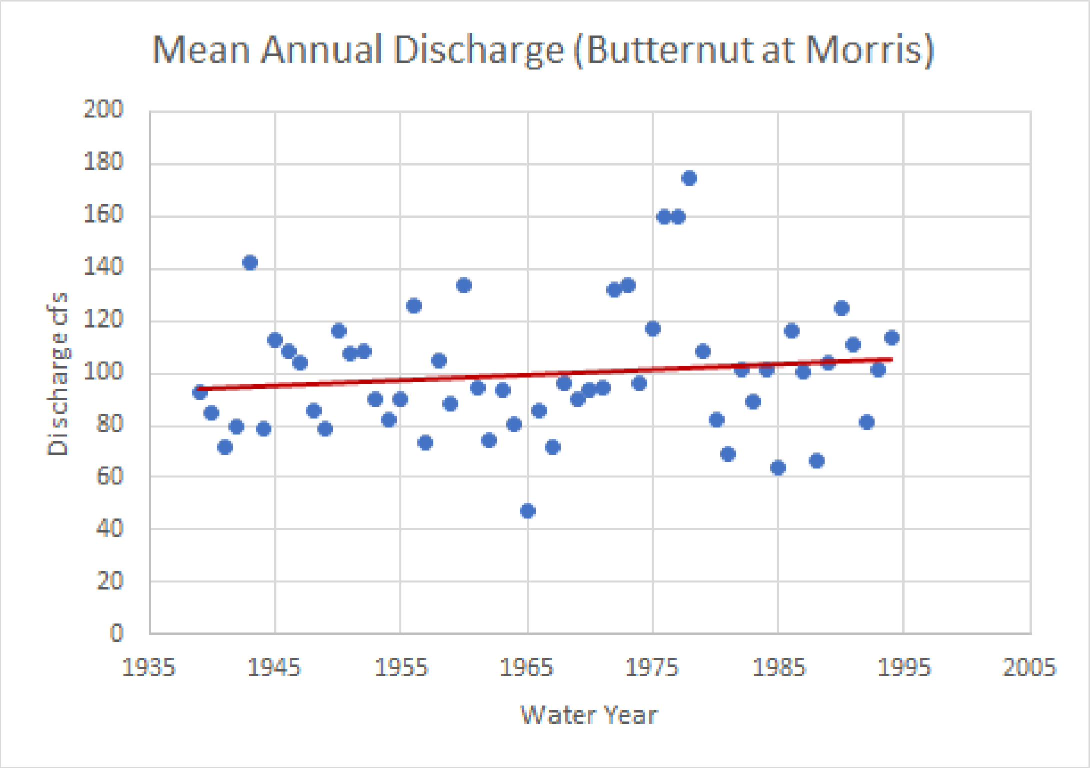


Figure 15. USGS stream discharge described as annual discharge (ft^3/s) recorded on Butternut Creek in Morris, NY (USGS 01502000). *Data only available until 1995. The gauge is no longer operational.

3.4.3 Underlying Geology

The underlying geology of an area has a large impact on not only the way water flows, but the minerals and sediments that the water carries due to erosional processes and subsurface flow. The Butternut Creek watershed is located on the northern Allegheny Plateau physiographic province (NYSDEC 2000). The province is characterized by deeply dissected shales, siltstones, and sandstones with some limestone and bedrock that exhibits variability in resistance to weathering and erosion resulting in bedrock outcrops and benches along valley slopes and hilltops (USDA-NRCS 2006). From roughly 600 - 350 million years ago during the Paleozoic era, sediment was deposited in the Plateau eventually forming the bedrock of the Butternut Valley (USDA-NRCS 2006). Glacial ice covered most of North America from approximately to 100 thousand years ago until roughly 15 thousand years ago when the retreat of the Wisconsin Glacier, the last glacier covering New York State (15,999 BCE), formed the current landscape of the Butternut Creek Watershed and Otsego County. The recession of the glacier resulted in extensive glacial till deposits in the valley. Glacial till is composed of an unsorted mixture of sand, silt, clay, and rock fragments (Otsego County 2017). There is variability in the depth of the till ranging from a few inches to hundreds of feet depending on location and elevation (Otsego County 2017).

Bedrock Geology

The Butternut Creek Watershed is dominated by siltstones, shale, and sandstones with some limestone layers (Rickard and Fisher 1970). The Upper Watershed is underlain by bedrock from the Moscow Formation (Dhmo) and Panther Mountain Formation (Dhpm) in the Hamilton Group with pockets of the Unadilla Formation (Dgu) in the Genesee Group and Tully Limestone towards the lower portion of the watershed (Figure 16) (Fisher et al. 1970). The Unadilla Formation continues into the Middle Watershed with small areas of Oneonta Formation (Dgo) in the lower portion of the watershed. The Moscow Formation also extends from the Upper Watershed. The Middle Watershed is where the transition to Upper Devonian bedrock occurs. The Lower Watershed contains bedrock almost exclusively from the Genesee Group and Tully Limestone divided between the Unadilla Formation and Oneonta Formation. There are small sections of the Sonyea Group, Cashaqua Shale (Ds) along the southern border of the Lower Watershed (Figure 16). The Sonyea Group is the youngest bedrock in the Butternut Watershed and Otsego County overall and consists of shale, siltstone, and sandstone (USDA-NRCS 2006). Descriptions of each formation are listed in the appendices and are from The Geologic Map of New York; Hudson-Mohawk Sheet, 1:250,000 (Fisher et. al. 1970).

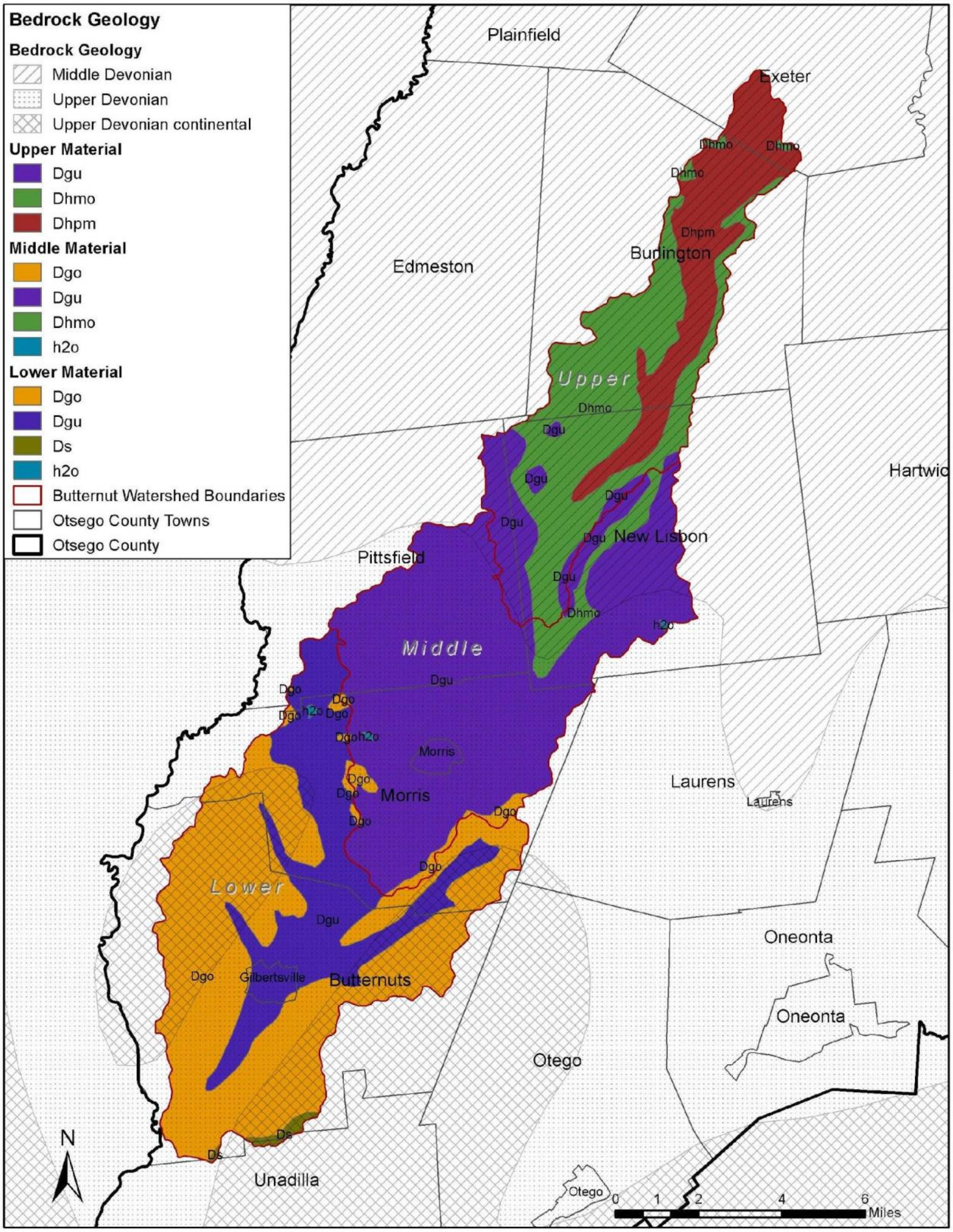


Figure 16. Bedrock Geology of Butternut Creek Watershed.

Surficial Geology

Surficial geology refers to the study of landforms and the unconsolidated sediment under them compared to bedrock geology which shows the type of intact bedrock at or near the earth's surface. The dominant surficial geology of the watershed is till that was deposited when the Wisconsin Glacier retreated (Figure 17) (Cadwell et al. 1986). Streams eroded into the glacial deposits as the glacier retreated redistributing the deposits through the valley. As a result, outwash and alluvial sand and gravel are common on the valley floor while glacial till lines the valley walls. Throughout the Upper, Middle, and Lower watershed the Butternut Creek and the surrounding floodplain is characterized as recent alluvium bordered in areas by kame deposits and by outwash sand and gravel in areas. Towards the bottom of the Lower Butternut watershed the Butternut Creek and surrounding area sediments shift to Lacustrine sand. These glacial deposits became the parent material of the soil types currently found in the Butternut Creek Watershed. Description and quantities of the different substrates from The Surficial Geologic Map of New York (Cadwell et al. 1986) can be found in Table 9.

Symbol	Material	Description	Total Acres
t	Till	Variable texture (boulders to silt), usually poorly sorted sand-rich diamict, deposition beneath glacier ice, permeability varies with compaction, thickness variable (1-50 meters).	73,127.76
al	Recent alluvium	Oxidized fine sand to gravel, permeable, generally confined to flood plains within a valley, in larger valleys may be overlain by silt, subject to flooding, thickness 1-10 meters.	5,086.68
k	Kame deposits	Coarse to fine gravel and/or sand, includes kames, eskers, kame terraces, kame deltas, ice contact, or ice cored deposition, lateral variability in sorting, texture and permeability, may be firmly cemented with calcareous cement, thickness variable (10-30 meters).	2,943.89
og	Outwash sand and gravel	Coarse to fine gravel with sand, proglacial fluvial deposition, well rounded and stratified, generally finer texture away from ice border, permeable, thickness variable (2-20 meters).	870.61
km	Kame moraine	Variable texture (size and sorting) from boulders to sand, deposition at an active ice margin during retreat, constructional kame and kettle topography, locally, calcareous cement, thickness variable (10-30 meters).	530.78
ls	Lacustrine sand	Generally quartz sand, well sorted, stratified, usually deposited in proglacial lakes, but may have been deposited on remnant ice, generally a near-shore deposit or near a sand source, permeable, thickness variable (2-20 meters).	487.92
r	Bedrock	Exposed or generally within 1 meter of surface, in some areas saprolite is preserved.	266.33

Table 9. Summary of surficial geology of the Butternut Creek Watershed (Cadwell and Dineen 1986).

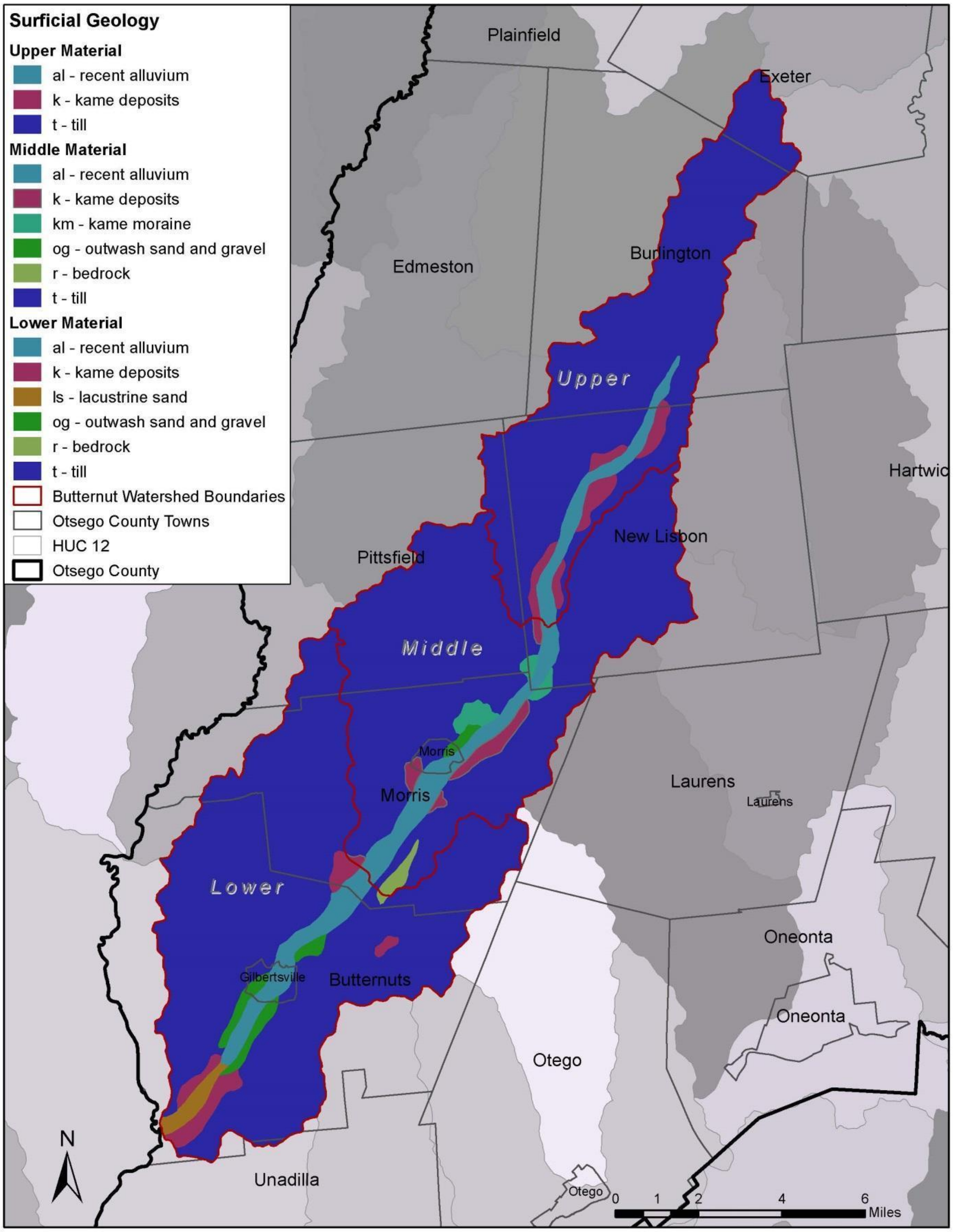


Figure 17. Surficial Geology of Butternut Creek Watershed.

3.4.4 Soils

There are five interacting factors in the development of soils: parent material, relief, climate, living organisms, and time (USDA-NRCS 2006). It is through a combination of these factors that the properties of a soil at a location are developed and varies widely from place to place (USDA-NRCS 2006). As a result, there is variability in the distribution of soil across the landscape. The properties and composition of soil are factors in determining the drainage, erosion, and stability of a landscape.

Bedrock and soil qualities have an impact on hydrologic function in a watershed (BCCD 2004). Characteristics such as a soil's ability to hold or drain water, the erosion potential, and compactibility influence these factors. Understanding how water moves through soils is critical to comprehending how soil is developed, the suitability of soil for different uses, and groundwater quality and quantity (USDA-NRCS 2006). It also plays an integral part in management decisions for a landscape including but not limited to: agricultural uses, wetland impacts, road and drainage networks, forestry applications, waste management, erosion and flood mitigation, and housing development.

Soil type determines the amount and nature of sediment derived from erosion of exposed material that influences the suspension of fine sediments. For example, suspension of finer sediments, such as silt and clay, will generate higher turbidity and sedimentation levels than other larger, consolidated materials (BCCD 2004). Streambank stability or instability is strongly influenced by the erodibility of soils. Soil type also influences the type of vegetation capable of growing on it (USDA-NRCS 2006). Vegetation can provide stability to streambanks with high erosion potential (Welch et al. 1998), and when vegetation is removed, exposing soil, erosion increases.

The dominant soil types in the Butternut Watershed overall are Mardin channery silt loam, followed by Volusia silt loam, Bath channery silt loam, Wellsboro channery silt loam, and the Lordstown-Chadakoin complex (Appendix J). They are characterized by medium texture, moderately deep to shallow in depth, and are generally found on slopes that are glacial till derived from shale, sandstone or limestone, and fall into two general soil units, Mardin-Lordstown-Bath and Wellsboro-Oquaga-Lackawanna, described in the Otsego County Soil Survey. Between the three subwatersheds there is variation in soil composition. The Upper and Middle Butternut watersheds share similar dominant soil types of Mardin channery silt loam, Volusia silt loam, and Bath channery silt loam (Appendix J). The Lower Butternut watershed is dominated by Wellsboro channery silt loam, followed by Oquaga-Arnot complex, Morris channery silt loam, Lackawanna channery silt loam, and then Mardin channery silt loam (Appendix J) (USDA-NRCS 2006).

Limitations of these soils include: a seasonal high water table, shallow depths to fragipan, drought conditions during dry periods, low fertility, high acidity and erodibility on steeper slopes (USDA-NRCS 2006).[3] The less sloping areas can support agriculture including corn, hay, or pasture while the more sloping areas are used for hay, pasture, or forestland (USDA-NRCS 2006). The steep areas are utilized for forestland while some areas remain covered in brush or non-woody plants. In both units, streams with steep banks and narrow steep-sided valleys are common (USDA-NRCS 2006).

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[3] Frangipan is defined as a dense, natural subsurface layer of hard soil with relatively slow permeability to water, mostly because of its extreme density or compactness rather than its high clay content or cementation.

The valley bottom soils and portions of the tributary soils cover less acreage in the watershed and are characterized primarily by hydric soils such as Chippewa and Norwich soils and Fluvaquents-Udifluvents complex, frequently flooded soils. These are somewhat poorly drained and found in depressions and along drainage ways on the lowest part of the landscape (USDA-NRCS 2006). The Fluvaquents-Udifluvents are found along streams that are subject to frequent flooding, scouring, and deposition and exhibit variability in texture and drainage (USDA-NRCS 2006). The seasonal high-water table, flooding, and frost action of these soils limit use with some areas being used as pasture or forestland and few areas cultivated for crops. Wetland regulations may apply to lands characterized by these hydric soils.

3.4.5 Wetlands and Floodplains

Wetlands are areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions (USACOE 1987). The three primary criteria for wetlands delineation are soils (See Appendix G for hydric soil location and acreage), hydrology, and vegetation (USACOE 1987, Masonis and Bodi 1998).

Wetlands provide multiple functions and ecosystem services critical to the health of a watershed and river ecosystem (Masonis and Bodi 1998). Federal protections for wetlands were established under Section 404 of the 1972 Clean Water Act. In New York State, wetlands of 12.4 acres in size or greater are protected under the 1975 Freshwater Wetlands Act which was codified in Article 24 of New York State Environmental Conservation Law (ECL) (NYSDEC 1997). The New York State Department of Environmental Conservation (DEC) is responsible for enforcing Article 24 regulations. Despite protections, it is estimated that nearly half the wetlands in New York State and overall nationwide have been lost to activities such as filling and dredging (NYSDEC 2020, Masonis and Bodi 1998).

Ecosystem services/functions provided by wetlands:

- Provide flood and stormwater control through hydrological absorption and large storage capacity for excess water;
- Provide erosion control by slowing water and filtering sediments, protecting streams, lake, and reservoirs, and buffering shorelines and agricultural soils from water erosion;
- Increase wildlife and fish habitat by providing area for feeding, nesting, spawning, resting, and cover breeding for migratory waterfowl, birds of prey, and many rare and endangered species;
- Act as a protection area for subsurface water resources by enhancing are area’s ability to recharge groundwater supplies;
- Provide areas for recreational and educational experiences including hunting, fishing, camping, research, and bird watching; and
- Provide water filtration for the surrounding watershed by removing harmful pollutants and excess nutrients which would eventually be passed down stream (USACOE 1987, NYSDEC 2020).

A National Wetlands Inventory (NWI), prepared by the United States Department of the Interior – Fish and Wildlife Service (USFWS), identifies the location of wetland areas nationwide that are regulated under Section 404 of the Clean Water Act (USFWS 2020a). Separately, New York State has mapped locations of wetlands that meet the state definition. As a result of the difference in regulations such as size, some of the State vs. Federal wetlands overlap and some do not. Each jurisdiction broadly protects areas of water or wet soils that support wetland plants (NYSDEC 2020a).

Within the Butternut Creek watershed, NWI mapped wetlands cover 3,766.67 acres and NYSDEC mapped wetlands cover 1,487.57 (Table 10). The Upper Butternut watershed has the largest percentage of the watershed covered by both NWI and NYSDEC wetlands at 6.21% and 2.44% respectively (Figure 18. The lower percentage of NYSDEC wetlands is likely due to the difference in regulation size, since the NYSDEC does not map or regulate wetlands less than 12.4 acres. The Middle Butternut watershed has the second largest percentage of federal wetlands, 4.63% followed by the Lower Butternut watershed, 3.33% (Appendix). However, the percentage of state wetlands is slightly higher for the Lower Butternut watershed compared to the Middle Butternut watershed. There are extensive wetland complexes in the valley bottom of all three sub watersheds.

The largest acreage of federal NWI wetlands is classified as Freshwater Forested/Shrub Wetland, followed by Freshwater Emergent Wetland, then Freshwater Pond (Table 10). A small amount of wetland acreage is classified as Riverine wetland, or wetlands contained within the stream channel. The majority of riverine wetlands are associated with Butternut Creek and its tributaries or are located in the valley bottom, and likely interact with the channels through groundwater or potentially surface water during high flow events. The Lower Butternut watershed has the greatest acreage of hydric soil which is one of the indicators that support wetland development. However, it does not have the largest acreage of mapped wetlands out of the three subwatersheds (Table 10). It is important to note that wetlands can be present that have not been mapped through the National Wetlands Inventory or by NYSDEC.

Wetland Type	Acres			Miles^2			Total Acres	Total Miles^2
	Lower	Middle	Upper	Lower	Middle	Upper		
NWI[1]	1,113.19	1,305.86	1,347.61	1.74	2.04	2.11	3,766.67	5.89
NYDEC[2]	553.65	403.87	530.05	0.87	0.63	0.83	1,487.57	2.32
%NWI	3.33%	4.63%	6.21%	3.33%	4.63%	6.21%	4.52%	4.52%
%NYDEC	1.66%	1.43%	2.44%	1.66%	1.43%	2.44%	1.79%	1.79%

[1] NWI – National Wetlands Inventory

[2] NYDEC – New York State Department of Environmental Conservation

Table 10. Distribution of NWI and NYDEC mapped wetlands in the Butternut Creek Watershed. Percent NWI and Percent NYDEC reflect area of wetland mapped related to area of each respective watershed.

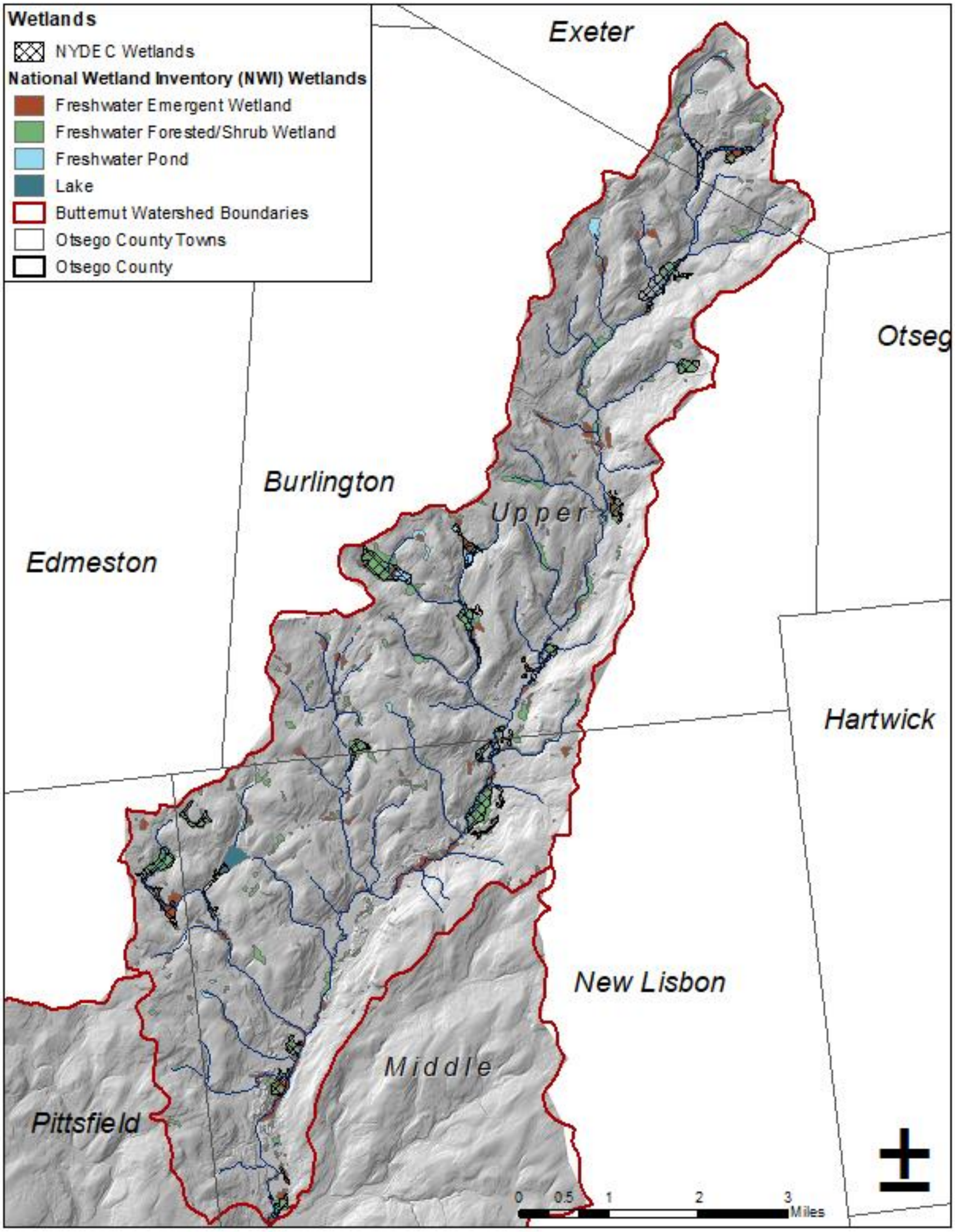


Figure 18. Wetlands mapped by National Wetlands Inventory and NYSDEC in the Upper Butternut Creek Watershed.

Floodplains and their associated wetlands are an important component of the landscape in the Butternut Creek watershed. These are areas of low-laying land that run adjacent to streams and other waterways that can provide overflow space for runoff during high water events (Otsego County 2019). They are dynamic in nature; constantly changing and moving as the stream channel moves or meanders across the floodplain (FWR et al. 2012). Dynamic physical and biological processes driven by climate, the hydrologic cycle, erosion and deposition, extreme natural events, and other forces have shaped and continue to shape floodplains (Wright 2007). Floodplains provide many benefits in a watershed.

- Water Storage and Diversion - When the floodplain is engaged, the stream is able to divert its energy in turn relieving pressure on stream banks which lessens the potential for accelerated erosion and downstream flooding (FWR et al. 2012). Vegetated floodplains provide more storage potential than unvegetated areas.
- Filtration - When the water moving across the landscape is slowed, the soil and plant matter can filter impurities and nutrients from the overland flow.
- Increase Groundwater Discharge - When the floodplain slows and stores the water, it increases the ability of the water to infiltrate and increase groundwater recharge.
- Protection of Human Infrastructure - By slowing the water as it crosses the rough land, there is a lower chance of destruction of bridges, homes, roadways, and undersized culverts.

Development in the floodplain reduces the function of a floodplain. Human influences, like encroachment, tend to be caused by backfill for development, roadways or agriculture (FWR et al. 2012). Floodplains can be disconnected from the stream channel by natural accelerated erosion during flood events, other natural causes, or human influences. As floodplain areas are encroached upon, they decrease in size and lose their ability to properly handle floodwaters (FWR et al. 2012).

Frequently flooded floodplains are referred to as 100-year floodplains (Otsego County 2019). It is important to note that a 100-year floodplain is not a flood that will occur once every hundred years but rather a flood that has a 1 in 100 or 1-percent chance of being equaled or exceeded in any given year (Otsego County 2019). In a watershed, a 100-year flood could occur multiple times in a relatively short time period (Otsego County 2019). The Federal Emergency Management Agency (FEMA) and the National Flood Insurance Program (NFIP) now refers to the 100-year flood as the “1-percent annual chance of flood” (Otsego County 2019). The 500-year flood has a 0.2-percent chance of being equaled or exceeded each year. The probability of a flood occurring informs the establishment of the Digital Flood Insurance Rate Maps (DFIRM) provided by FEMA for Otsego County. The 1-percent annual chance of flood establishes the area that has flood insurance and floodplain management requirements. As of 2017, all communities in Otsego County adopted the new FEMA flood maps (DFIRMS). The flood zones are used by FEMA to designate Special Flood Hazard Areas (SFHA) and for insurance rating purposes (FEMA 2019). SFHA are defined as the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year (FEMA 2019). The additional information provided in the FEMA DFIRM designated as 0.2- Percent Annual Chance Flood Hazard or Moderate flood hazard areas is not used for insurance rating purposes and is categorized as a flood zone subtype in the digital database (FEMA 2019).

As outlined in the *Otsego County Hazard Mitigation Plan* (Otsego County 2019), the Digital Flood Insurance Rate Mate (DFIRM) data provided by FEMA for Otsego County show the following flood hazard areas:

- 1-Percent Annual Chance Flood Hazard: Areas subject to inundation by the 1-percent-annual chance flood event. This includes Zone A, Zone AE, and Zone AO. Mandatory flood insurance requirements and floodplain management standards apply. Base flood elevations are provided in Zone AE. Zone AO has associated flood depths derived from detailed hydraulic analyses. Zone A has no determined flood depths.
- 0.2-Percent Annual Chance Flood Hazard: Area of minimal flood hazard, usually depicted on FIRMs as the 500-year flood level or Shaded X Zone.

Butternut Creek is listed in the *Otsego County Hazard Mitigation Plan* as one of the tributaries to the Susquehanna River that is susceptible to flooding (Otsego County 2019). The FEMA DFIRM data for the Butternut Creek watershed identifies floodplain designated *Zone A* extensively along the mainstem and some of the tributaries. (FEMA 2017). The Lower Butternut Creek watershed also has flood zones mapped as *Zone AE* meaning those areas have base flood elevations. The Upper Butternut Creek watershed has the least amount of mapped floodplain and the Lower Butternut Creek watershed has the largest area of mapped floodplain (Table 11). However, looking at the percentage of watershed area mapped as floodplain the Middle Butternut Creek watershed has a slightly higher percentage than the Lower Butternut Creek watershed, 3.74% and 3.64% respectively. The town of Butternuts has the largest area of mapped floodplain encompassed by the town boundaries within the Butternut Creek watershed followed by the town of Morris and the town of New Lisbon (Table 11). The Village of Gilbertsville has the highest percentage of the village or town covered by mapped floodplain at 22.98% and of the towns with mapped floodplain Pittsfield has the lowest percentage, 0.15%. The towns of Exeter, Laurens, and Unadilla do not have any area in the Butternut Creek watershed with mapped floodplain. Overall, the Butternut Creek watershed has 3.40% area mapped as floodplain. There are a few additional acres in the Lower Butternut Creek watershed in the Town of Butternuts mapped as a 0.2-Percent Annual Chance Flood Hazard (Table 11). In Otsego County there have been 19 flood-related major disasters (DR) or emergency declarations by FEMA (Otsego County 2019). This is reflective only of FEMA declarations; between 1950 and August 2018 there were 59 flood events in Otsego County (Otsego County 2019) (For more information, see the Otsego County Background Report). A map can be found in Appendix K.

On July 17, 2021 heavy flash flooding impacted many communities in the Butternut Valley including the Town of Morris, Village of Gilbertsville, and the Town of Butternuts. The flooding severely damaged road and bridge networks along with numerous structures in the Village of Gilbertsville. Initial estimates of flood damage exceeded $7 million as of August, 2021.

Town or Village	Area in watershed (acres)	1-Percent Annual Chance Flood Hazard				0.2-Percent Annual Chance Flood Hazard			
		Area (Acres)			% of Town/ Village Area[1]	Area (Acres)			% of Town/ Village Area[1]
		Lower	Middle	Upper		Lower	Middle	Upper	
Butternuts	23,406.65	983.05	--	--	4.20%	987.04	--	--	4.22%
Gilbertsville (Village)	642.80	147.75	--	--	22.98%	147.75	--	--	22.98%
Morris	21,865.10	84.57	809.33	--	4.09%	84.57	809.33	--	4.09%
New Lisbon	15,442.40	--	175.14	335.39	3.31%	--	175.14	335.39	3.31%
Morris (Village)	482.82	--	56.46	--	11.69%	--	56.46	--	11.69%
Pittsfield	10,588.74	--	15.87	--	0.15%	--	15.87	--	0.15%
Burlington	10,570.17	--	--	221.06	2.09%	--	--	221.06	2.09%
Exeter	1,337.85	--	--	--	--	--	--	--	--
Laurens	1.80	--	--	--	--	--	--	--	--
Unadilla	160.61	--	--	--	--	--	--	--	--
Total (acres)	84,498.95	1,215.37	1,056.79	556.45	3.35%	1,219.36	1,056.79	556.45	3.35%
Percent of Watershed Area		3.64%	3.74%	2.56%	3.40%	3.65%	3.74%	2.56%	3.40%

Table 11. FEMA mapped Floodplain distribution by town or village across Butternut Creek Watershed. Mapping source FEMA DFIRM (FEMA 2017).[1]Area of town or village in Butternut Creek watershed

3.4.6 Streams

New York State designates in Title 5 of Article 15 of the Environmental Conservation Law (ECL) the protection and preservation of lakes, rivers, streams and ponds (NYSDEC n.d.). As outlined by the Protection of Waters Program, all waters of the state are provided a class and standard designation based on existing or expected best usage of each water or waterway segment.

- AA or A – waters used as a source of drinking water.
- B – best usage for swimming and other contact recreation, but not for drinking water.
- C – waters supporting fisheries and suitable for non-contact activities.
- D – the lowest classification standard.
- T - may support trout population
- TS - may support spawning trout population

A small pond or lake located within the course of a stream, 10 acres or less, are considered to be part of a stream and are subject to regulation under the stream protection category of Protection of Waters. Streams and small water bodies located in the course of a stream with a classification of AA, A, or B, or with a classification of C with a standard of (T) or (TS) are collectively referred to as "protected streams," and are subject to the stream protection provisions of the Protection of Waters regulations.

In the Butternut Creek watershed, the majority of streams are classified as C, waters supporting fisheries and suitable for non-contact activities (Table 12). Over 60% of the streams are classified as having the potential to support trout populations and/or trout spawning. Trout require cool, clean water for survival and the presence of trout has been used as an indicator of overall good water quality and habitat in a stream (McCullough and Stegemann 1991). The entire Butternut mainstem in the Upper Butternut watershed is classified as supporting trout spawning habitat, C(TS) (Figure 19). The Middle Butternut watershed has three main tributaries, Stony Creek, Aldrich Creek, and Silver/Reservoir Brook, and two smaller unnamed tributaries that have trout spawning habitat classified waters (Figure 20). Trout habitat continues in the mainstem from the Upper Butternut watershed into the Middle Butternut watershed until the lower portion of the Middle Butternut watershed where the mainstem shifts to a classification standard of C. The Lower Butternut watershed has areas of AA waters or waters used as a drinking source in the headwaters of Dunderberg Creek (Figure 21). Four tributaries in the Lower Butternut watershed support trout spawning habitat, Dry Brook, Helbert Brook, Shaw Brook, and Cahoon Creek. Several tributaries and sections of the mainstem Butternut in the Lower Butternut watershed also support trout populations. There are no sections of stream throughout the entire watershed classified as D, the lowest classification standard (Table 12).

Stream Classification Standard[1]	Miles of Stream				Percent of Watershed			
	Lower	Middle	Upper	Total	Lower	Middle	Upper	Total
AA	3.87	0.03	--	3.90	4.38%	0.04%	--	1.61%
AA(T)	4.40	--	--	4.40	4.99%	--	--	--
B(T)	0.40	--	--	0.40	0.46%	--	--	--
C	35.40	39.24	19.37	94.02	40.11%	45.27%	28.70%	38.78%
C(T)	23.22	23.83	20.54	67.59	26.31%	27.49%	30.43%	27.88%
C(TS)	20.97	23.58	27.58	72.13	23.75%	27.20%	40.86%	29.75%
Total	88.27	86.68	67.50	242.45				

Table 12. Miles of NYSDEC classified stream in the Butternut Creek Watershed. [1]NYSDEC Protection of Waters, Article 15

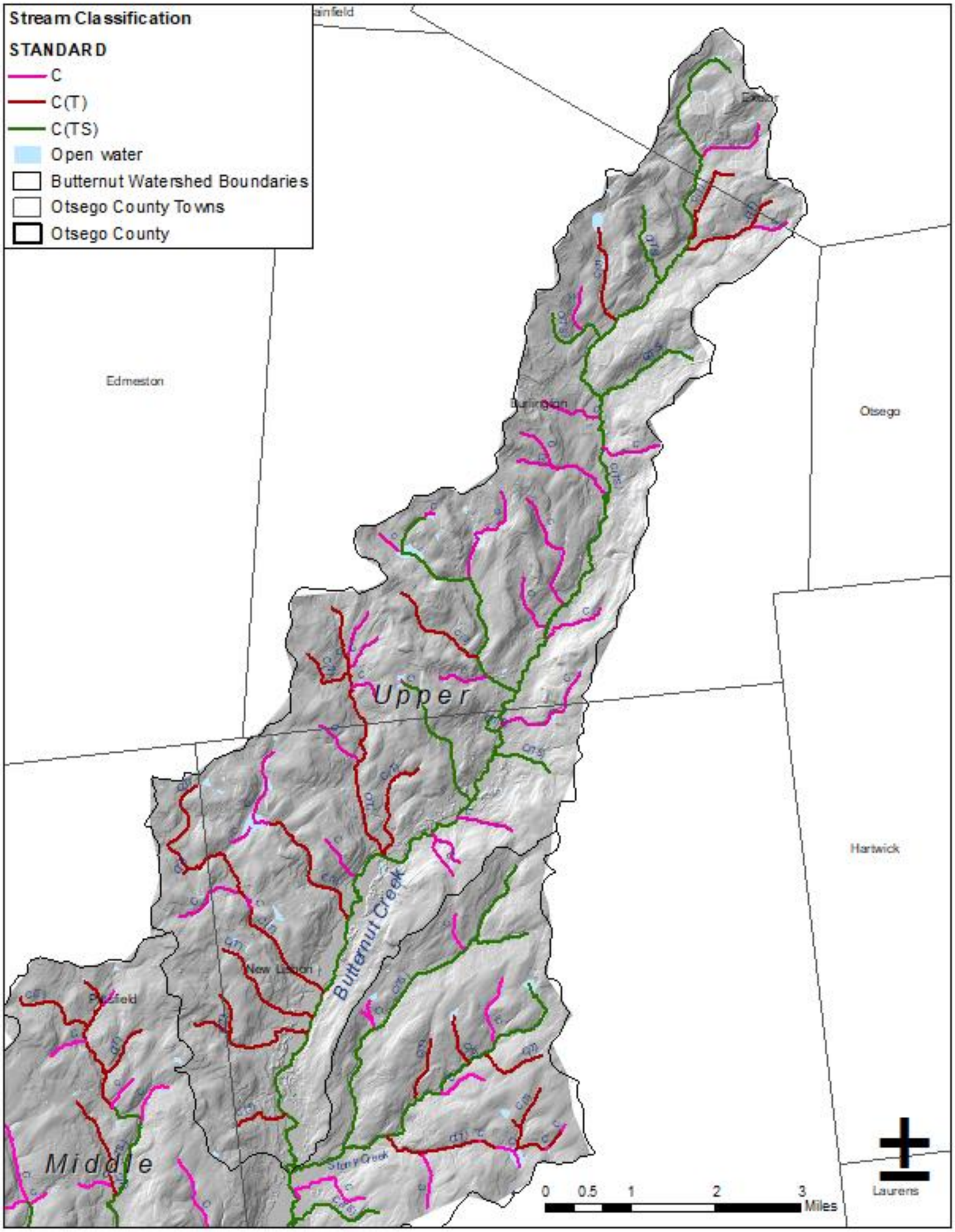


Figure 19. Stream Classification Standards, NYSDEC, in the Upper Butternut Creek Watershed.

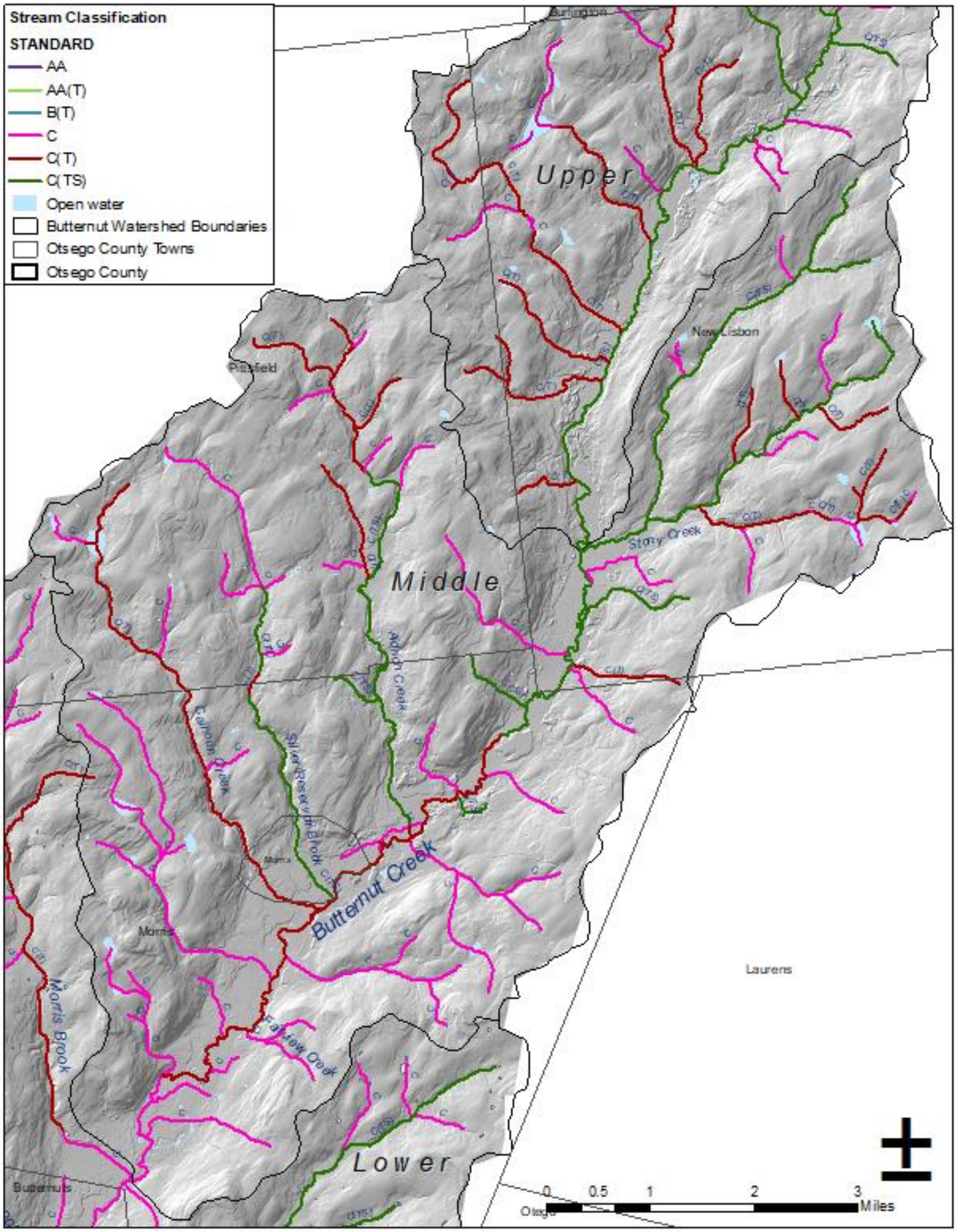


Figure 20. Stream Classification Standards, NYSDEC, in the Middle Butternut Creek Watershed.

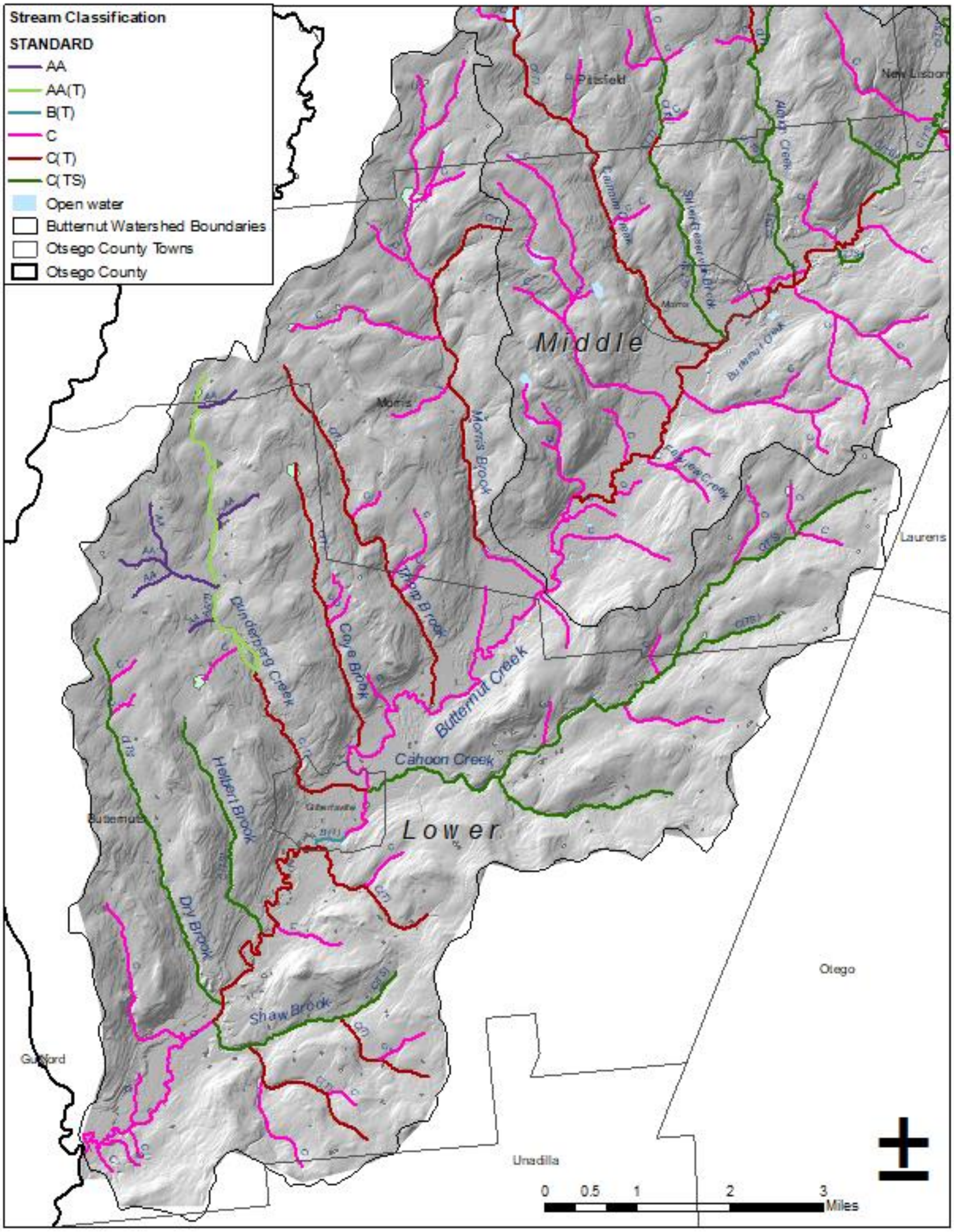


Figure 21. Stream Classification Standards, NYSDEC, in the Lower Butternut Creek Watershed.

Classifying a channel network by order is another way of examining a stream system. The system developed by Strahler (1957, 1964) is useful for categorizing and grouping streams of shared geomorphological and ecological properties (Naiman et al. 2005, Vannote et al. 1980, Montgomery 1999). Most streams in the Butternut Creek watershed are first order tributaries or streams that are fed only by groundwater and receive no tributary inputs (Table 13) (Naiman et al. 2005). This is true for each subwatershed as well, followed by second order streams. The Upper Butternut watershed does not have any fourth order streams and is characterized by smaller tributaries (Figure 22). Whereas the Middle Butternut watershed and Lower Butternut watershed have larger tributaries with multiple branches (Figure 22). The distribution of stream order between the Middle Butternut watershed and Lower Butternut watershed is similar (Table 13). Seventeen miles upstream of the confluence of the Unadilla River, the Butternut Creek evolves into a 4th order stream, with a more moderate gradient of 12 ft/mile (Stensland 2002*).* Note there are slight discrepancies between the overall lengths of stream between different stream datasets due to different mapping methodologies.

Order	Miles of Stream				Percent of Watershed			
	Upper	Middle	Lower	Total	Upper	Middle	Lower	Total
1	43.55	47.12	37.75	128.42	48.7%	52.2%	55.4%	51.8%
2	22.74	24.48	15.20	62.42	25.4%	27.1%	22.3%	25.2%
3	9.67	6.57	15.24	31.48	10.8%	7.3%	22.3%	12.7%
4	13.47	12.13	--	25.60	15.1%	13.4%	--	10.3%
Total	89.43	90.30	68.18	247.19	--	--	--	--

Table 13: Stream order classification in the Butternut Creek watershed

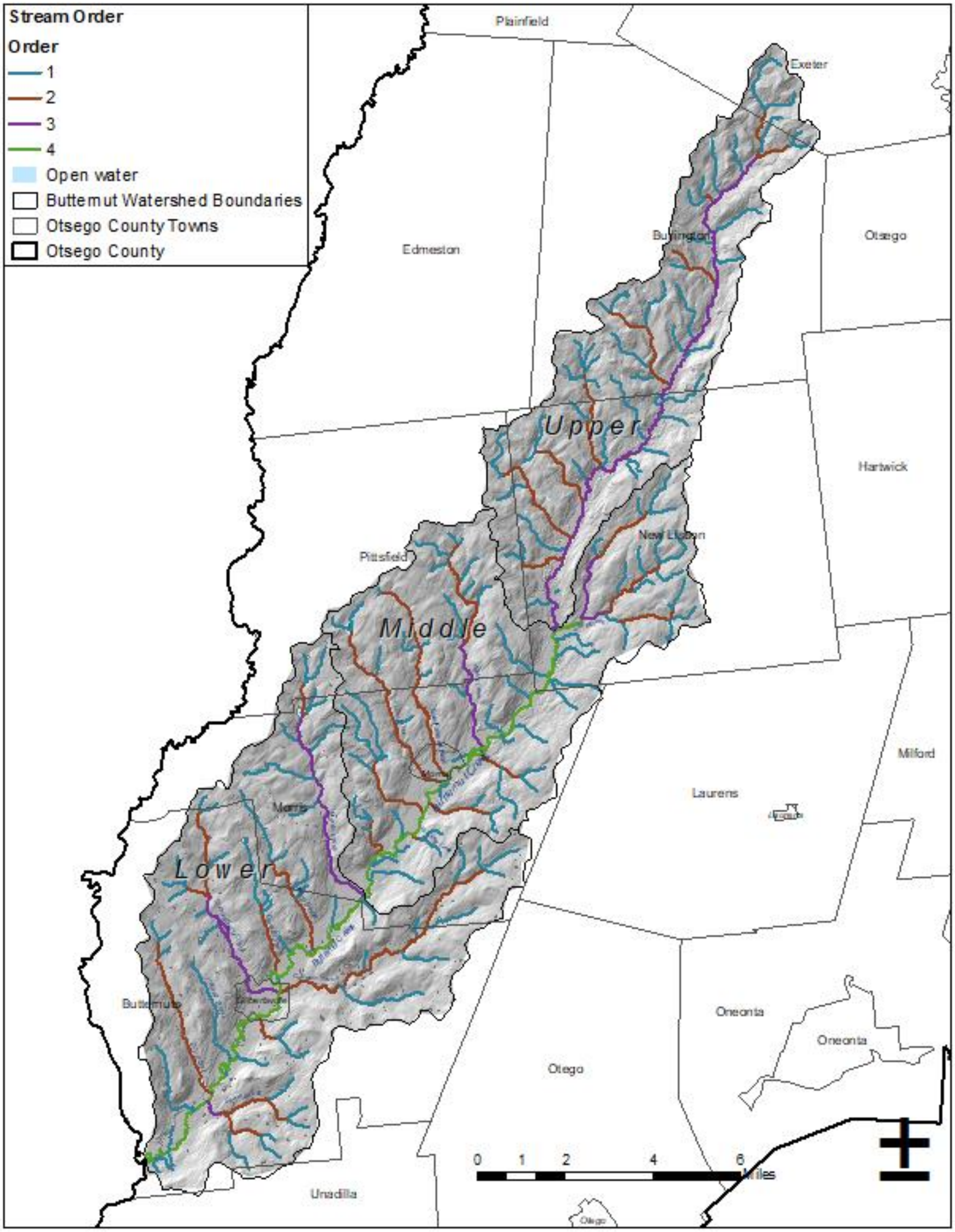


Figure 22. Stream Order in the Butternut Creek Watershed.

3.4.7 Water Quality

Water quality in the Butternut Creek watershed is regulated by the Phase III Watershed Implementation Plan for the New York portion of the Chesapeake Bay watershed. Established in 2010 the Chesapeake Bay Total Maximum Daily Load (TMDL) has set targets for the water quality parameters described below. The status and trends of water quality in the Butternut Creek watershed have important downstream impacts. Understanding the conditions at the local watershed level of Butternut Creek is critical to improving water quality at a regional level.

Water quality conditions are impacted by direct point inputs (point source) such as combined sewer overflows (CSOs) or a known discharge from municipal or industrial wastewater. Another type of pollution source is nonpoint source pollution (NPS). Nonpoint source pollution comes from multiple natural and human-made pollutant sources contributing to surface runoff and groundwater infiltration that ultimately ends up in lakes, rivers, wetlands, coastal waters, and groundwater (NYSDEC 2020a). Examples of this include but are not limited to: excess agricultural and residential fertilizer nutrients in the form of nitrogen and phosphorus; sediment from eroding streams, cropland and forest land, and construction sites; and pathogens and nutrients from livestock, pet wastes, and faulty septic systems (NYSDEC 2020a). Excess nutrients can degrade water quality and increase eutrophication (increased algal growth). Storm water runoff from road sides and un-vegetated fields can also lead to the introduction of excess nutrients and pollutants. High rainfall events can initiate accelerated bank erosion due to increased water velocity. This can lead to increased sediment load within the system. These large sediment loads move downstream and settle out in less turbid areas causing fish passage blockages and disconnection to flood plains. Suspended sediment levels have a strong impact on stream biota with elevated levels potentially having lethal effects (Welch et al. 1998). Increased levels of TSS can alter fish migration, feeding, and growth, and cause direct mortality (Welch et al. 1998). The deposition of fine sediment on the stream bed negatively affects fish eggs and young fish survival and also reduces biomass and taxa richness of invertebrates (Chapman 1988, Welch 1992, Quinn and Peterson 1994, Welch et al. 1998).

There is only one registered point source discharge under the New York State Pollution Discharge Elimination System (SPDES) Program in the Butternut Creek watershed located at the Gilbertsville-Mt Upton Central School (SPDES# NY0249319) (NYSDEC 2020c). There are no Multi-Sector General Permit (MSGP) locations or registered Concentrated Animal Feeding Operations (CAFO) located in the watershed (NYSDEC 2020c). The rest of the watershed is affected by nonpoint source pollution largely from agricultural activities and the distribution of road chemicals in the winter. A smaller portion of nonpoint source pollution can be attributed to yard care, forest management, and the presence of dirt roads. In more urbanized watersheds, a measure of “impervious cover” or the amount of paved or hard surfaces in an area is an important tool in assessing the amount of nonpoint source pollution.

There have been several survey efforts to collect water quality data in the Butternut Creek watershed. A study by the Otsego County Water Quality Coordinating Committee surveyed the lower Butternut Creek watershed, near the confluence of the Unadilla river, over the time period between May 2009 and May 2010 as part of a larger study aimed at gathering baseline conditions in the Upper Susquehanna Watershed (OCWQCC 2010). The parameters measured were ammonium (NH_3), nitrite + nitrate (NO_x), total nitrogen (TN) and total phosphorus (TP). Nutrient export volumes were calculated for each parameter. For the Butternut Creek the estimated nutrient export for nitrite + nitrate (NO_x), total nitrogen (TN) and total phosphorus (TP) was 3.2 lbs/acre, 4 lbs/acre, and 0.14 lbs/acre respectively (OCWQCC 2010).

In a study conducted in 2012 (carried out by the Otsego County Conservation Association and funded by the Scriven Foundation), monthly baseline water quality data was collected from 50 Otsego County streams in response to potential hydraulic fracturing natural gas exploration from August 2010- April 2012 (Crosier 2012). The variables sampled were pH, conductivity, and total dissolved solids (TDS). The study found TDS and conductivity peaked in the winter months and in the summer months with relatively lower levels in the fall and spring likely attributed to changes in flow and use of road salt in winter months (Crosier 2012). There was no seasonal pattern observed for pH. The study found geology strongly influenced pH, conductivity, and TDS. Limestone bedrock watersheds had a higher conductivity because limestone allows for the dissolution of carbonate minerals into the water which neutralizes acids and raises stream pH (Allan and Castillo 2007, Crosier 2012). However, smaller watersheds had lower conductivity values and TDS concentrations in some of the limestone-based areas. The table below describes the water quality for the six sites that were sampled in the Butternut Creek watershed (Table 14).

Stream Name	Conductivity (mS/cm)	TDS (mg/L)	pH	Area (sq mi)	Sub-watershed
Aldrich Brook (S)*	0.076 ± 0.04	83.0 ± 28.6	7.70 ± 0.28	7	Middle
Cahoon Creek (S)	0.103 ± 0.04	138.6 ± 71.4	7.81 ± 0.38	10.6	Lower
Dunderberg Creek (S)	0.101 ± 0.05	135.4 ± 80.4	7.90 ± 0.38	6.2	Lower
Morris Brook (S)	0.065 ± 0.02	90.0 ± 20.5	7.81 ± 0.35	7.8	Middle
Stony/Mill Creeks (S)	0.054 ± 0.02	75.0 ± 30.1	7.63 ± 0.80	8.9	Middle
Upper Butternut Creek (L)*	0.106 ± 0.04	123 ± 31.2	7.58 ± 0.37	43	Upper

* S =Shale bedrock, L = Limestone bedrock

Table 14. *Adapted from Crosier (2012) Table 2*. Mean conductivity, TDS, and pH for streams monitored in Otsego County, NY ± 1 standard deviation for the 6 out of 50 sites surveyed in Otsego County that were in the Butternut Creek watershed. Means calculated from data collected monthly from Aug 13, 2010 – April 21, 2012.

There are currently two monitoring locations in the Butternut Creek watershed as part of a county-wide stream monitoring program conducted by citizen volunteers and facilitated by Otsego County Conservation Association (OCCA). The program's goal is to collect a suite of water quality variables to show baseline conditions and track long term changes at nine locations throughout Otsego County utilizing volunteers from the community (OCCA 2020). Additional sites will be added as funding allows. Variables measured once a month include: dissolved oxygen, temperature, pH, conductivity, water clarity, nitrate, and orthophosphate. The program started in October 2017 and continues through the present. Both sites are located on the mainstem Butternut Creek in the Middle Butternut Creek watershed. One location is at County Route 12 and is referred to in this report as the New Lisbon site and the other is approximately five miles downstream in the Village of Morris referred to as the Morris site.

Site	Temperature (°C)	Conductivity (ms/cm)	Clarity (cm)	DO (mg/L)	pH	Nitrate (mg/L)	Phosphate (mg/L)
Morris[1]	9.87±7.28	0.151±0.048	55.69±12.84	8.89±1.83	7.04±0.11	0.14±0.33	0.01±0.02
New Lisbon[2]	9.25±7.34	0.132±0.032	58.57±5.06	9.83±1.87	6.99±0.07	0.00±0.00	0.02±0.03

[1] Morris – also referred to as Butternut Creek @ Morris

[2] New Lisbon – also referred to as Butternut @ 12

Table 15. Mean temperature, conductivity, water clarity, dissolved oxygen, pH, nitrate, and phosphate for Butternut Creek at Morris, NY and New Lisbon, NY ± standard deviation. Means calculated from data collected monthly from October 10, 2017 –May 17, 2020.

Water temperature values varied seasonally for both sites with lower temperatures in the winter and warmer temperatures in the summer months. Minimum temperatures were found in February 2018, 0.80 °C at the New Lisbon site and in January 2019 0.35°C at the Morris site. Maximum water temperatures were found in July 2019, 23.4 °C, for the New Lisbon site and in June and July 2020, 22.7°C, for the Morris site. The Morris site had overall slightly higher temperatures for the summer months in 2018 when both sites were sampled (Table 15, Figure 23).

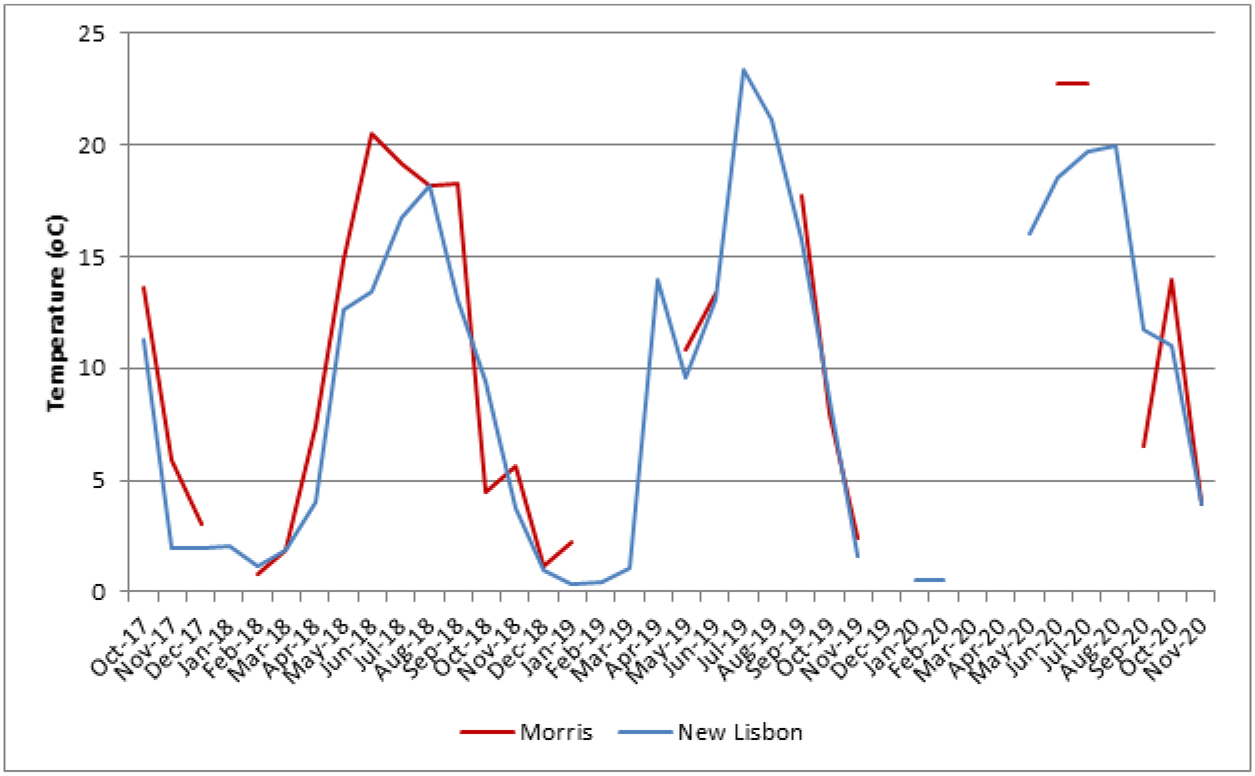


Figure 23. Water temperature measurements for Butternut Creek from October 2017 through November 2020.

Conductivity values (or the measure of ions in the water) for both sites varied throughout the year (Table 15, Figure 24). The sites had similar conductivity recordings with a few exceptions for the Morris site. The maximum value recorded to date for the Morris site, 0.264 mS/cm, was considerably higher than almost all other values and occurred in January 2020 with prior year maximum value of 0.244 mS/cm in December 2019. The Morris site is located in an area with more impervious surface compared to the New Lisbon site, which could cause increased surface runoff containing road salt in the winter months resulting in higher conductivity levels. The minimum value for the Morris site occurred in October 2019, 0.070 mS/cm. The New Lisbon site maximum value was recorded during sampling in July 2018, 0.185 mS/cm and the minimum value was observed in April 2019, 0.060 mS/cm. Both sites are in the middle to low range for conductivity values compared to the other seven sites in the watershed (OCCA 2020). Note conductivity values have been converted to mS/cm in this report to allow comparison to previous conductivity sampling in the Butternut Creek watershed (Crosier 2012). The data supports the results of previous conductivity sampling which found higher conductivity values in the northern part of Otsego County where limestone is found in the bedrock (Crosier 2012).

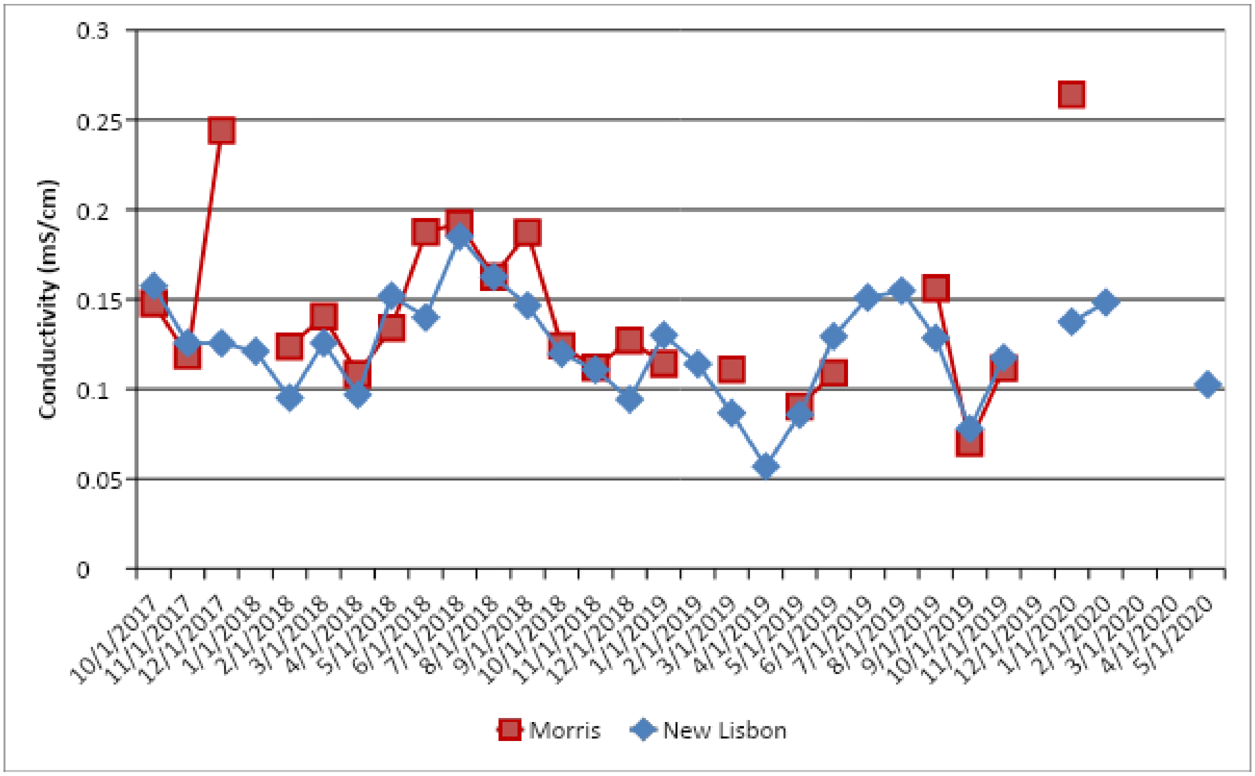


Figure 24. Conductivity measurements for Butternut Creek from October 2017 through May 2020.

Water clarity indicates the ability of light to penetrate the water column (OCCA 2020). The amount of light penetrating to the bottom of the water column is important for algae and aquatic plants to be able to carry out photosynthesis. For both sites water clarity remained high at the maximum recording value of 60 cm with a few exceptions likely due to rain events increasing the amount of sediment suspended in the water (Figure 25). The Morris site had a greater number of lower readings and a lower monthly mean indicating more sediment is accumulated as water flows downstream in the watershed (Table 15). Compared to the other sites in the watershed the Morris site had the lowest water clarity reading of all sites of 9 cm in February 2018 but was not consistently the lowest overall (OCCA 2020). Overall, the sites sampled indicate high water clarity in Butternut Creek.

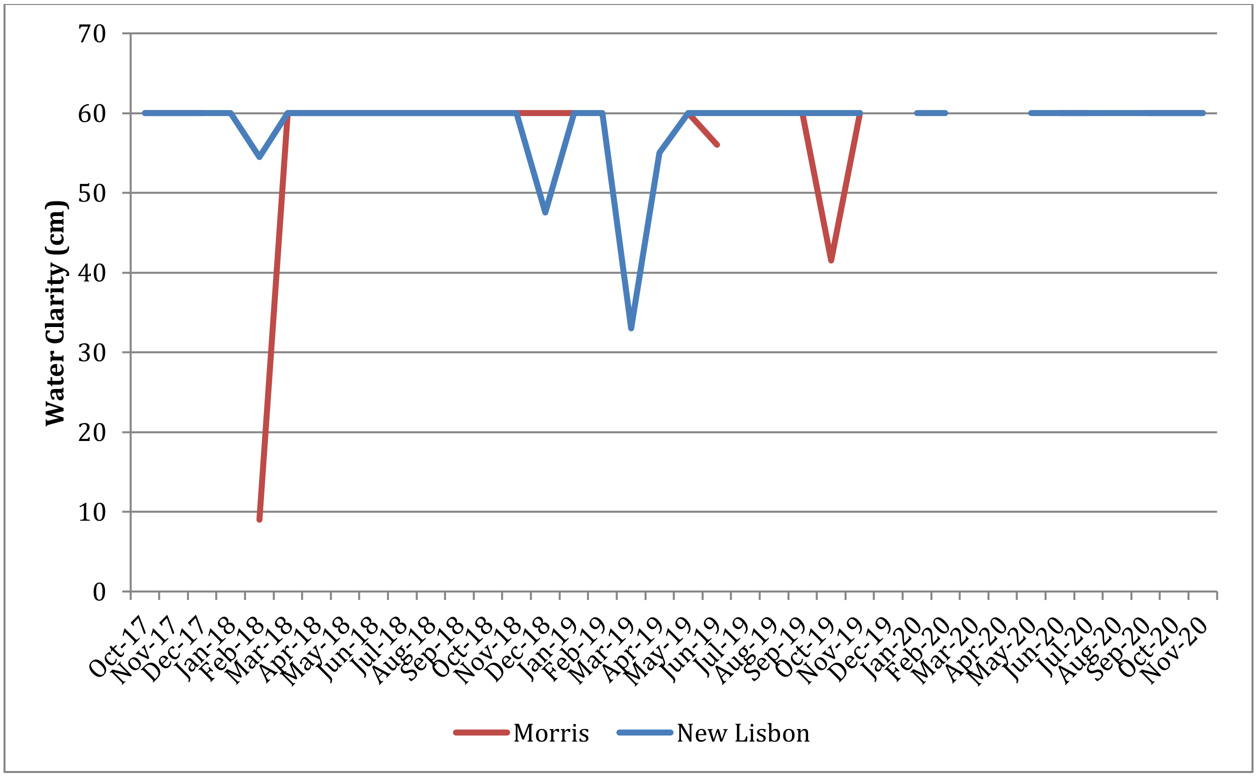


Figure 25: Water clarity measurements for Butternut Creek from October 2017 through May 2020.

Dissolved oxygen fluctuated seasonally for both Butternut Creek sites with higher levels in the winter and lower levels in the summer (Table 15, Figure 26). Dissolved oxygen the molecular oxygen dissolved in water and is critical to survival of aerobic biota (Welch et al. 1998). Levels at both sites remained above 5 mg/L indicating decent water quality. Lower dissolved oxygen values usually accompany increased stream temperatures as cooler water carries more oxygen (Welch et al. 1998).

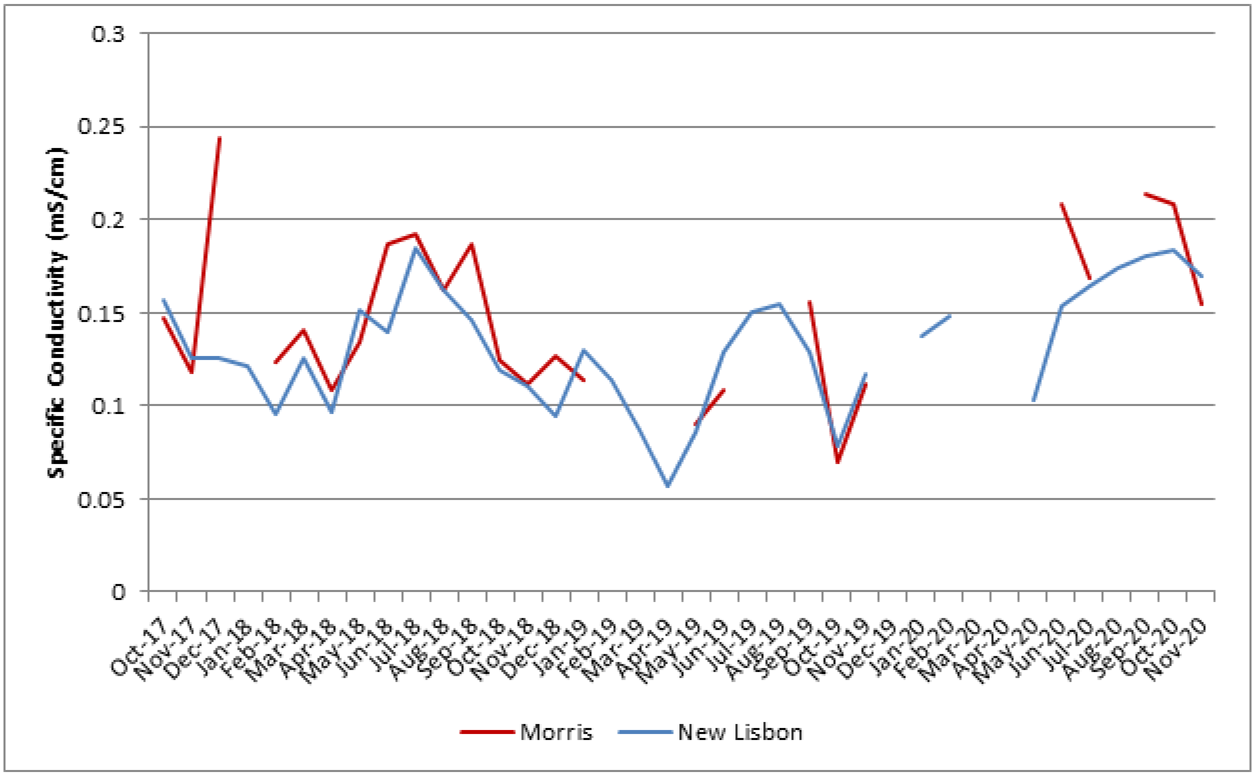


Figure 26. Dissolved oxygen measurements for Butternut Creek from October 2017 through May 2020.

The pH levels at both sites are approximately 7 (Figure 27, Table 15). The pH scale is from 1-14, with lower numbers considered acidic and higher numbers basic (OCCA 2020). Water is typically considered neutral and falls in the middle range (6-8) as the data recorded indicates with some variation attributed to underlying geology (OCCA 2020). Compared to the other sites sampled, the Butternut Creek pH values were slightly lower but within the normal range. Compared to the sites sampled in 2010-2012 the present values are also slightly lower.

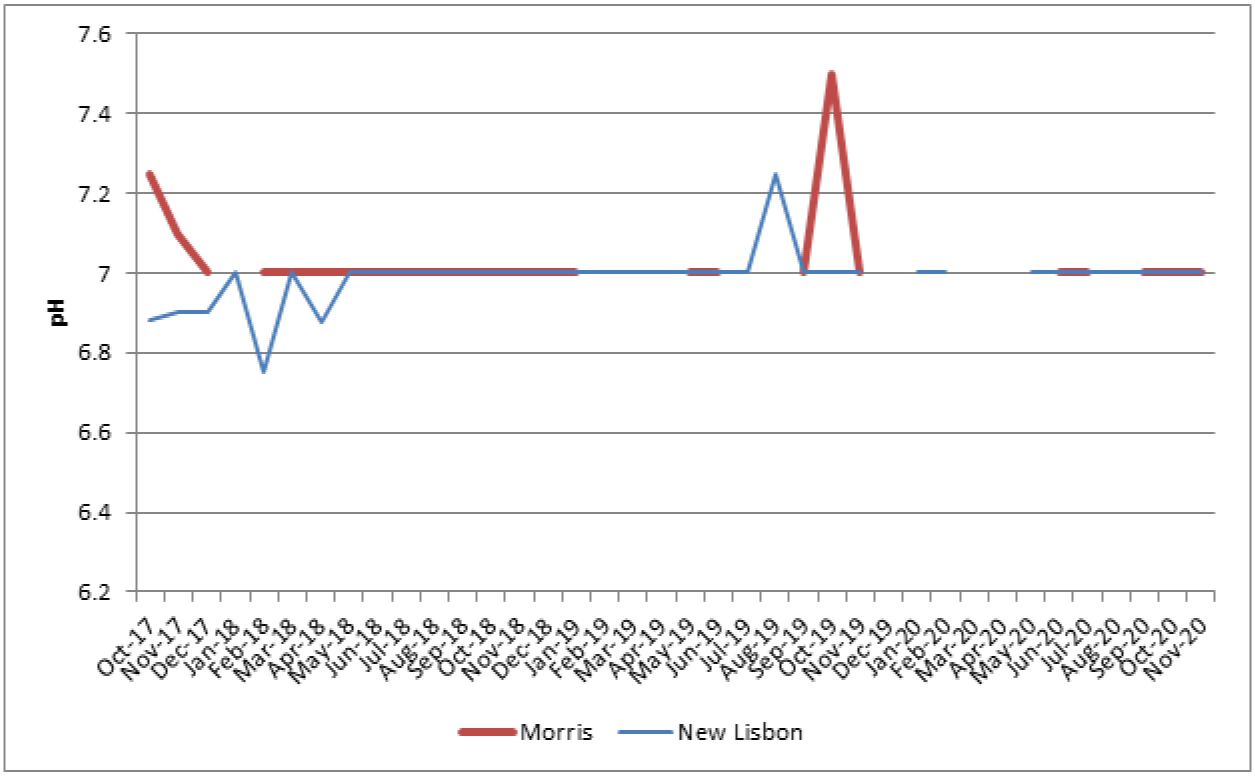


Figure 27. pH measurements for Butternut Creek from October 2017 through May 2020.

Nutrient levels (nitrate and orthophosphate) can be indicative measures of nonpoint source pollution caused by agricultural activities in a watershed. These can be important data to assess when trying to target agricultural best management practices in the watershed. Nitrate levels at the New Lisbon site were consistently low throughout the sample period. The Morris site nitrate levels remained low overall but had higher readings in spring 2019 and fall 2018 and 2019 (Table 15, Figure 28). The Morris site is one of five sites throughout the Otsego County wide sampling that showed elevated levels (OCCA 2020). Samples of orthophosphate at the two Butternut Creek locations varied throughout the year without exhibiting an overall trend (Figure 29). Levels at both sites remained below 0.08 mg/L. In 2017/2018 orthophosphate levels were increased at the New Lisbon site but then readings in 2019 remained low during same months. The New Lisbon site had some of the highest orthophosphate levels for 2017/2018 compared to the other sites in Otsego County. Alternatively, orthophosphate at the Morris site remained low in 2018 and then increased at times in 2019 and 2020. Nitrate and orthophosphate are nutrients that can be indicators of degraded water quality conditions. Increased levels of these nutrients from agriculture and lawn maintenance cause increased algal growth (OCCA 2020).

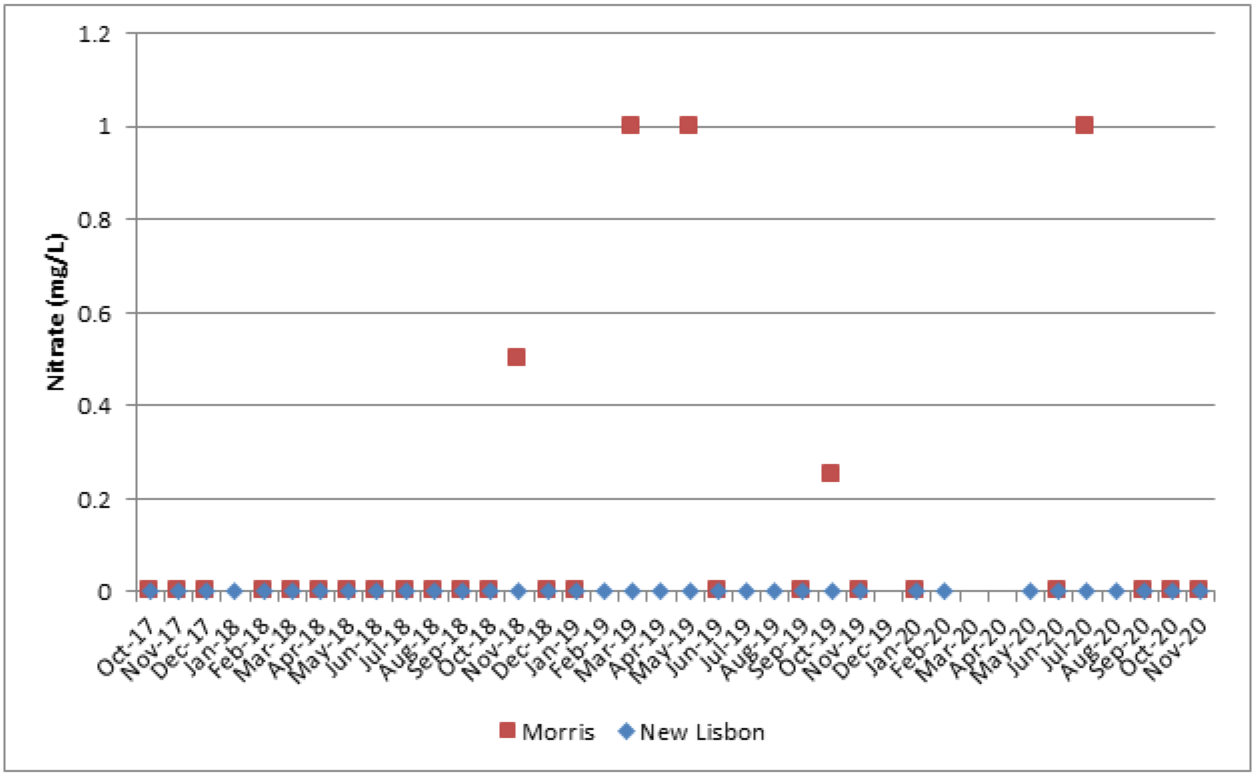


Figure 28. Nitrate measurements for Butternut Creek from October 2017 through May 2020.

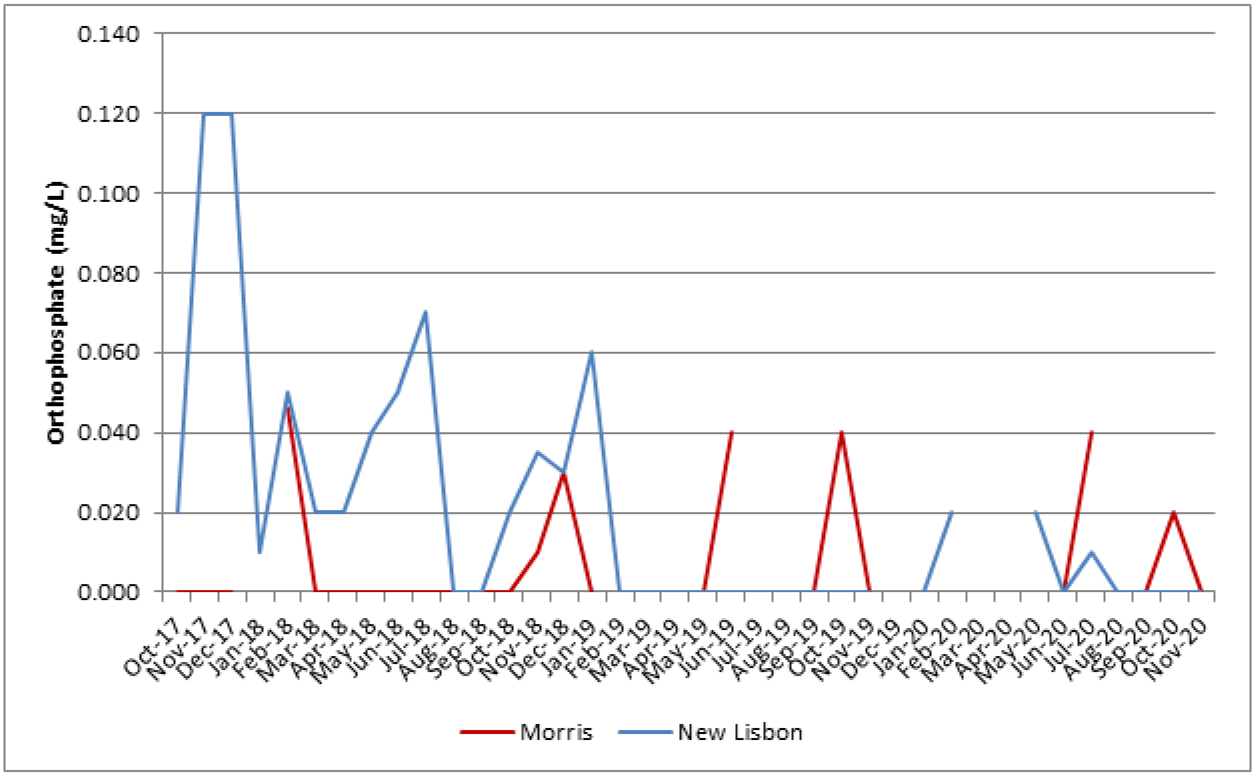


Figure 29. Orthophosphate measurements for Butternut Creek from October 2017 through May 2020.

A study conducted in 2017 (Sleeper 2017) examined pH, specific conductivity, total dissolved solids, temperature, total nitrogen (TN) and phosphorus (TP), nitrite + nitrate, discharge, turbidity, and total suspended solids (TSS) in the Butternut Creek watershed. A two-day flood event was analyzed for TSS, TN, and TP using an autosampler and compared with baseline flow conditions. The flood conditions consistently had higher TN and TP values compared to the baseline flow and were consistent with increases in discharge. The research supports the theory that flood events are the primary cause of nutrient and sediment transport compared with baseline flow (Sleeper 2017). The study also examined turbidity in the several tributaries and on the mainstem during and after flood conditions. Turbidity levels in all but one tributary, Stony Brook, returned to normal levels two days later. Additionally, the site measured downstream of Stony Brook on the mainstem Butternut Creek had considerably higher turbidity values suggesting Stony Brook is likely a major contributor of sediment to Butternut Creek (Sleeper 2017).

The study also found that the ratio of organic to inorganic material in suspended sediment decreased with TSS concentration indicating higher flows create more inorganic material from bank collapse and channel erosion (Sleeper 2017). When evaluating nutrient loading from TSS, TN, TP compared with discharge longitudinally from upstream to downstream at locations on Butternut Creek, each variable increased as discharge increased moving downstream (Sleeper 2017). Specific conductance (conductivity), pH, and turbidity were also evaluated from upstream to downstream with varied results but within the range for a healthy aquatic environment. Specific conductance and pH fluctuated from site to site without a clear trend longitudinally. Turbidity increased at the downstream locations but was highest in New Lisbon and at Morris Fairgrounds (a site adjacent to the OCCA Morris site) (Sleeper 2017).

In June of 2019, the Susquehanna River Basin Commission (SRBC) installed a real-time water quality monitoring station on Butternut Creek at the Flatiron Bridge in the Lower Butternut Creek watershed as part of the Remote Water Quality Monitoring Network (SRBC 2020). The station continuously measures and reports water quality conditions on five water quality parameters: temperature, pH, specific conductivity, dissolved oxygen, and turbidity.

Temperature changed seasonally with peaks in July and August in 2019 and June and July of 2020 (Figure 30). Technical issues with equipment caused data gaps in August 2020. Lower temperatures occur during the winter months and through the early spring. This is consistent with the Citizen Science monthly temperature recordings at the Morris and New Lisbon locations (Figure 23). However, the maximum temperatures were consistently over 25°C in 2019 and for stretches in 2020 compared with the upstream sampling locations and the average temperature at the Flatiron Bridge location was 11.72°C compared to 9.87°C at Morris and 9.25°C at New Lisbon. The maximum temperature recorded during the sampling period was on 7/20/2019 and the minimum temperature recorded was on 2/22/2020 (Table 16).

Specific Conductivity also varied throughout the year with some seasonally patterns at the Flatiron Bridge location with elevated levels in the fall and the lowest values during the summer months (Figure 31). Maximum values were recorded on 10/03/2020 and minimum values recorded at 0.00 (mS/cm) for several time periods most often during June through August (Table 15, Figure 31). The average was slightly lower compared to the sample locations further upstream in the watershed (Table 14, Table 15). The occurrences of maximum conductivity readings did not correspond to the timing of maximum readings at the Morris and New Lisbon locations. The lower specific conductivity values at the Flatiron

Bridge location could be due to the location representing a larger drainage basin being located at almost the bottom of the watershed as well as shale and sandstone dominated bedrock substrate.

Turbidity, measured in nephelometric turbidity units (NTU), is another measure of water clarity and specifically looks at the amount of light that is scattered by material in water. Turbidity levels on average remained low at the Flatiron Bridge sample location with spikes most often associated with storm events (Figure 31). The maximum reading was observed on 6/1/2020 (Table 16, Figure 317). The maximum value of 853.6 NTU that occurred on 6/1/2020 increased sharply from approximately 7 NTUs four hours prior and then quickly returned to a lower reading of approximately 7 NTU within four hours after which is a sudden increase and decrease for a watershed of the size.and morphology of the Butternut. It is possible a sudden storm event could have caused it or impacts from a prior rain event. There was increased discharge recorded at the Unadilla River USGS gage in Rockdale on May 31, 2020. Minimum values were observed during July of 2019 which corresponds with the range of high water temperatures during that time (Table 16, Figure 35, Figure 31). Average turbidity remained low at 9.75 NTUs indicating overall good water clarity in Butternut Creek which relates to the water clarity readings during the monthly sampling at the upstream locations. It is beneficial to have the continuous monitoring location at Flatiron Bridge to capture the increases in turbidity that can be missed during the monthly sampling.

Dissolved oxygen remained higher in the winter when water temperatures were cooler and lower in the summer months when the water temperature was higher (Figure 33). The maximum values occurred in February of 2020 which was also when the coldest water temperatures were recorded (Table 16, Figure 33). The maximum values occurred during July and August of 2020. Unfortunately, water temperatures during this time period are missing due to equipment failure issues but typically these are the warmest months of the year. The average dissolved oxygen was over 10 mg/L and levels remained consistently over 5 mg/L indicating overall good water quality (Table 16, Figure 33).

Readings of pH at the Flatiron Bridge location mostly hovered between seven and eight throughout the year with a few exceptions (Figure 34). In July of 2019, the pH was consistently below seven and approached five at one point but in July of 2020 remained over seven (Figure 34).

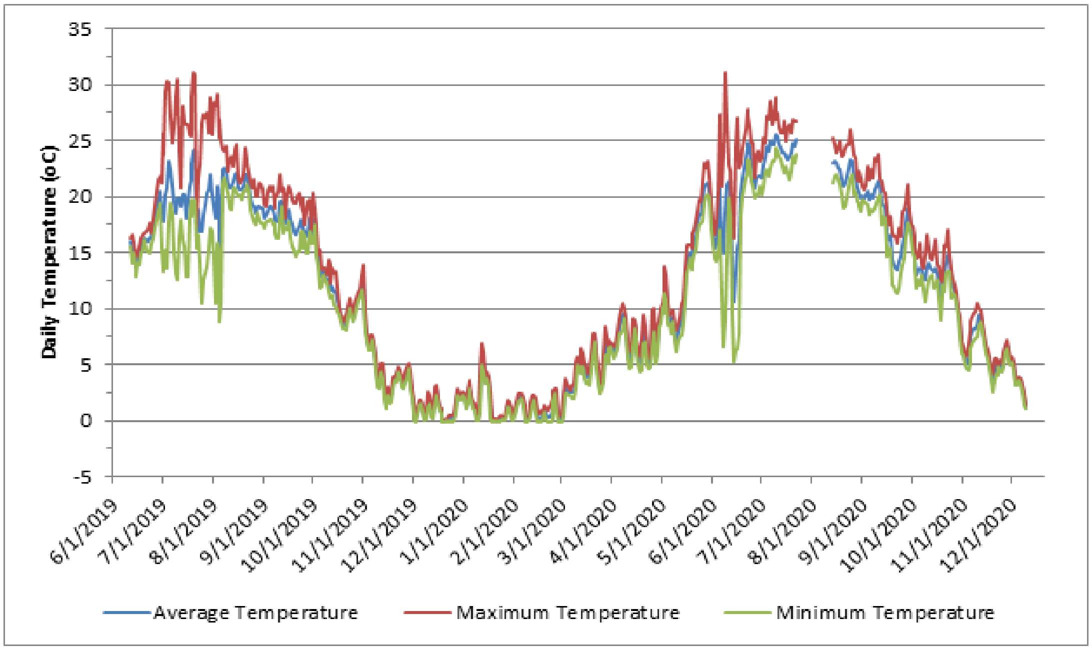


Figure 30. Water temperature measurements for Butternut Creek at Flatiron Bridge from June 11, 2019 through December 9, 2020 (SRBC 2020).

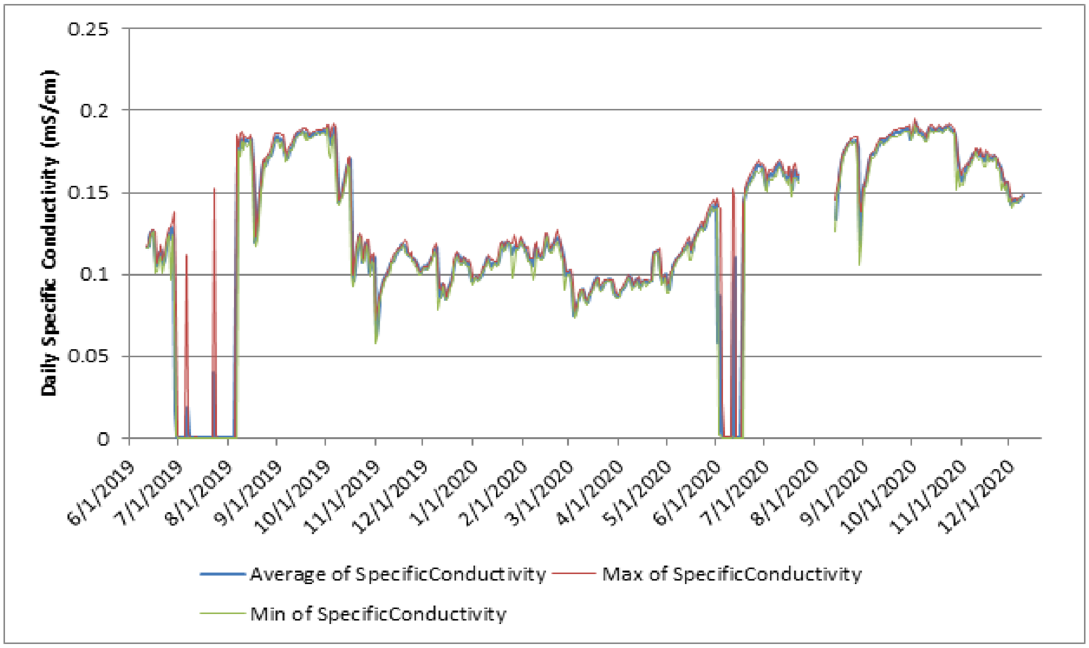


Figure 31. Specific conductivity measurements for Butternut Creek at Flatiron Bridge from June 11, 2019 through December 9, 2020 (SRBC 2020).

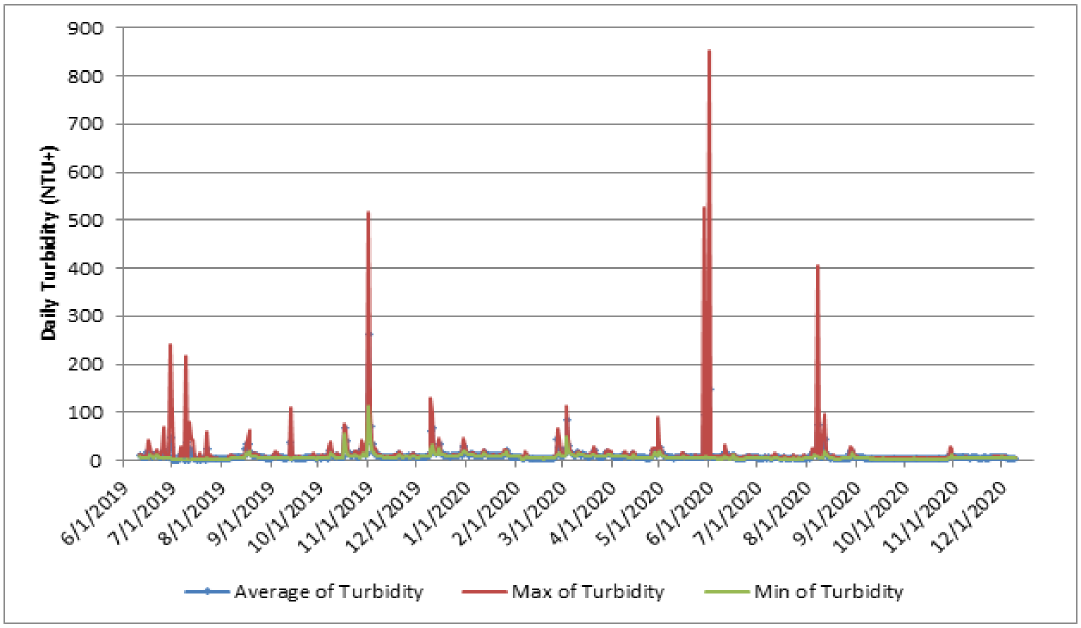


Figure 32. Turbidity measurements for Butternut Creek at Flatiron Bridge from June 11, 2019 through December 9, 2020 (SRBC 2020).

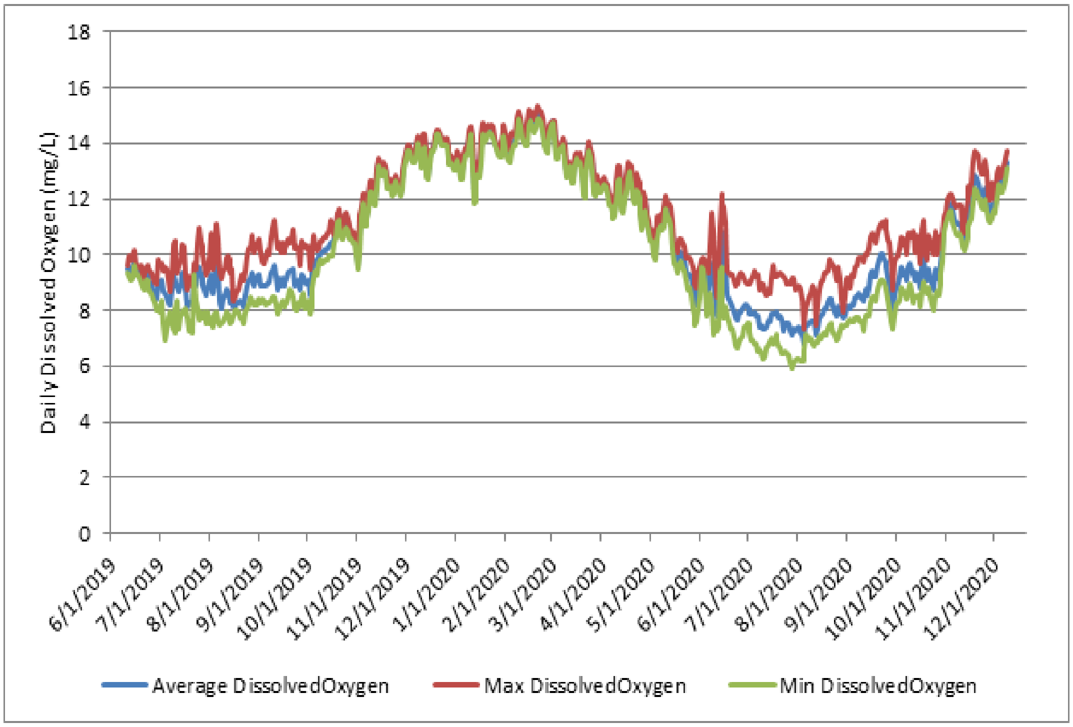


Figure 33. Dissolved oxygen measurements for Butternut Creek at Flatiron Bridge from June 11, 2019 through December 9, 2020 (SRBC 2020).

Figure 34. pH measurements for Butternut Creek at Flatiron Bridge from June 11, 2019 through December 9, 2020 (SRBC 2020).

Parameter	Samples[1]	Average	Max	Min	Stdev
Temperature (C)	3159	11.72	31.15	-0.11	8.01
Sp Cond (mS/cm)	3159	0.12	0.195	0	0.05
pH	3284	7.29	8.27	5.07	0.29
Turbidity (NTU+)	3257	9.75	853.6	0	25.14
ODO (mg/L)	3283	10.60	15.35	5.94	2.31

[1] number of samples varies due to quality control process

Table 16. Summary of available data from 6/11/2019 through 12/09/2020 for the Butternut Creek SRBC water quality monitoring station at Flatiron Bridge.

3.4.8 Biological Characteristics

3.4.8.1 Fisheries

Fish can be indicators of the overall ecological condition of a stream due to their role in the food chain among other organisms such as invertebrates, plants, algae, small mammals, and other fish (Naiman 2005). The Butternut Creek itself is classified as a warm water fishery for the lower 15 miles and shifts to a cold water fishery at approximately 1,200 ft. elevation approximately 16 miles upstream (Angell 2017, NYSDEC 2018). There are a wide variety of aquatic habitats in Butternut Creek ranging from rocky, fast moving, shallow riffles to deep, slow moving pools. The diversity of habitats supports different species of fish. Warmwater fish species found in Butternut Creek include largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), walleye (*Sander vitreus*), chain pickerel (Esox niger), rock bass (*Ambloplites rupestris*), pumpkinseed (*Lepomis gibbosus*), and yellow perch (*Perca flavescens)*. The Butternut Creek also supports cold water fisheries including brook trout (*Salvelinus fontinalis*) and brown trout (*Salmo trutta)* due to the temperature remaining below 70° in the summer (NYSDEC 2009, Wells 2016a). Early fish stocking programs from 1926-1934 stocked brook trout, brown trout, rainbow trout, small mouth bass, walleye, and yellow perch (NYSDEC 2016a). Brown trout were historically stocked 16 miles upstream of Morris, NY as recently as 2011 (NYSDEC 2018). The brown trout stocking program was suspended in 2012 to evaluate the response of brook trout to the estimated decrease in brown trout population (Pokorny 2016). A 2011 survey conducted by NYSDEC found wild brook trout more numerous than wild/stocked brown trout at six survey locations in 15.8 miles of stream (Wells 2016b).

At the headwaters of the Butternut Creek is Basswood pond. The pond was built in 1959 as the first public fishing pond constructed in New York (NYSDEC 2018). It is situated in the 711-acre Basswood Pond State Forest and is stocked with brook trout, brown trout, and rainbow trout (NYSDEC 2004, NYSDEC 2016). The NYDEC periodically reclaims the pond using Rotenone, a fish toxicant, to maintain the trout populations (Strensland 2002). In the middle Butternut, approximately 20 miles downstream, Morris Reservoir was also stocked with brook trout and brown trout from 1977 through 1997 (NYSDEC 2016a). Historically several of the larger tributaries were stocked with a brook trout from 1926 - 1934 (Aldrich Creek, Calhoon Creek, Copes/Dry Brook, Coye Brook, Dunderburg Creek, Garrattsville Creek, Halbert Brook, Morris Brook, and Stony Creek) (NYSDEC 2016a). Crystal Lake was also stocked from 1926-1928 with smallmouth bass. There are public fishing easements in the Upper Butternut watershed on Butternut Creek in Burlington and Garrattsville (Appendix D) (NYSDEC 2009).

A recent survey of fish species in Butternut Creek found 18 different species with the greatest diversity found at a site downstream of New Lisbon (Angell 2017). The most common fish species was the slimy sculpin (*Cottus cognatus*) and the least common species were the redside dace (*Clinostomus elongates*) followed by burbot (*Lota lota*). As expected, the cold water species, brook trout and burbot, were found in the upstream sites and more warm water species were found downstream of New Lisbon, including rock bass, pumpkinseed, and smallmouth bass. The study also found smaller size classes of brook trout which indicates a naturally reproducing population. The least number of fish caught was at the Morris

Fairgrounds site indicating the site has potential water quality impairments (see water quality section – OCCA citizen science data). A 2018 fish survey found 12 different species at one location on the Butternut Creek (Coney and Lord 2019). The most common species found were the Cut lip minnow (*Exoglossum maxillingua*), Tessellated darter (*Etheostoma olmstedi*), Slimy Sculpin (*Cottus cognatus*), Creek Chub (*Semotilus atromaculatus*), and the Spottail Shiner (*Notropis hudsonius*) (Coney and Lord 2019). Compared to the other sites in the Upper Susquehanna Watershed surveyed, the Butternut Creek was one of the sites with the highest species diversity. The NYSDEC surveys on Butternut Creek from 1935 to 2004 documented 46 different species (NYSDEC 2016b). The most frequently caught species include: the white sucker (*Catostomus commersonii*), Common shiner (*Luxilus cornutus*), Eastern Blacknose Dace (*Rhinichthys atratulus*), and brook trout.

3.4.8.2 Benthic Macroinvertebrates

One important method to determine the quality of water in a stream is to monitor the aquatic benthic macroinvertebrates, which are small animals without backbones that live on the bottom of aquatic environments and are large enough to be seen with the naked eye (Orzetti 2010, Peterson 2017). Macroinvertebrates are valuable indicators of the health of aquatic environments, in part because they are benthic (meaning they are typically found on the bottom of a stream or lake) and they are for the most part sessile (do not move over great distances). Therefore, they cannot easily move away from pollution or environmental stress. Because different benthic macroinvertebrates react differently to environmental stressors, quantifying the diversity and density of different benthic macroinvertebrate species at a given site can create a picture of the environmental conditions of the stream and also the watershed (Rand and Petrocelli 1985, Rosenberg and Resh 1993, Hershey and Lamberti 1998).

Trend analysis using benthic macroinvertebrates is used to determine the overall health of a body of water. Health can be measured in several different ways. Tolerance indices measure the relative sensitivity of different organisms to levels of pollution or environmental stressors. Three common indices measuring the structure of the community are the Hilsenhoff Biotic Index (Hilsenhoff 1987, 1988), the Biotic Index (Winget 1979) and Percent Model Affinity - PMA - (a statistical similarity measure predicting how a community looks compared to other healthy stream communities, but better suited to predict non-organic pollution) (Novak and Bode 1992). Functional feeding group measures can be used to examine the community function via food web dynamics (trophic interactions) (Cummins 1979, Cummins 1989, Palmer 1993). These indices together can not only give a picture of water quality health, but an overall snapshot of the and integrity of the aquatic system.

A general trend can be seen in the pollution tolerance of benthic macroinvertebrate to water quality degradation, and thus, order of disappearance of species from stream habitats (Jones and Clark 1987). A healthy body of water will typically contain a majority of benthic macroinvertebrates that are intolerant of environmental stressors, such as mayflies (Ephemeroptera), stoneflies (Plecoptera) and caddisflies (Trichoptera) (Voshell and Wright 2002). As environmental stressors increase, the families within these orders will tend to disappear from the community. Therefores, an impaired body of water may contain a majority of benthic macroinvertebrates that are tolerant of these conditions such as midges (Chironomidae) leeches (Hirundinidae), oligochaete (Oligochaetae) worms and tubifex worms and pouch snails (Jones and Clark 1987; Benke 1981; Pillard 1996; Coimbra 1996; Voshell and Wright 2002; Orzetti 2010). Bioassessments can provide benchmarks to which other waters may be compared and can also be used to define rehabilitation goals and to monitor trends.

A survey in July 2003 conducted by the NYSDEC Stream Biomonitoring Unit (Bode et al. 2004) sampled macroinvertebrate species at eight sites throughout the Butternut Creek watershed to evaluate water quality conditions and the impacts on Hellbenders. The results showed stream water quality ranging from non-impacted to slightly impacted. Two sites in Morris and Mount Upton were rated as slightly impacted in terms of species richness (number of different kinds of organisms in a sample). Also, the uppermost site in Morris was slightly impacted based on %EPT (mayflies, stoneflies, caddisflies) scores calculated. The Mount Upton site had large numbers of oligochaete worms that can tolerate pollution indicating some increased levels of environmental pollution at the site. However, the site was deemed non-impacted and did not pose a threat to hellbender populations (Bode et al. 2004). At the time siltation and nutrient enrichment were the only impacts noted, and the authors found the results did not indicate water quality to be limiting factor for hellbender populations (Bode et al. 2004). A prior survey by the NYSDEC Stream Biomonitoring Unit in 1997 at one site on the Butternut Creek below the Flatiron Road bridge evaluated water quality as non-impacted (Bode et al. 2004).

A benthic macroinvertebrate survey was conducted on the Butternut Creek in 2002 as part of a Master's project at the State University College at Oneonta (Stensland 2002). Samples were collected from 18 sites between Basswood Pond at the headwaters to the confluence of Butternut Creek and the Unadilla River from July 1, 2002 to July 15, 2002. Assessments of physical habitat (PHA), family biotic index (FBI), percent model affinity (PMA), and %EPT were made at each site.

The data collected and evaluated showed the Butternut Creek macroinvertebrate community to be in overall good health. Indicators suggested that the Butternut Creek has a diverse and abundant benthic macroinvertebrate community. In particular there was an absence of oligochaetes which can be indicators of organic pollution stress. As distance from the source (near Basswood Pond) increased, the shredder (food web measure) population decreased possibly due to sampling time in July when leaf material declined after the fall (Stensland 2002). There was variability between sites and different ratings for each site depending on what biological index was used. Stensland (2002) found similar results to Bode et al. (2004) at the site above State Route 23 Bridge in Morris and attributed the degraded conditions to legacy pollution from a former sanitation management site located upstream and a defunct industrial site adjacent to the creek, but indicated further research was needed (Stensland 2002). Recommendations to improve water quality conditions further include riparian plantings to reduce silt load and alleviate the erosional effects of high water levels.

A more recent survey of benthic macroinvertebrates in the summer of 2017 (Peterson 2017) evaluated nine sites and compared the results with the work of Stensland (2002). The study found an improvement in water quality in the upper portion of the watershed and a decline in water quality in the lower portion of the watershed. Specifically, Peterson (2017) found an increase in total organisms collected, percent EPT, and the family biotic index in the upper half of the watershed. The site near the Village of Morris had a decline in organisms, families present, %EPT, and FBI from the upstream site. Previous sampling at this area also identified degraded conditions (Bode et al. 2004, Stensland 2002). Peterson (2017) hypothesized the lack of riparian buffers in this area may be contributing to the degradation. The lower portion of the stream sampled had PMA scores for water quality of moderately and slightly impacted. There was an increase in total organisms collected due to the large presence of a pollution tolerant species suggesting a decline in water quality in the lower end of the stream. A list of macroinvertebrate species found during sampling efforts in 2002 and 2017 can be found in Appendix E (Stensland 2002, Peterson 2017). Peterson (2017) recommended further research should focus on the reach of Butternut Creek from where it crosses County Route 12 to where it bypasses Morris

Fairgrounds. The two Butternut Creek water quality monitoring sites that are part of the county- wide long term status and trends monitoring program discussed in the above *Water Quality-Physical and Chemical Section* are located in this reach and will inform further research into water quality degradation in this section of Butternut Creek (OCCA 2020).

3.4.8.3 Species of Concern

American Eel

Historically, American Eels (*Anguilla rostrata*) were prevalent in the Upper Susquehanna Watershed including Butternut Creek and its tributaries. The American eel is catadromous, meaning they spawn in salt water but spend the majority of their development in fresh water (Reily and Minkkinen 2016). American Eel populations have been declining throughout their range primarily due to overharvest, poor water quality, habitat loss/fragmentation from blockages (mills, dams) preventing upstream migration, and turbine mortality in hydroelectiric power stations during downstream migration (Reily and Minkkinen 2016, ASMFC 2000). Due to the loss of access to upstream habitat from dams and other barriers in the Susquehanna River Watershed there is an ongoing effort to restore the eel populations by reintroducing young eel to headwater streams (Reily and Minkkinen 2016). In 2019, young eels at the elver growth stage were transported from the Conowingo Dam on the Susquehanna River in Maryland at River Mile 10 and relocated to two tributaries in the Upper Susquehanna River Watershed (Coney and Lord 2020). One of the elver release sites was on Butternut Creek at Bailey Road where an estimated 6,000+ elvers were released with future releases planned for subsequent years (Coney and Lord 2020).

Upstream passage for the American Eel may be beneficial to recruitment of the native freshwater mussel Eastern Elliptio (*Elliptio complanata*). Mussel larvae called glochidia are parasitic and must attach to the gills of a host species before metamorphosing into the subsequent juvenile life stage. Eastern Elliptio (pearly mussel) relies on eels as the parasite's primary host species (Lord and Pokorny 2012). Increasing or improving passage for eels could increase recruitment of Eastern Elliptio which could lead to improvements in water quality and ecosystem function. Additionally, the American Eel may act as a native biological control for the invasive species, rusty crayfish (*Orconectes rusticus*), through predation and/or competition (Mount 2009, Turrin 2009, Velez-Espino and Koops 2010, Kelsey 2010). However, the research also suggests rusty crayfish could in turn prey upon young eels. Understanding this relationship is important to American Eel restoration efforts.

Freshwater Mussels

Freshwater mussels are large (2-30 cm) bivalves that live in sediment in freshwater systems (Bauer and Wachtler 2000). North American has the greatest diversity of freshwater mussel species worldwide with over 300 species of mussels out of 1000 recognized species (Strahler et al. 2004). They are important in a watershed because of their high ecological value (water quality indicators), importance to human health, cultural value, and their biodiversity (USFWS 2019). Freshwater mussels are viewed as indicators of water quality (Zemken et al. 2013). They help filter bacteria, algae, and contaminants. Freshwater mussels are a valuable food source for many wildlife species and important to Native Americans of New York culturally as a food source and used for ornamentation, tools, and as a trade commodity (USFWS 2019). Freshwater mussels, in general, may also increase stream stability by their position in streambeds and bottoms thereby potentially reducing erosion and flooding impacts (USCA 2020). They also perform vital aeration and mixing of sediment when they burrow into the streambed which is important for other macroinvertebrates (USCA 2020). As described in the American Eel section, freshwater mussels rely on specific fish species to host their larva.

Freshwater mussels are considered one of the most imperiled organisms in North America. Major threats to mussels include habitat loss from dams, stream channelization and dredging, construction and maintenance of bridges and highway projects, decrease in water quality, land-use changes, and interactions with invasive species primarily zebra mussels and rusty crayfish (USFWS 2019, USCA 2020).

Currently there are only 12 species of freshwater mussels remaining in New York out of the 49 species historically found in the state (USCA 2020). All 12 species have been reported in the Susquehanna River basin. A 2011 freshwater mussel survey of the Butternut Creek found extensive mussel beds including the species Yelllow lampmussell (*Lampsilis cariosa*) which is listed by NY State as a Species of Greatest Conservation Need (SGCN) (Lord and Pokorny 2012). Other pearly mussel species found alive include Eastern lampmussels (*Lampsilis radiata*), Eastern elliptios (*Elliptio complanata*) and Squawfoots *(Strophitus undulatus*). The study recommended protecting the extensive Eastern elliptios beds in the Butternut Creek and suggested the population could be used as reproductive material for other areas of the New York portion of the Upper Susquehanna Watershed once their host species, the American eel, have been successfully introduced to the watershed (Lord and Pokorny 2012). A more recent survey found high numbers of Eastern elliptio and Yellow lampmussel in Butternut Creek at Bailey Road compared with other survey sites in the Upper Susquehanna Watershed (Coney and Lord 2019).

Eastern Hellbenders

The Butternut Creek watershed is one of the few areas in New York where Eastern Hellbenders (*Cryptobranchus aleghaniensis alleghaniensis*) have been documented. A survey in 1996 found an estimated 20-55 animals, all sexually mature adults over 25 years old (Blais 1996). The study raised concerns about hellbender reproduction due to the absence of younger hellbenders. Siltation and loss of habitat have been identified as a possible reason for their decline in reproduction. Hellbenders prefer high water quality with well oxygenated, unpolluted, and swift running streams (NYSDEC 2018). They have specific habitat requirements including abundant cover from logs, rocks, undercut stream banks for nesting and foraging (Blais 1996). During winter they need deep water pools and fast flowing riffles that remain open year-round (NYSDEC 2018). The NYSDEC listed the eastern hellbender as a species of special concern in NYS in 1983 (NYSDEC 2018).

The Upper Susquehanna Coalition is supporting ongoing conservation efforts to enhance the Eastern Hellbender population in the Upper Susquehanna River Watershed in conjunction with project partners including NYSDEC, United States Fish and Wildlife Service (USFWS), The Wetland Trust (TWT), State University of New York School of Environmental Science and Forestry (SUNY ESF), Lycoming College and The Bronx Zoo. Eastern hellbender eggs collected from local waterways were reared at the Bronx Zoo before being transported The Wetland Trust (TWT) facility for additional acclimation measures prior to release. The juvenile hellbenders were tagged with a micro-chip prior to release into streams in the Upper Susquehanna Watershed, including the Butternut Creek in 2018 for post release distribution and monitoring purposes. Additional habitat improvements were implemented including stream substrate augmentation and creation of artificial habitat features to benefit the released hellbenders and enhance the existing habitat for adult salamanders. The research and restoration efforts will help understand what is limiting reproduction and development of eastern hellbenders by addressing several of the challenges facing the species and ultimately work to restore the population in the Butternut Creek watershed.

Swallowtail Shiner

The Swallowtail shiner (*Notropis procne*), has an imperiled state conservation status (S2) (NY Heritage Program accessed July 20, 2020). The fish are approximately six cm in size, live for approximately two to three years, and spawn in the late spring and early summer. They live in warm, moderate to low gradient, clear to often turbid, creeks and small to large rivers and usually occupy pools and slow runs with sand, gravel, or rock bottom (Lee et al. 1980, Page and Burr 1991). While these fish have not recently been documented in the Butternut Creek, according to the NYS Environmental Resource Mapper and the NY Nature Explorer, they have been known to occur in the area and in similar creeks in the Upper Susquehanna watershed.

3.4.8.4 Invasive Species

Invasive species can cause significant changes in biodiversity and ecosystem function and there can be an economic cost to the negative impacts of invasive species (Kuhlmann 2016). They often outcompete native species and may lack predators resulting in their populations expanding beyond what they would normally be in their native habitats (Kelsey 2010, Olden et al. 2006). Two invasive species studied in the Butternut Creek watershed are Japanese Knotweed (*Polygonum cuspidatum)* and the Rusty crayfish. Other invasive species present in the watershed such as Wild Parsnip (*Pastinaca sativa)*, Multiflora Rose (*Rosa multiflora)*, Honeysuckle species (*Lonicera* sp.), Garlic Mustard (*Alliaria petiolate)* have not been studied and documented in detail.

Japanese Knotweed (*Polygonum cuspidatum*), native to eastern Asia, has spread through the United States after a likely introduction in the mid-19th century (NYIS 2009). Knotweed spreads rapidly by seed, stem fragments, and rhizomes (NYIS 2019). It can thrive in disturbed areas and create monoculture stands that compete with native plant communities. It is common to find along streams and rivers, disturbed areas, low-lying areas, roadsides, and around old homes and farmsteads (NYIS 2009). Mechanical control is difficult for larger stands therefore the most effective best management practice (BMP) is through chemical control (NYIS 2009).

A study in 2013 surveyed 13 sites on Butternut Creek for invasive species and found Japanese knotweed at five sites throughout the Upper, Middle, and Lower Butternut Creek watersheds (Yoo et al. 2013). A complete census of knotweed distribution has not been completed. However, through local conversations with landowners, data from the Otsego County Soil and Water Conservation District physical assessment, and other agencies doing work in the watershed, the presence of knotweed on Butternut Creek is known to be extensive in the Middle and Lower Butternut Creek watershed with smaller pockets in the Upper Butternut Creek watershed.

Rusty crayfish have been expanding from their original range in the Ohio River drainage throughout much of northeastern North America and often replace native crayfish and increase crayfish densities in streams (Kuhlmann and Hazelton 2007). Crayfish play a key role in freshwater ecosystems as consumers and prey, and also as disturbance agents (Kuhlmann and Hazelton 2007). As one of the largest invertebrates in a freshwaters stream and being a generalist omnivore, changes in crayfish species and density can have consequences on biodiversity, community structure, and ecosystem function (Kuhlmann and Hazelton 2007, Kulmnann 2016).

The Butternut Creek was surveyed for rusty crayfish from 1999-2005 as part of a larger effort to document the species in the Upper Susquehanna watershed. Rusty crayfish were not documented in Butternut Creek at this time (Kuhlmann and Hazelton 2007). However, surveys in 2010 documented rusty crayfish in the Lower Butternut Creek watershed and in 2013 rusty crayfish were found in the Middle Butternut Creek watershed (Kulmann 2020). As part of a different study in 2013, rusty crayfish were documented at one out of thirteen sites on Butternut Creek in the Upper Butternut Creek watershed (Yoo et al. 2013). A 2018 survey on Butternut Creek at Bailey Road found native crayfish species in relatively high densities, Northern Clearwater crayfish (*Orconectes propinquus*) and common crayfish (*Cambarus bartonii*) (Coney and Lord 2019). Rusty Crayfish were also found at this site at somewhat lower density during the survey. A repeat survey in 2019 found similar densities of the three species (Coney and Lord 2020). As discussed above, interactions between the American Eel and rusty crayfish (*Orconectes rusticus*) are currently being researched to understand the impact each species has on each other and ultimately the overall freshwater ecosystem (Mount 2009, Turrin 2009, Velez-Espino and Koops 2010, Kelsey 2010).

3.5 Agriculture

Agriculture is an important landuse in the Butternut Creek watershed that is impacted by and impacts the physical attributes of the watershed. The watershed has an abundance of soil types that are capable of supporting different types of agriculture, and thus streams, wetlands and floodplains, water quality, benthic macroinvertebrates, fisheries and habitats have been impacted. There is a coordinated effort between NYS DEC, NYS Department of Agriculture and Markets (NYS DAM), the New York State Soil and Water Conservation Committee (NYS SWCC), the Upper Susquehanna Coalition (USC), and the county Soil and Water Conservation Districts to support increased planning for use and performance of conservation practices with best management practice (BMP) implementation on farms through programs such as the Agricultural Environmental Management Program (AEM) and the Agricultural Nonpoint Source Abatement and Control Program (AgNPS) (NYSDEC 2020e). The AEM program coordinates agricultural and environmental conservation agencies and programs to provide voluntary, incentive-based conservation services for farmers (NYSDEC 2020e). Otsego County is actively involved in the AEM program which is facilitated by Otsego County Soil and Water Conservation District because all three Butternut Creek subwatersheds are listed as priority one watersheds for addressing water quality issues (nitrogen, phosphorus, sediment, and pathogen) as outlined in the Agriculture Environmental Management (AEM) Strategic Plan (OCSWCD 2015).

According to the 2012 Census of Agriculture there were a total of 995 farms in Otsego County (Otsego County 2017). A survey in 2013 found 584 active farms in Otsego County (Gibson 2013). County-wide, there has been a loss of farms and farmland. In 1940 there were 496,518 acres of farmland and 3,750 farms in Otsego County (Stensland 2002, New York Agricultural Statistics Service 2000). By 1998 there were 225,700 acres of farmland and 1,045 farms in Otsego County which decreased further in 2012 to 180,750 acres and 995 farms in 2012 (Gibson 2013, Peterson 2017, Stensland 2002, USDA 2012). The rate and quantity of decline of farmland and active farms is not specifically known in the Butternut Creek watershed, but there has been an assumed similar declining trend. There were an estimated 30 active farms in the Butternut Creek watershed observed in the 2013 survey (Gibson 2013). From 2004-2020, 51 farms in the Butternut Creek watershed have participated in the AEM program representing a range of types of farms with dairy being the dominant farm type (Table 18) (OCSWCD 2020). There is a discrepancy between the two datasets because the number of farms participating in the AEM program includes all farms participating in the program from 2004 to 2020 and does not account for farm loss and likely includes additional farms after the 2013 survey. The exact number of active farms in the Butternut Creek watershed is not currently available and an additional survey is recommended.

Farm Type	**Watershed**	**Total**

	Lower	Middle	Upper	
Beef	5	2	2	9
Dairy	9	13	3	25
Goat	0	2	1	3
Sheep	2	4	2	8
Horse	2	1	0	3
Crops	1	0	2	3
Total	19	22	10	51

Table 18. Farms participating in the AEM program from 2004 to 2020 in the Butternut Creek Watershed (OCSWCD 2020).

A large portion of land in the Butternut Creek watershed is within Agricultural Districts (Figure 35, Table 19) (Cornell IRIS & NYS DAM 2019). The development of Agricultural Districts as part of the NY State Agriculture and Markets Law (AML) began in 1971 to focus state and county level efforts to preserve, protect, and encourage the development and improvement of agricultural land for food and other products (Otsego County 2017). The Land Evaluation Site Assessment (LESA) identified six priority areas for farmland conservation based on a suite of land evaluation and site assessment criteria, such as but not limited to: NRCS farmland classification, distance to protected farmland, distance to floodplains, distance to streams, and distance to agricultural districts (Otsego County 2017). Two of the six areas, the State Highway 51 Corridor and the Butternut Valley/Laurens area, have large portions of land that are in the Butternut Creek watershed.

Watershed	**Acres in Ag District**	**Percent of watershed**
Lower	17,326.47	52%
Middle	566.86	2%
Upper	5,264.28	24%
Total	23,157.61	28%

Table 19. Distribution of land in Agricultural Districts in the Butternut Creek Watershed (Cornell IRIS & NYS DAM 2019).

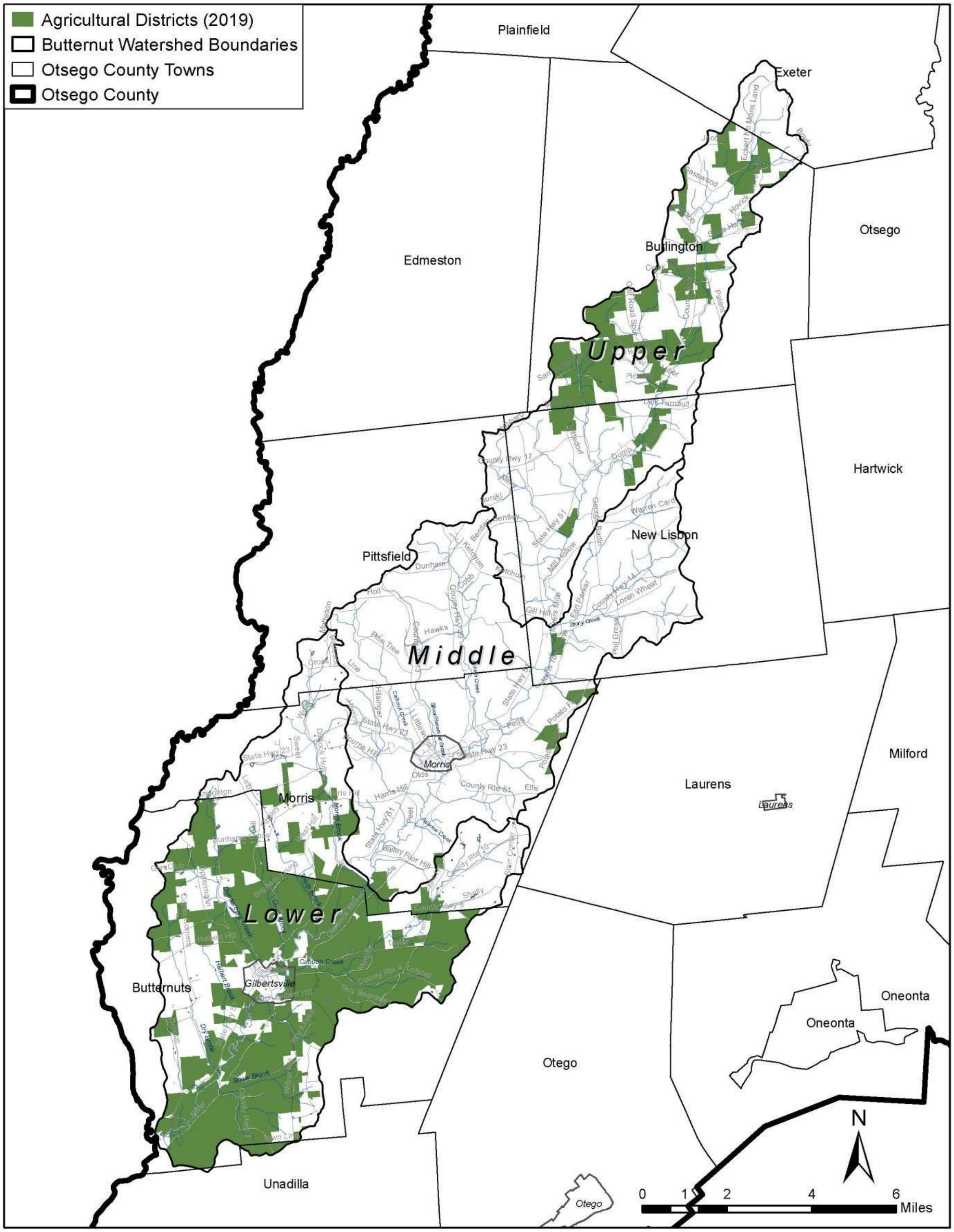


Figure 35. Agricultural Districts in the Butternut Creek Watershed (Cornell IRIS & NYS DAM 2019).

3.5.1 Agricultural Soil Types

While Section 2.4.4 focused on Soil Types, this section focuses on soils in the context of their connection to agricultural practices. There are four agricultural designations of soils in New York State as defined by the U.S. Department of Agriculture (USDA): Prime Farmland, Prime Farmland if Drained, Farmland of Statewide Importance, and Not Prime Farmland (Otsego County 2017). The classification of soils is important to identify areas of land most suitable for agricultural purposes (Otsego County 2017, USDA-NRCS 2006). As defined by the USDA, Prime Farmland is land most suited for the production of food, feed, fiber, forage, and oilseed crops based on physical and chemical characteristics such as soil quality, growing season, and moisture supply (USDA-NRCS 2006). Additional classification requirements relate to soil properties, including temperature, moisture regime, erodibility, pH, water table, permeability, rock fragment content, and others (Otsego County 2017). Prime Farmland if Drained soils meet all the same requirements of Prime Farmland soils except for the water table conditions and the soils are suitable for drainage.

Farmland of Statewide Importance is land that does not meet the requirements for Prime Farmland but is an important part of the agricultural resource base in the area (USDA-NRCS 2006). New York State classifies Farmland of Statewide Importance based on land that does not meet the Prime Farmland or Prime Farmland if Drained classification, but are in the land capability classes 1, 2, 3, or 4w (Otsego County 2017). Usually, it is less productive than Prime Farmland and can be seasonally wet, cannot be easily cultivated, and is usually more erodible than Prime Farmland (USDA-NRCS 2006). All soils that are not classified as Prime Farmland, Prime Farmland if Drained, or Farmland of Statewide Importance are classified as Not Prime Farmland.

In the Butternut Watershed 11.07% of the overall watershed is classified as prime farmland (Table 20, Figure 36). Only 1.95% of the watershed is classified as Prime Farmland if Drained, but 53.67% of the watersheds soils are classified as Farmland of Statewide Importance. The Middle Butternut Watershed has the greatest area classified as the three farmland soils, followed by the Upper Butternut Watershed, and then the Lower Butternut Watershed (Table 20, Figure 37). A list of soils classified for Farmland in the Butternut Watershed can be found in Appendix F.

Farmland Classification	**Acres**			**Total (Acres)**	**Percent**
	Lower	**Middle**	**Upper**		
All areas are Prime Farmland	3,070.30	3,720.99	2,430.95	9,222.24	11.07%
Prime Farmland if Drained	704.81	523.98	392.14	1,620.92	1.95%
Farmland of Statewide Importance	17,380.88	16,075.23	11,261.07	44,717.18	53.67%
Not Prime Farmland	12,225.05	7,902.81	7,625.73	27,753.59	33.31%
Total Acres*	21,155.99	20,320.19	14,084.16	55,560.34	
% Watershed Classified*	63.38%	72.00%	64.87%	66.69%	

Table 20. Distribution of Farmland Classified Soils in the Butternut Creek Watershed. * Excluding Not Prime Farmland

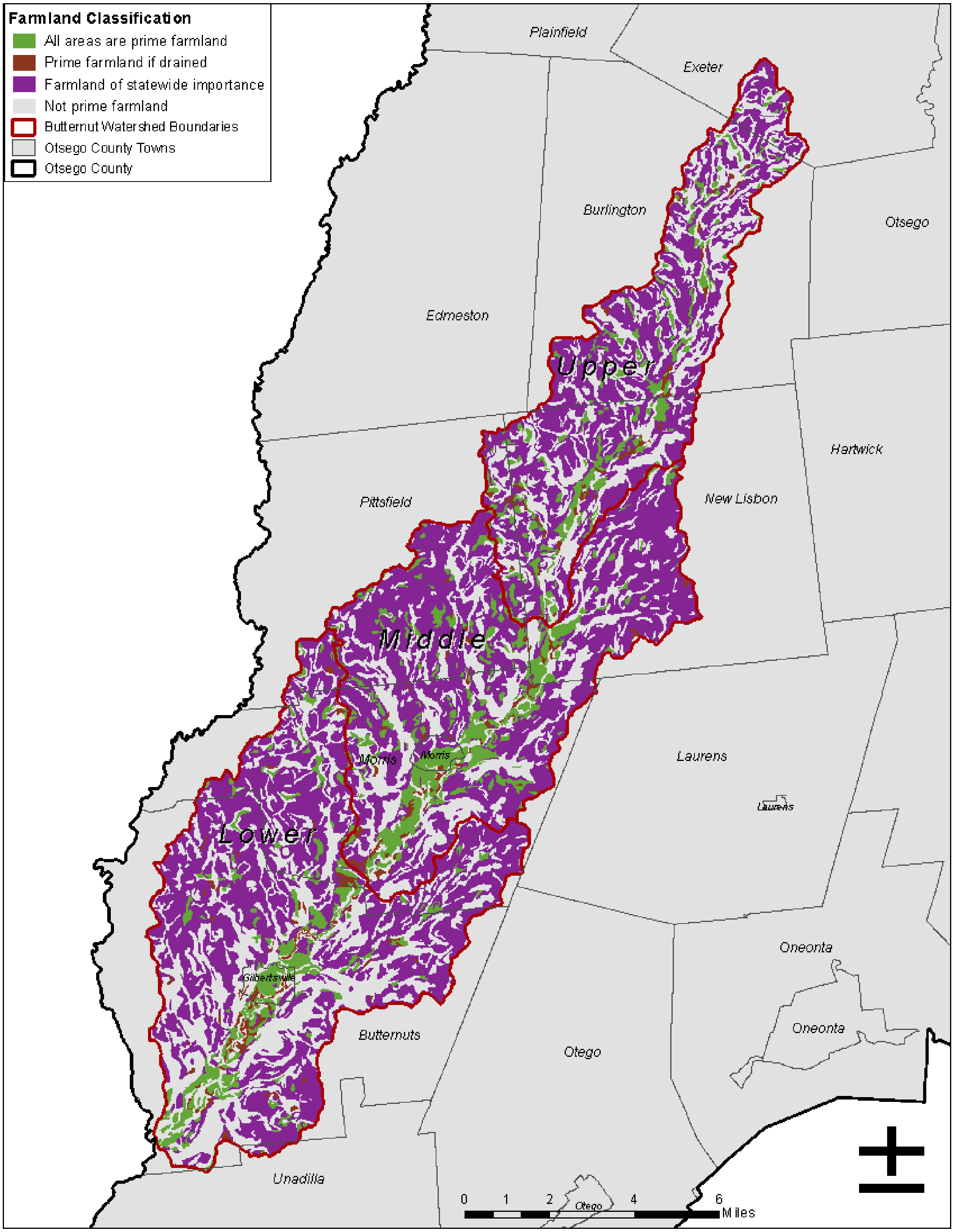


Figure 37. Farmland classified soils in the Butternut Creek Watershed.

3.5.2 Land Evaluation Site Analysis (LESA) Model

In 2017, OCCA in conjunction with SUNY Oneonta developed a Land Use Site Analysis model for the update to the Otsego County Agriculture and Farmland Protection Plan (Otsego County 2017). This GIS model is based on the Natural Resource Conservation Service method for farmland conservation. Using this approach, OCCA and SUNY Oneonta identified Land Evaluation factors and site assessment factors to evaluate the land for farmland production (Table 21). The planning committee weighted criteria based on a factor's importance in the community and produced a score for each 10-meter cell in the GIS mapping tool. The planning committee recognized that all agricultural land in Otsego County is important, yet those that received higher scores meet more of the important farmland conservation criteria.

Green areas typically refer to land with optimal crop productivity and soil characteristics near positive environmental and land use factors (e.g., proximity to other agricultural parcels, protected land, and land within an agricultural district). Red areas could refer either to land with poor soil characteristics or land in close proximity to negative site characteristics (e.g., proximity to heavily traveled roads, hamlet boundaries, etc.) (Figure 38). The model is intended to inform landowners and policymakers where to prioritize farmland conservation efforts in green areas. It should be noted that this analysis provides an estimate of the location of land suitable for agricultural production. Alterations to the weights and criteria used in this analysis could change the outcome of the model's output.

Land Evaluation Category	Square miles
Great (64-85)	20.80
Good (56-63)	39.04
Okay (47-55)	31.08
Marginal (36-46)	22.25
Bad (11-35)	12.59

Table 21. Land evaluation scores and corresponding square miles for agricultural efficacy in the Butternut Creek watershed. Scores derived from the Land Evaluation Site Assessment Model. For more information see the Otsego County Agriculture and Farmland Protection Plan (Otsego County 2017).

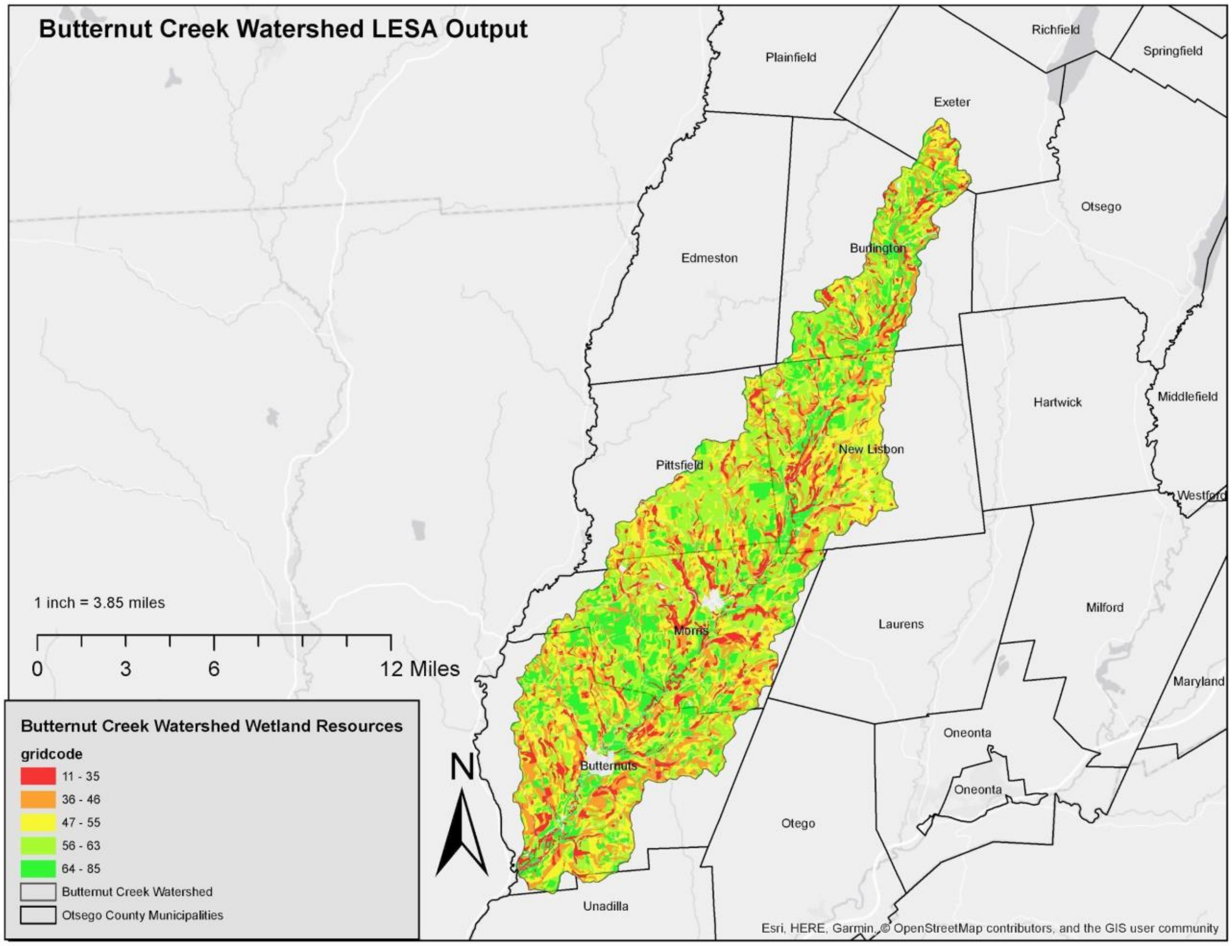


Figure 38: Land Evaluation Site Assessment (LESA) Scores for the Butternut Creek Watershed

4 Existing Plans and Programs

4.1 New York Phase III Chesapeake Bay Watershed Implementation Plan

The United States Environmental Protection Agency (EPA) established the Chesapeake Bay Total Maximum Daily Load (TMDL) in December 2010 to address ongoing water quality problems caused by excessive nutrients and sediment. Seven jurisdictions (Delaware, Pennsylvania, Maryland, New York, Virginia, Washington D.C., and West Virginia) comprise the Chesapeake Bay watershed and are covered by the TMDL. As part of the TMDL, EPA assigns each jurisdiction pollution reduction targets for nitrogen, phosphorus, and sediment. The Chesapeake Bay Partnership finalized an updated set of nitrogen and phosphorus reduction targets for each jurisdiction in July 2018. All targets are expected to be met by 2025.

Each jurisdiction is responsible for developing and implementing watershed implementation plans (WIP) that describe the contributions each state will make towards achieving their targets. The New York State Department of Environmental Conservation (NYS DEC) submitted the final Phase I WIP in December 2010, the final Phase II WIP in January 2013, and the final Phase III WIP in May 2021.

The following source sector chapters (Agriculture, Wastewater, Developed, and Other Remaining Sectors) represent New York's Phase III WIP for the Chesapeake Bay TMDL. The source sector chapters document how nutrient and sediment reductions can be achieved and maintained. They may be modified and updated based upon: federal funding criteria; application of adaptive management stemming from lessons learned through the two-year milestone process; the needs and priorities of local communities in the Chemung and Susquehanna watersheds; changes to EPA's Chesapeake Bay Watershed Model, including New York specific data inputs to the model; and/or updated projections of loads related to climate change and growth. Like the Phase II WIP, load reduction targets were developed for each sector based on balancing the amount of opportunity available to reduce loads from each sector, cost to implement practices in each sector, and achieving equity between sectors. NYS DEC expended considerable effort to determine the best balance of load reductions among sectors (NYSDEC 2019).

4.2 Otsego County Strategic Prioritization Plan

The Otsego County Strategic Prioritization Plan is the result of a collaborative public planning process, which generated over sixty key initiatives organized into four central themes. These themes, or 'missions', guide officials to support the people of Otsego County, promote quality development, increase opportunities for economic growth and achieve fiscal savings by identifying areas of government that are best suited for consolidation and shared services. The goal of the plan is to foster an environment in the County where businesses, residents, and employees of a variety of ages, abilities, and experiences will live, work, play, learn, and thrive. Building on the four fundamental themes that emerged for the County, the Board of Representatives has identified the following four missions:

- Support the people of Otsego County.
- Create quality places where people what to live, work, and play.
- Diversify our economy.
- Increase government capacity and efficiency.

Under these main themes, the County has been implementing several key initiatives since 2016. These include:

- Attract/Retain/Expand Businesses (Mission 3)
- Combat Opioid Epidemic (Mission 1)
- Consolidation/Shared Services (Mission 4)
- Coordination/Communication (Mission 4)
- County Government Reorganization & Support/Invest in County Personnel (Mission 4)
- Energy – Natural Gas, Solar, Wind (Mission 2 & Mission 3)
- Hamlet/Main Street Revitalization (Mission 2 & Mission 3)
- Higher Education (Mission 1 & Mission 3)
- Housing (Mission 2 & Mission 3)
- Infrastructure - Broadband, Natural Gas, Road, Sewer, Water (Mission 2 & Mission 3)
- Outdoor Recreation/Tourism (Mission 1 & Mission 3)
- Transportation (Physical, Transit, Policy) (Mission 2 & Mission 3)

This watershed management plan will support: consolidation of government services; coordination and communication between jurisdictions; and outdoor recreation. Unfortunately, the Strategic Prioritization Plan does not prioritize and key initiatives that directly address water quality (Otsego County 2016).

4.3 Otsego County Hazardous Mitigation Plan

Otsego County's Hazard Mitigation Plan (HMP) was updated in 2019 and is a living document that the Butternut Creek watershed's communities can use to reduce their vulnerability to hazards. It forms the foundation for a long-term strategy to reduce disaster losses and creates a framework for decision making to reduce damages to lives, property, and the economy from future disasters (Otsego County 2019). In order to be current with relevant population, climate, and other socio-economic factors, these plans are updated every five years. Like this watershed management plan, development of the Hazard Mitigation Plan was a stakeholder-based process with communities from the Butternut Creek watershed participating to ensure their needs were met. Sections of the plan that address the water quality, habitat, and biological criteria impacted by climate include drought, extreme temperatures, flood, landslide, severe storm, and severe winter storms (Otsego County 2019).

4.4 Forestry Management Plans in the Butternut Creek Watershed

There are six state forests within the Butternut Creek watershed with a total acreage of 3,300. The forests are: Basswood Pond State Forest, Texas Schoolhouse State Forest, Calhoun Creek State Forest, General Jacob Morris State Forest, and Wagner Farm State Forest. There is also one state park that is mainly forested with management of that land falling under the jurisdiction of NYS OPRHP (Office of Parks, Recreation and Historic Preservation). There is one county forest in the watershed; Chapin Memorial Forest; that is managed by the Otsego County Highways, Recreation, and Forestry Branch under the supervision of the Otsego County Soil and Water Conservation District. Each forest land is managed differently depending upon managing agency, goals for the landuse, and level of conservation protection. Below is a list of the various management plans that govern the above public forest lands.

- Leatherstocking Unit Management Plan (Basswood Pond and Texas Schoolhouse State Forests) (NYSDEC 2020)

4.5 Town and Village Comprehensive Plans

New York State Town Law §272-a (Village Law §7-722) defines comprehensive plans as a document or set of documents which outline a municipality's plan for development over a 10- to 20-year planning horizon. Comprehensive plans are intended to evaluate current conditions in a given municipality and identify achievable action steps that can help it achieve its long-term development goals. As of the development of this plan, six out of the 11 municipalities in the Butternut Creek Watershed do not have adopted Comprehensive Plans. This means that it will be increasingly difficult for county or state-level policymakers to identify the value these communities place on watershed protection and the priority actions these municipalities wish to take with respect to improving water quality.

4.5.1 Town of Burlington

The town of Burlington completed their comprehensive plan in 2013 (Otsego County 2016). According to the plan's community vision and mission statement, they strive for: an exceptional quality of life; valued natural, recreational, and cultural resources; responsible growth and fiscal planning; responsiveness to meeting the diverse needs of the citizens; and a welcoming manner towards visitors, residents and businesses. To accomplish this, they laid out two goals.

- To encourage local economic development in the Town of Burlington.
- Protect agricultural farmland and existing farms.

4.5.2 Town of Butternuts

The latest comprehensive plan was completed in 2013 (Otsego County 2016). Their vision statement is:

> "The Town of Butternuts is located in southwestern Otsego County in central New York. Nestled within the township's scenic hills, woods, fields and Butternut Valley is the picturesque village of Gilbertsville, which is the nation's first village to be listed in its entirety as a National Historic Site. The Town's closely-knit community has a reputation for independence and a strong cultural identity that includes a time-honored and resilient agricultural base and a vibrant and expanding arts community. Residents have high regard for the region's natural beauty, clean, quiet environment and quality of life."

To accomplish this, the town pledged to:

- Maintain clean air, water, open spaces, soils and other natural resources so they may be used and enjoyed by all citizens in the Town.
- Protect rural, historic, aesthetic features as they are the foundation for our quality of life.
- Maintain the attractiveness of the Town and protect scenic values and vistas. Develop a diverse, enduring and sustainable economy based on agriculture, and business enterprises and services that will attract new residents and support long time residents.

- Promote diversification of farms to encourage a variety of traditional, niche, agritourism, food processing and other types of agri-businesses.
- Maintain a low density of population in the Town that does not adversely affect agriculture and encourage higher density of development in hamlets and near the Village; encourage uses that are consistent with this land use pattern.
- Promote a sense of community.
- Minimize traffic hazards and congestion, and ensure that existing roads are suitably maintained and improved.
- Ensure that recreational opportunities exist.
- Promote self-sufficiency.
- Strive to live in harmony with the Town's natural environment.
- Be supportive of all residents and encourage land uses and activities in a way that does not create nuisances or infringe on normally expected, reasonable rights of others.
- Provide a framework that guides future development in the Town so that it is possible for everyone who lives or intends to live in the Town of Butternuts to remain happy in that situation, while maintaining respect and consideration for the rights and preferences of others.

4.5.3 Town of Edmeston

At this point in time, the town does not have an adopted comprehensive plan.

4.5.4 Town of Exeter

At this point in time, the town does not have an adopted comprehensive plan.

4.5.5 Town of Laurens

The most recent comprehensive plan from the Town of Laurens was completed in 2005.

4.5.6 Town of Morris

At this point in time, the town does not have an adopted comprehensive plan.

4.5.7 Town of New Lisbon

The town of New Lisbon’s most recent comprehensive plan is dated 2008 (Otsego County 2016). The plan’s vision statement is as follows:

> “In our Vision for the Town of New Lisbon in the future, our community character is preserved, civic pride sustained and quality of life enhanced. In the coming years, we carefully manage new growth and development while respecting private property rights in order to protect the integrity of our Town, its hamlet centers, small businesses, cultural & civic institutions, public parks, and our natural resources; preserve historic buildings, open space, a vibrant agricultural & farming community and scenic vistas to and from the Butternut Creek; enhance the provision of business services and access to telecommunications infrastructure; provide sustainable public infrastructure and services to meet growing community needs in a cost effective manner; provide housing

> opportunities for a range of household incomes; and set quality design standards to ensure that new growth and redevelopment enriches our community aesthetics and is in harmony with the existing fabric of the Town of New Lisbon.”

To accomplish this vision, the town laid out a series of goals and strategies:

- Protect the Town’s scenic views, rural community atmosphere, and natural quality for its intrinsic and economic value.
- Support growth in small-scale industries that complement rural character of the community.
- Protect the Town’s scenic views, rural community atmosphere, and natural quality for its intrinsic and economic value.
- Ensure transportation systems are sufficient to support agri-businesses and other industries.
- Provide facilities to meet existing and anticipated community needs.
- Support growth in small-scale industries that complement rural character of the community.

4.5.8 Town of Pittsfield

At this point in time, the town does not have an adopted comprehensive plan.

4.5.9 Town of Unadilla

The most recent comprehensive plan for the town of Unadilla was completed in 1989 (Otsego County 2016). The plan lays out a vision focusing on the following characteristics:

- Community Development
- Culture and Recreation Value
- Economic Development
- Government
- Housing and Neighborhood Quality
- Land Use and Zoning

4.5.10 Village of Gilbertsville

At this point in time, the Village does not have an adopted comprehensive plan.

4.5.11 Village of Morris

At this point in time, the Village does not have an adopted comprehensive plan.

4.6 Private Conserved Lands (see land-use section)

There are many conserved lands of various types within the Butternut Creek watershed. In total, there are 1,609.19 acres of land in conservation easements. The Otsego Land Trust reports approximately 1,495 acres under conservation easement, and the Natural Resource Conservation Service holds 195.10 acres. According to the Otsego Land Trust, a conservation easement is legal document that restricts development and incompatible uses while protecting natural resources, farmland, and scenic areas. Otsego Land Trust (OLT) conservation easements are rarely "forever wild", and often do permit some amount of compatible development. Landowners are also able to manage forests, conduct agriculture, and engage in recreational activities. OLT conservation easements are recorded at the County Clerk's office, just like any other deed, and are perpetual with the land regardless of owner. For more information, please contact OLT at info@otsegolandtrust.org.

For conserved lands under state or county jurisdiction, please see the appropriate section for plan details.

4.7 Statewide Comprehensive Outdoor Recreation Plan (SCORP) 2020-2025

The purpose of the SCORP (prepared by the New York State Office of Parks, Recreation and Historic Preservation (OPRHP)) is to fulfill two primary objectives: First, it serves as a status report and general guidance document for the planning, preservation and development of the State's outdoor recreation resources. Second, fulfill a federal recreation mandate under the Land and Water Conservation Fund Act. Every five years, each state must provide an outdoor recreation plan prior to consideration by the Secretary of the Department of the Interior for financial assistance for outdoor recreation acquisition and development projects. Areas covered under the SCORP include state parks and historic site, boat launches, land trails (including snowmobile trails), water trails, heritage areas, and preservation areas.

There are four themes that the SCORP follows. These are:

- Keep the outdoor recreation system welcoming, safe, affordable, and accessible.
- Improve the visitor experience.
- Restore and enhance the State outdoor recreation system with an emphasis on conservation and resiliency.
- Celebrate and teach history while promoting historic preservation efforts across the State.

Within these themes, each of these sites must work towards accomplishing the following goals:

- Connect children and adults with nature and recreation by improving access to outdoor recreation opportunities.
- Inform the public about outdoor recreation opportunities.
- Engage the public through programming.
- Reinvent and redesign the State's outdoor recreation system.
- Build a 21st century green and resilient outdoor recreation system; repair and green aging infrastructure and open new facilities.
- Expand and protect natural connections between parks and open space.
- Restore, conserve, and protect the State's biodiversity.
- Expand historic preservation efforts across the State, at the local and regional level, and cultivate pride of place.

Within the Butternut Creek watershed, Gilbert Lake State Park falls under this plan and as such must be maintained under these guidelines (NYSOPRHP 2019).

4.8 New York Statewide Trails Plan

The Statewide Trails Plan provides a vision, goals, and objectives for the creation of a statewide trails system. The plan identifies a proposed framework for greenway trails, long distance hiking trails, and water trails along with strategies to address the various issues encountered by trail users, maintainers, and land managers. The purpose of the plan is to advance the State's vision for an interconnected world-class network of land and water trails designed to be sustainable, protect the environment, provide connectivity throughout the state, and enhance the quality of life for citizens. In the Butternut Creek watershed, Gilbert Lake State Park has a series of trails that must adhere to this plan (NYSOPRHP 2010).

4.9 Otsego County Conservation Association Citizen Monitoring Program

The Otsego County Conservation Association in conjunction with the Alliance for Aquatic Resource Monitoring created the Citizen Science Stream Monitoring program in 2017. The purpose of the program is to collect baseline data to document surface water conditions in the county and use that data to help inform policy and development decisions that can impact the aquatic environment. Program emphases were developed by a group of stakeholders including the Otsego County Soil and Water Conservation District, Otsego Land Trust, Butternut Valley Alliance, SUNY Oneonta Biological Field Station, SUNY Oneonta Department of Earth and Atmospheric Sciences and the Dave Brandt Chapter - Trout Unlimited. To date, OCCA with a group of volunteer monitors, has collected data from 12 sites around Otsego County (eight sites currently active). Two of the 12 sites are located in the Butternut Creek watershed and have been continuously monitored monthly for three years. The sites are located on the main stem of the Butternut Creek at the junction of Route 12 in New Lisbon, and at the Otsego County Fairgrounds and Hillington Cemetery in the Village of Morris. Water quality data collected includes: dissolved oxygen, specific conductance, water temperature, ambient temperature, nitrate-nitrogen, orthophosphate, and water clarity (OCCA 2020). For more information on the citizen science program and up-to-date data trends, see the program's website at: http://occainfo.org/citizen-science/.

4.10 Rotating Integrated Basin Studies (RIBS)

The NYS Department of Environmental Conservation (DEC) began the RIBS program in 2002 with a pilot study in the Mohawk River basin. Following this pilot study, the program began monitoring the Chemung River Basin in 2003 and the Susquehanna River basin in 2004. Since then, sites have been monitored every five years. The purpose of the RIBS program is to assess and document water quality; identify long-term water quality trends; characterize naturally occurring or background conditions; and establish baseline conditions for determining the effectiveness of restoration and protection activities. The Butternut Creek is part of the Susquehanna River Basin and was last sampled in 2018 and is slated to be sampled again in 2023.

4.11 Water Assessments by Volunteer Evaluators (WAVE)

Water Assessments by Volunteer Evaluators (WAVE) is citizen-based water quality assessment developed by NY DEC. The purpose of WAVE is to enable citizen scientists to collect biological data (benthic macroinvertebrates) for assessment of water quality on wadeable streams in New York State. There are two WAVE sites located in the Butternut Creek watershed. One site is located at the Otsego County Fairgrounds on the main stem of the creek (Latitude 42.55 Longitude -75.24). The site was last sampled in 2018 where the data collected showed no known water quality impacts. The other site is located behind the Morris Fire Department (Latitude 42.55 Longitude -75.25). The site was last sampled in 2017 where the data showed no known water quality impacts. For more information or to become a WAVE volunteer visit the WAVE website at https://www.dec.ny.gov/chemical/92229.html.

4.12 Professional External Evaluations of Rivers and Streams (PEERS)

The Professional External Evaluations of Rivers and Streams (PEERS) project, started in 2012, partners with professional organizations outside of the DEC that are collecting biological data to assess water quality in rivers and streams. To be eligible to be a PEERS volunteer organization, personnel must satisfy the criteria for professional status. The criteria for sample collection are satisfied by experience conducting professional environmental assessments, while the criteria for sample identification are stricter; requiring Society for Freshwater Science certification in Eastern Groups 1, 2, 3 and 4 (http://www.sfstcp.com/). Like data collected from the WAVE program, they can an important to help assess the overall health and water quality of a stream.

5 Addressing Climate Change

The ability to address climate change must be based on the best available science and common-sense planning utilizing existing partnerships, plans, and innovative thinking. New York State has accounted for the changing climate in the state watershed implementation plan. The Chesapeake Bay Program Partnership has developed models forecasting nutrient load projections through 2025. New York has committed to adopting these new targets beginning with the 2022/2023 milestones.

To address the impacts that climate change will bring, the NY Phase III WIP and the Chesapeake Bay Program Partnership state that each jurisdiction should follow these guiding principles:

- Capitalize on Co-Benefits – Maximize BMP selection to increase climate or coastal resiliency, soil health, flood attenuation, habitat restoration, carbon sequestration, or socio-economic and quality of life benefits.
- Account for and integrate planning and consideration of existing stressors – Consider existing stressors such as future increase in the amount of paved or impervious area, future population growth, and land-use change in establishing reduction targets or selection/prioritizing BMPs.
- Align with existing climate resiliency plans and strategies where feasible– Align with implementation of existing greenhouse gas reduction strategies; coastal/climate adaptation strategies; hazard mitigation plans; floodplain management programs; DoD Installation Natural Resource Management Plans (INRMPs); fisheries/habitat restoration programs, etc.
- Manage for risk and plan for uncertainty – Employ iterative risk management and develop robust and flexible implementation plans to achieve and maintain the established water quality standards in changing, often difficult-to-predict conditions.
- Engage Federal and Local Agencies and Leaders – Work cooperatively with agencies, elected officials, and staff at the local level to provide the best available data on local impacts from climate change and facilitate the modification of existing WIPs to account for these impacts (NYSDEC 2019).

5.1 Defining Climate Change

According to the U.S. Global Change Research Program, climate change is a significant threat to the health of American people through increases in temperature, frequency and intensity of extreme weather events, changes in precipitation, and rising sea levels. Scientists have long understood that the earth's climate is changing. Ever since the 1850's, when scientists realized that carbon dioxide (CO_2) creates a greenhouse effect that warms the earth to make it suitable for life on the planet, they also realized that with industrialization and the release of more carbon dioxide that the "greenhouse" effect would intensify and continue to warm the earth. Since industrialization in the late 19th century, the increased emission of carbon dioxide into the atmosphere from the burning of fossil fuels coupled with deforestation and land-use change, the planet has been warming at a rate previously unseen. The concentration of carbon dioxide in the atmosphere since the industrial revolution has increased by about 40% which is driving this increase in global surface temperatures and other widespread changes in Earth's climate that are unprecedented in the history of modern civilization (Figure 39). While there are natural factors that do drive changes in the climate such as the amount of the sun's energy that enters and leaves the earth's atmosphere naturally, the long-term warming trend cannot be explained by these alone. The only other changing factors that have had an effect on the warming trend are increases in global emissions of greenhouse gases (GHG) (carbon dioxide, methane, nitrous oxide, etc.). In fact, without these increased emissions (and to a lesser extend land-use change), natural conditions alone would have had a cooling effect on the climate (Wuebbles 2017).

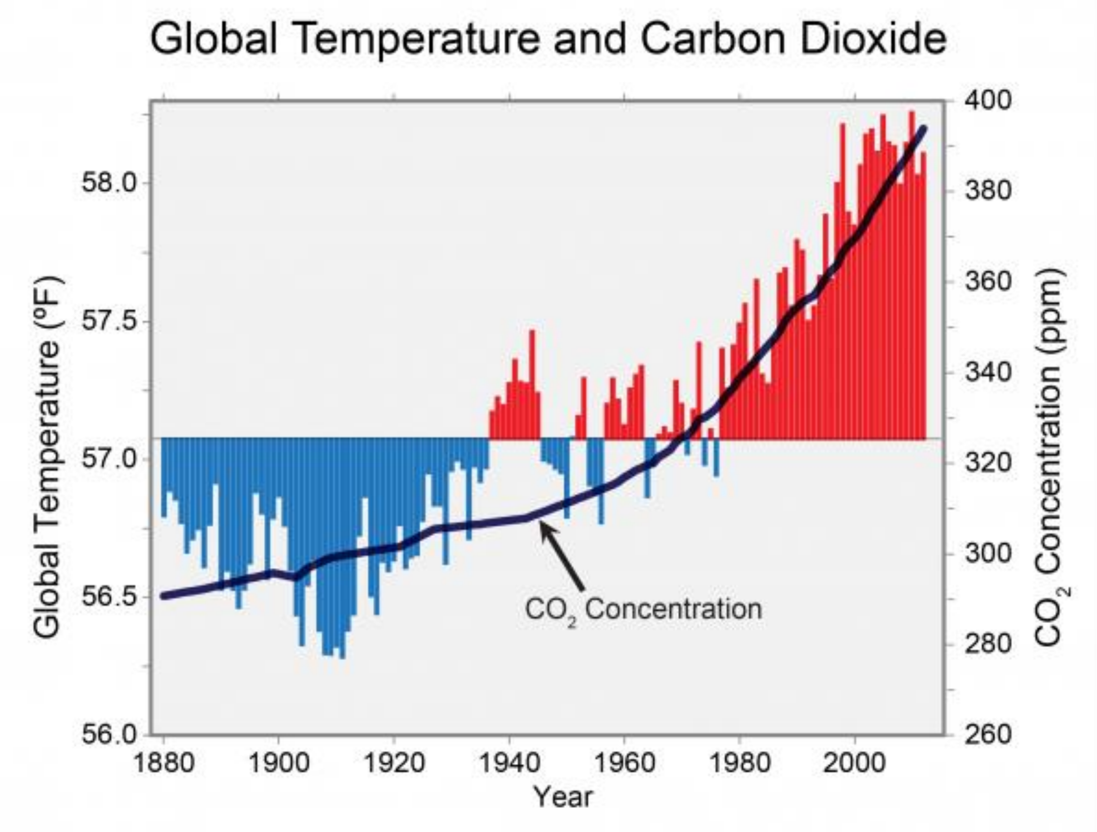


Figure 39. Global temperatures and carbon dioxide concentrations in the atmosphere. Red bars show temperatures above the long-term average, and blue bars indicate temperatures below the long-term average. The black line shows atmospheric carbon dioxide (CO2) concentration in parts per million (ppm). (Figure source: updated from Karl et al. 2009).

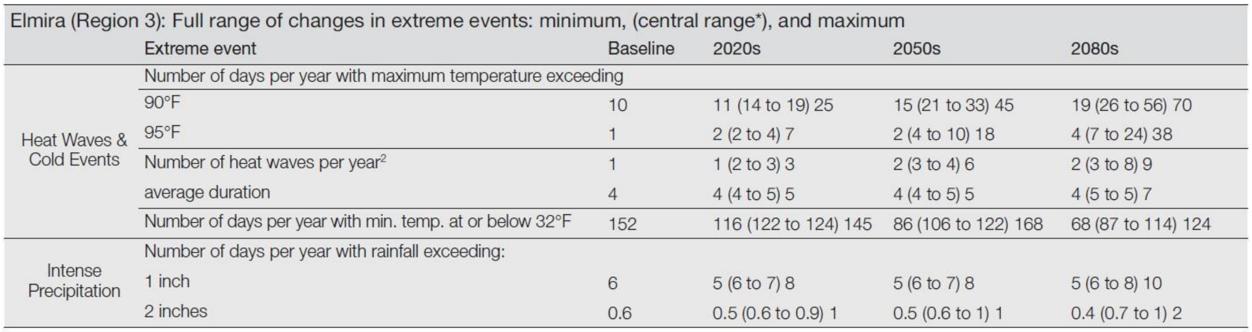
5.2 Expected Climate Conditions

The northeastern United States has experienced a greater increase in extreme precipitation than any other region in the United States, with a more than a 70% increase in the amount of precipitation falling in 100-year precipitation events between 1958 and 2010. In New York, the annual average temperature statewide has risen approximately 2.4°Fahrenheit (Horton 2014). According to a 2014 ClimAID report, Otsego County is expected to warm by 3.7 degrees Fahrenheit by 2020 (Horton 2014). These outcomes can affect local water supplies, increase the risk of weather-related disasters, and induce flooding which will increase nutrient and sediment loads through erosion and nonpoint source pollution testing the capacity of the Butternut Valley to respond to such events. The inability to respond could make compliance with the Chesapeake Bay TMDL challenging, as altered precipitation patterns and increased extreme weather events increase the severity and frequency of hazardous algal blooms and increase nutrient and sediment loads to the Chesapeake Bay watershed.

As the headwaters of the Chesapeake Bay watershed, Otsego County is the first line of defense when it comes to protecting the Bay’s waters. Despite that, over the past three years, the Otsego County Soil and Water Conservation District has been facing significant budgetary constraints, limiting their ability to meet local Bay cleanup targets.

5.3 Expected Impacts

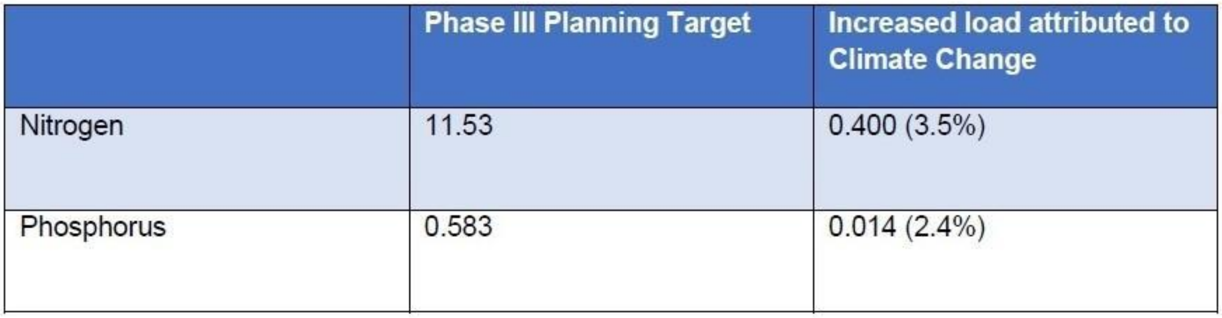
With expected increases in temperatures ranging from 2.0–3.0ºF by the 2020s, 2 3.5–5.5ºF by the 2050s and 4.5–8.5ºF by the 2080s the consequences for more interannual variability in precipitation (increases in winter and decreases in late summer and early fall), more extreme weather events, and an earlier onset to spring, the resulting impact of higher spring flows and heavy rainfall on drier grounds in the summer will result in a change in run-off patterns across the Butternut Valley (Horton 2014). Increased run-off across agricultural lands will increase loadings of nutrients (nitrogen and phosphorus) and sediment into waterways (Tables 22 and 23). However, there may be opportunities to explore new varieties, new crops, and new markets may come with higher temperatures and longer growing seasons.



Elmira (Region 3): Full range of changes in extreme events: minimum, (central range*), and maximum

	Extreme event	Baseline	2020s	2050s	2080s
Heat Waves & Cold Events	Number of days per year with maximum temperature exceeding				
	90°F	10	11 (14 to 19) 25	15 (21 to 33) 45	19 (26 to 56) 70
	95°F	1	2 (2 to 4) 7	2 (4 to 10) 18	4 (7 to 24) 38
	Number of heat waves per year[2]	1	1 (2 to 3) 3	2 (3 to 4) 6	2 (3 to 8) 9
	average duration	4	4 (4 to 5) 5	4 (4 to 5) 5	4 (5 to 5) 7
	Number of days per year with min. temp. at or below 32°F	152	116 (122 to 124) 145	86 (106 to 122) 168	68 (87 to 114) 124
Intense Precipitation	Number of days per year with rainfall exceeding:				
	1 inch	6	5 (6 to 7) 8	5 (6 to 7) 8	5 (6 to 8) 10
	2 inches	0.6	0.5 (0.6 to 0.9) 1	0.5 (0.6 to 1) 1	0.4 (0.7 to 1) 2

Table 22: Extreme event projections: The values in parentheses in rows two through four indicate the central 67% range of the projected model-based changes to highlight where the various global climate model and emissions scenario projections agree. The minimum values of the projections are the first number in each cell and maximum values of the projections are last numbers in each cell (Horton 2014).
* The central range refers to the middle 67% of values from model-based probabilities across the global climate models and greenhouse gas emissions scenarios. Source: Columbia University Center for Climate Systems Research. Data are from USHCN and PCMDI



	Phase III Planning Target	Increased load attributed to Climate Change
Nitrogen	11.53	0.400 (3.5%)
Phosphorus	0.583	0.014 (2.4%)

Table 22: Climate model projections for nutrient loading across the New York portion of the Chesapeake Bay watershed.

With increased loadings, there will be an increased need for best management practices to be implemented. Additionally, water management will be a challenge due to increased heavy precipitation events and more frequent intense summer deficits making the ground hard and more prone to extreme runoff during intense rain events. There is also a disproportionate need within rural areas like the Butternut Creek watershed for additional assistance to help adapt to a changing climate.

Climate change will make compliance with the Chesapeake Bay TMDL more challenging, as altered precipitation patterns and increased extreme weather events increase the severity and frequency of hazardous algal blooms and increase nutrient and sediment loads to the Chesapeake Bay watershed. As the headwaters of the Chesapeake Bay watershed, Otsego County and the Butternut Creek waters is the first line of defense when it comes to protecting the Bay's waters. Despite that, over the past three years, the Otsego County Soil and Water Conservation District has been facing significant budgetary constraints, limiting their ability to meet local Bay cleanup targets.

As mentioned above, one of the largest impacts to more frequent extreme precipitation events is flooding. According to the Butternut Valley Alliance, the Butternut Creek Watershed suffered 500-year flood events in 2005 and 2011. In addition, flash flooding in July 2021 in the Butternut Creek Valley resulted damages exceeding $7 million.

Flood Events per County, 1994–2006

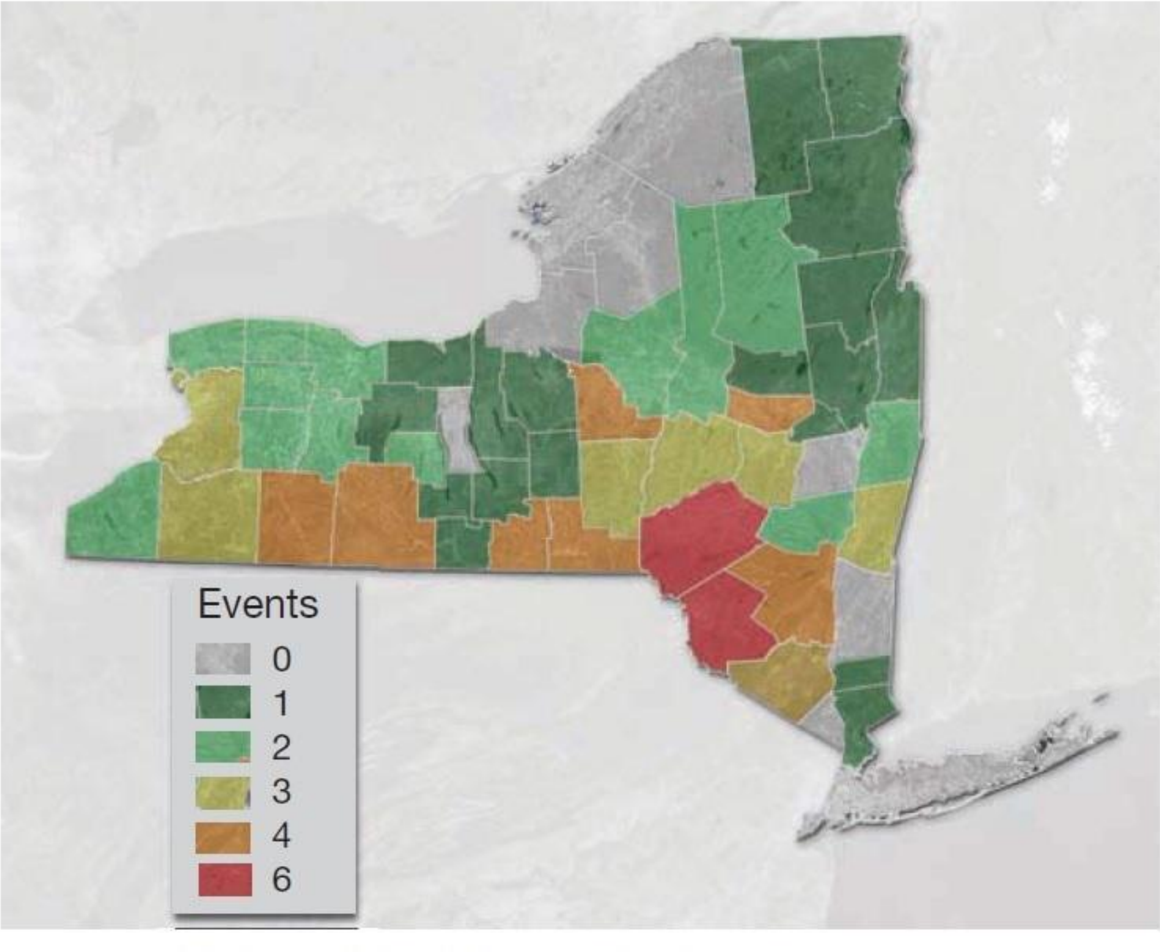


Figure 40: Number of Federal Emergency Management Agency (FEMA)-declared flood disasters in New York State counties (FEMA) (Horton 2014).

5.4 Current Planning Tools

Below is a compilation of planning tools currently in place to address climate change. The plans listed below are arranged from state plans to local planning tools.

5.4.1 Community Risk and Resiliency Act (CRRA) (September 22, 2014 - Bill A06558/S06617-B)

The purpose of the bill is to ensure that state monies, facility-siting regulations, and permits include consideration of the effects of climate risk and extreme-weather events. To meet its obligation to develop guidance for the implementation of CRRA, NYS DEC has proposed a new document, the State Flood Risk Management Guidance (SFRMG). The SFRMG is intended to inform state agencies as they develop program-specific guidance to require that applicants demonstrate consideration of sea-level rise, storm surge, and flooding, as permitted by program-authorizing statutes and operating regulations. The SFRMG incorporates possible future conditions, including the greater risks of coastal flooding presented by sea-level rise and enhanced storm surge, and of inland flooding expected to result from increasingly frequent extreme-precipitation events (CRRA 2014). The bill includes five major provisions:

1. Official Sea-Level Rise Projection
2. Consideration of Sea-Level Rise, Storm Surge and Flooding in Facility Siting, Permitting and Funding.
3. Smart Growth Public Infrastructure Policy Act Criteria:
4. Model Local Laws Concerning Climate Risk
5. Guidance on Natural Resiliency Measures

5.4.2 Climate Action Plan Interim Report (August 2010)

The purpose of the Climate Action Plan was to set a NYS goal of reducing greenhouse gas (GHG) emissions 80 percent below 1990 levels by 2050 (or 80 by 50) and establish the Climate Action Council to determine how to meet the goal. The resulting Climate Action Plan identifies challenges and assesses how economic sectors can reduce GHG emissions and adapt to climate change in a coordinated fashion. The Agriculture, Forestry, and Waste Management Mitigation subgroup (AFW) points to several strategies for renewable energy production, adaptation, and greenhouse gas mitigation while striving to conserve other natural resources (such as water quality, habitat protection, etc.). Agricultural practices included in the AFW portion of the Plan include significant implementation of on-farm anaerobic digesters, perennial biomass production, on-farm energy audits, manure nutrient treatment and recycling, etc. (NYSCAC 2010).

5.4.3 ClimAID: Integrated Assessment for Effective Climate Change Adaptation Strategies in New York State

This state-level assessment of climate change impacts is specifically geared to assist in the development of adaptation strategies. It acknowledges the need to plan for and adapt to climate change impacts in a range of sectors: Water Resources, Coastal Zones, Ecosystems, Agriculture, Energy, Transportation, Telecommunications, and Public Health (Horton 2014).

5.4.4 Regional Greenhouse Gas Initiative (RGGI)

New York and eight other Northeastern and Middle Atlantic states participate in the Regional Greenhouse Gas Initiative (RGGI). RGGI is the first mandatory market-based emissions trading program in the U.S. to reduce carbon dioxide (CO_2) emissions, and the first anywhere to use the cap-and-invest model for reducing pollution. RGGI states invest most of the proceeds from the quarterly CO_2 emission allowance auctions in consumer benefit programs with emphasis on end-use energy efficiency, renewable energy deployment and greenhouse gas abatement technology development (RGGI 2020).

5.4.5 Climate Smart Communities

Members of the Climate Smart Communities program are a network of New York communities engaged in reducing greenhouse gas emissions and improving climate resilience. The program provides guidance to local governments on best practices for mitigating and adapting to climate change. Communities can act in two main ways to minimize the risks of climate change and reduce its long-term costs:

- Reducing GHG Emissions: Starting now to reduce GHG emissions and create permanent carbon sinks that remove GHG emissions from the atmosphere - these actions will help stabilize atmospheric levels of carbon dioxide at manageable levels and avoid severe climatic changes.
- Adapting to a Changing Climate: Altering the built and natural environment in anticipation of predicted climatic changes, or in response to actual changes, will alleviate the risks associated with unavoidable changes in climate.

There are currently no certified communities in the Butternut Creek watershed. However, the Town and New Lisbon and the Village of Laurens have taken the Climate Smart Communities Pledge (NYSCSC 2020).

5.4.6 NYS Climate Resilient Farming Program

The goal of the Climate Resilient Farming program is to reduce the impact of agriculture on climate change (mitigation) and to increase the resiliency of New York State farms in the face of a changing climate (adaptation). Soil and Water Conservation Districts use the Agricultural Environmental Management (AEM) Framework to plan and assess their environmental risks. Historically, farmers working through the AEM framework have only been able to receive funding through the Agricultural Non-Point Source program, for water quality concerns. Climate Resilient Farming fills those gaps by allowing farmers to proactively address risks due to the changing climate while also mitigating their greenhouse gas emissions (NYSDAM 2020).

5.4.7 Cornell Climate Smart Farming Program

The Climate Smart Farming (CSF) program is a voluntary initiative that offers a suite of online tools for farmers in New York to increase farm resiliency to extreme weather and climate variability, increase agricultural productivity and farming incomes sustainably, and reduce greenhouse gas emissions from agricultural production by adopting best management practices. CSF tools include: U.S drought monitor, NOAA Seasonal outlook-temperature, NOAA Seasonal outlook- precipitation, Adapt-N Nitrogen Management tool, Cover crop tool for vegetable growers, USDA Plant Hardiness Map, COMET-Farm greenhouse gas accounting tool, Winter cover crop planting scheduler, and Growing degree day calculator (Cornell University 2020).

5.4.8 Otsego County Hazard Mitigation Plan

Otsego County's Hazard Mitigation Plan (HMP) was updated in 2019 and is a living document that the Butternut Creek watershed's communities can use to reduce their vulnerability to hazards. It forms the foundation for a long-term strategy to reduce disaster losses and creates a framework for decision making to reduce damages to lives, property, and the economy from future disasters (Tetratech, 2019). In order to be up to date with relevant population, climate, and other socio-economic factors, these plans are updated every five years. Like this watershed management plan, development of the Hazard Mitigation Plan was a stakeholder-based process with communities from the Butternut Creek watershed participating to ensure their needs were met. Sections of the plan that address the water quality, habitat, and biological criteria impacted by climate include: drought, extreme temperatures, flood, landslide, severe storm, and severe winter storms (Otsego County 2019).

6 Gap Analysis

During the planning process, several gaps in information were identified. Two meetings were held in January 2021 between the OCCA and the SWCD to identify and discuss gaps in the information related to the BCWMP. Gaps identified are broken into three categories: physical (i.e., the need for more flow monitoring gages), social (i.e., the level or lack thereof of municipal coordination), and biological (i.e. the presence of invasive species in the watershed). A gap analysis was conducted to identify gaps that can be addressed by future courses of research and/or the implementation of new programs and policies. Gap analyses are intended to be a fluid endeavor--meaning that additional gaps in information can be identified as existing gaps are remedied.

6.1 Physical

Gaps in physical data refer to water quality, quantity, and flow; watershed information and conditions; and climate.

- Roads/Roadside Ditches - Data is missing or not easily accessible regarding roads (types and condition), roadside ditches, and maintenance facilities (type and storage material).
- Limited ability, at the municipal scale, to map physical infrastructure assets.
- Regular water temperature data to determine cold water influence areas for protected species.
- Hydraulic modeling and regular flow data to determine channel incision and flooding impacts.
- Historical aerial/LiDAR image and map analysis to examine historic channel occupancy.
- Digital Elevation Model (DEM) correction to increase the accuracy of surface models.
- Culvert assessment data using Cornell Capacity Model
- Additional regular water quality data utilizing continuous monitoring stations at downstream locations of upper and middle Butternut Creek subwatersheds.
- Instream habitat monitoring especially where species at risk occur.
- Data regarding impacts of climate change within the watershed (i.e., flooding, storm events, precipitation).

6.2 Social

Gaps in social data refer to those things that have to do with the human condition, policy, and funding.

- Limited staff capacity, at the municipal level, to manage water quality.
- Lack of centralized/unified approach to watershed management through land-use regulation, cooperative agreement, or other forms of partnership.
- Reliance on private landowners to implement water quality BMPs in partnership with private or quasi-governmental organizations such as the Otsego County Soil and Water Conservation District, the Wetlands Trust, the Otsego Land Trust or the Upper Susquehanna Coalition.
- Limited ability to fund large-scale water quality improvement projects.

- Uneven approach to land-use regulation across the watershed.
- Lack of regular coordination on watershed matters between municipalities.
- Lack of centralized information hub for water quality practices in watershed (Local Highway Departments USC, Wetland Trust, academia, OCSWCD, etc.).

6.3 Biological

Gaps in biological data refer to the flora and fauna both in the stream and within the watershed that have an impact on stream condition.

- Natural resource inventory data regarding flora and fauna, especially as it relates to stream health.
- Inventory and mapping of invasive species present and extent of invasion.
- Regular monitoring of species at risk and spawning trout populations.
- Regular benthic macroinvertebrate monitoring, especially where spawning trout populations are present.

7 Defining Best Management Practices

A best management practice (BMP) can be defined as a tool used to help control water pollution and meet environmental quality goals, i.e., water quality standards. Several types of BMP's have been placed on the land in the Butternut Creek watershed to date, however, more will be recommended to help improve water quality and maintain or meet standards in the Chesapeake Bay watershed. As of 2017, there are over 200 BMP's accredited by the Chesapeake Bay Program, with many more being used that are variations of the 200 defined by the Bay Program. The following is a description of the major BMP's as understood and practiced in New York State. These are summarized from the Phase III New York Watershed Implementation Plan (NYSDEC 2019) and the Quick Reference Guide for Best Management Practices (CBP 2018). For more detailed information, refer to the above two documents.

7.1 BMP's for Cropland/Hay

7.1.1 BMP: Conservation Tillage (Conservation, High Residue, Low Residue)

Conservation tillage involves planting and growing crops with minimal soil disturbance. Much of the vegetation cover or crop residue remains on the soil surface to minimize sediment erosion from bare fields. This best management practice is divided into three separate BMPs:

- Conservation tillage - requires two components a minimum 30% residue coverage at time of planting and a non-inversion tillage method;
- High residue, minimum disturbance tillage - eliminates soil disturbance by plows and maintains a minimum of 60% crop residue cover on the soil surface as measured after planting;
- Low residue tillage - requires 15-29% cover, strip till or no-till, and less than 40% soil disturbance.

7.1.2 BMP: Cover Crops

There are over 104 different cover crop BMP's listed in the Chesapeake Bay Watershed Model. effectiveness estimates vary between species, planting dates, and seeding techniques. Cover crop BMPs are divided into three main categories:

- Traditional Cover Crops - This practice involves planting and growing, but not harvesting, crops with minimal soil disturbance to reduce erosion and nutrients leaching to groundwater or volatilizing by maintaining a vegetative cover on cropland and holding nutrients within the root zone.
- Traditional Cover Crops with Fall Nutrients - Similar to traditional cover crops but includes manure applied after the harvesting of the summer crop but before cover crops are planted. The cover crops may not be harvested in the spring.
- Commodity Cover Crops - Commodity Cover Crops differ from traditional cover crops because they may be harvested for grain, hay or silage but may not receive nutrient applications. The intent of this practice is to modify normal small grain production practices by eliminating fall and winter fertilization so that crops function similarly to cover crops by scavenging available soil nitrogen for part of their life cycle.

7.1.3 BMP: Forest Buffers and Narrow Forest Buffers

Forest Buffers are linear wooded areas, usually accompanied by shrubs and other vegetation, that are adjacent to rivers, streams, and shorelines. Forest buffers help filter nutrients, sediments and other pollutants from runoff as well as remove nutrients from groundwater. Forest buffers can be classified by their width over 35 feet or under 35 feet (narrow). Both types of forest buffers may be applied to cropland and hay (NYSDEC 2019).

7.1.4 BMP: Grass Buffers and Narrow Grass Buffers

Grass buffers are linear strips of grass or other non-woody vegetation maintained between the edge of crop or hay fields and streams or rivers that help filter nutrients and sediment and improve habitat. Grass buffers can be classified by their width over 35 feet or under 35 feet (narrow) (NYSDEC 2019).

7.2 BMP’s for Cropland/Hay/Pasture

7.2.1 BMP: Nutrient Management Core, Rate, Placement, and Timing N/P

Nutrient Management Plans (NMPs) optimize nutrient use to minimize nutrient loss while maintaining crop yield. These plans attempt to maximize use of on-farm nutrients, such as manure and cover crops, and minimize nutrient imports (purchased fertilizer). Sediment reduction is not achieved with NMP’s. These plans must be developed by certified planners in New York, and usually done with local Soil and Water Conservation Districts through the Agriculture Environmental Management (AEM).

The Nutrient Management Plan BMP is divided into Core Nutrient Management and Supplemental Nutrient Management. To determine nutrient reduction possibilities, each acre of cropland is assigned an overall nutrient application goal within a county and when core nutrient management is implemented, the Chesapeake Bay Watershed Model reduces the nutrient application goal. An efficiency credit is then applied if the supplemental components are also implemented. The expected efficiencies within the plan vary depending on the type of cropland covered under the plan.

7.2.2 BMP: Manure Incorporation and Manure Injection

Manure incorporation is defined as mixing of dry, semi-dry or liquid manure, bio-solids, or compost into the soil within a specified timeframe after application, while manure injection allows for the manure to be mechanically applied to the root zone at the time of application, resulting in immediate incorporation. Manure injection provides the greatest level of nutrient reduction loss and reduces odors more effectively compared to traditional manure incorporation. This practice is also compatible with conservation tillage practices. The benefit of both practices is that it prevents a significant portion of the ammonium in manure from volatilizing to ammonia and reduces surface runoff losses relative to surface application. Both practices are applied on a per acre basis and can be implemented and reported for cropland on both low-till and high-till land uses that receive manure, pasture, and hay with manure (NYSDEC 2019).

7.3 BMP’s for Pasture

7.3.1 BMP: Forest Buffer and Narrow Forest Buffer with Exclusion Fencing

Similar to the forest buffers described above, they may also be used to improve the water quality flowing off pastures. Again, buffers should be over 35 feet, and buffers from 10 - 35 feet do not receive full upland restoration credit. The difference with pasture buffers is the installation of exclusion fencing on actively grazed pastures to keep animals out of the restored area (NYSDEC 2019).

7.3.2 BMP: Grass Buffer and Narrow Grass Buffer with Exclusion Fencing

Resembling the grass buffers described above, this best management practice can be used to improve water quality. Again, buffers should be over 35 feet, and buffers from 10 - 35 feet do not receive full upland restoration credit. The difference with pasture buffers is the installation of exclusion fencing on actively grazed pastures to keep animals out of the restored area (NYSDEC 2019).

7.3.3 BMP: Off-stream watering without fencing

This practice requires the use of off-stream drinking water troughs or tanks away from streams. The purpose of this practice is to minimize livestock contact with surface water. Direct contact of pastured livestock with surface water results in manure deposition, streambank erosion, re-suspension of streambed sediments and nutrients, and aquatic habitat degradation. By minimizing this direct contact and providing drinking water away from streams/surface water in a shaded area, there should be less direct manure deposition and less instream and riparian habitat degradation abating the amount of sediments and nutrients entering the streams (NYSDEC 2019). This practice is not preferred unless also installing a buffer with exclusion fencing to ensure animals stay out of the stream.

7.3.4 BMP: Prescribed Grazing/Precision Intensive Rotational Grazing

The purpose of prescribed grazing is to manage forage availability by reducing the time livestock spend grazing on an area. In combination with other aforementioned best management practices, prescribed grazing can:

- improve the uniformity of manure and urine deposition over the pasture allowing nutrients to be taken up by the forage material.
- help prevent soil erosion, reduce surface runoff and improve forage cover, while utilizing animal manures.
- reduce overgrazing and direct access to surface water.

Specific practices include exterior and interior fencing, laneway development or improvement, pasture seeding or improvement, watering systems (well, pond, spring development, pipelines, water troughs), and brush management. There may be major barriers with this practice because switching to prescribed grazing can be a major change in operational management (NYSDEC 2019).

7.3.5 BMP: Horse Pasture Management

Like the above-mentioned BMP, Horse Pasture Management includes rotating grazing to maintain pasture cover and managing high traffic areas. High traffic area management is used to reduce the highest load contributing areas associated with pasture lands. These are often feeding areas, such as hay deposits around fence lines. This practice applies to all pasture lands, not just those with an adjacent stream. Again, when used in conjunction with other BMP’s including exclusion fencing, off-site watering, and buffer installation there can be an improvement in water quality (sediments and nutrients). These practices should be incorporated into any horse pasture management plan (NYSDEC 2019).

7.4 BMP's for Animal/Barnyard Management

7.4.1 BMP: Animal Waste Management Systems

This best management practice is designed for proper handling, storage, and use of wastes from confined animal operations. They include collecting, scraping and/or washing wastes and contaminated runoff from confinement areas into appropriately designed waste storage structures. Waste storage structures are typically made of concrete and require continued operation and maintenance. Covered manure management systems can:

- emit less ammonia.
- prevent losses of liquid manure to surface water and nutrient leachate to groundwater.
- prevent dry manure to come into contact with precipitation or wet soils and prevent nutrient leaching.
- reduce storage and handling loss by reducing the pool of nutrients in the manure available for land application (manure recovery) (NYSDEC 2019).

7.4.2 BMP: Barnyard Runoff Control and Loafing Lot Management

This best management practice is often grouped with other barnyard control practices and is defined as the stabilization of areas intensively used by people, animals, or vehicles by establishing vegetative cover, surfacing with suitable materials, and/or installing needed structures. They include diversions, rainwater gutters, and similar practices. They can be installed as part of a total animal waste management system or as a stand-alone practice, particularly on smaller operations (NYSDEC 2019).

7.4.3 BMP: Dairy Precision Feeding and Forage Management

This best management practice focuses on nutrient source reduction at the feeding end of dairy operations. Approximately two-thirds or more of the imported nutrients to dairy farms come in purchased feed, significant reductions in nutrient imports can be accomplished with changes in ration and crop management. This practice works well in tandem with other management techniques (waste management, stream corridor restoration) to help reduce nutrient additions before they enter surface water. Additionally, these practices can benefit the farmer economically by cutting down on the amount of feed purchased and/or wasted (NYSDEC 2019).

7.5 BMP's for All Agricultural Lands

7.5.1 BMP: Non-Tidal Wetland Restoration

Agricultural wetland restoration activities re-establish natural water flow conditions that existed prior to installing artificial field drainage. Projects can restore or enhance existing wetlands or create a new wetland. Restored wetlands may be any wetland type including forested, scrub-shrub, or emergent marsh (NYSDEC 2019). Properly functioning wetlands serve as sponges on the land to help slow down water flow across the land and help filter out sediment and take up excess nutrients.

7.5.2 BMP: Land Retirement and Alternative Crops

Agricultural land retirement takes marginal, highly erosive, or ceasing operation cropland out of production by establishing permanent vegetative cover such as hay, grasses, shrubs and/or trees. By maintaining a constant cover on these lands, these practices can decrease erosion, take up nutrients and sequester carbon (to aid in combating climate change). This BMP is broken into three categories: alternative crops (warm season grasses); land retirement to agricultural open space; and land retirement to pasture. This BMP is especially important because agricultural land, namely cropland, is one of the highest nutrient sources in the Chesapeake Bay Watershed Model and agricultural land use changes usually result in less nutrient runoff (NYSDEC 2019).

7.5.3 BMP: Soil Conservation and Water Quality Plans

Farm conservation plans, completed through the Agricultural Environmental Management (AEM) program, are a combination of agronomic, management and engineered practices that protect and improve soil productivity and water quality and prevent natural resource deterioration on a farm.

- Soil Conservation Plans - Comprehensive plans that meet USDA-NRCS criteria to help control erosion by modifying operational or structural practices such as crop rotations, tillage practices, or cover crops. Structural practices are longer term and may include: grass waterways in areas with concentrated flow, terraces, diversions, sediment basins and drop structures (NYSDEC 2019).

7.5.4 BMP: Tree Planting

Akin to forest buffer plantings, this practice utilizes tree plantings to stabilize erodible soils and help take up excess nutrients from retired crop or pasture or agricultural open spaces. Trees planted as a riparian buffer do not count for this practice and are a stand-alone best management practice (NYSDEC 2019).

7.5.5 BMP's for Dirt and Gravel Roads and Roadside Ditches

There are currently no Chesapeake Bay Program or NY State DEC accredited practices to remediate for dirt and gravel roads. However, the NY State Phase III WIP (NYSDEC 2019) does recognize the need for erosion and sediment control for these areas. Currently, the Chesapeake Bay Watershed Model only gives credit for practices that control erosion and sedimentation from dirt and gravel road surfaces and does not credit any BMPs implemented to control erosion of roadside ditches and NY historically does not report these BMP's to the Bay Program.

However, local highway departments and the Otsego County Soil and Water Conservation District can utilize several roadway practices to minimize the flow of water across and along rural roads. These include: including hydro-seeding, grade breaks (check dams), under-drains, French mattresses (allowing water under the road through course stone), crown reshaping, profile and cross slope modification, high-water bypass techniques and the use of different surface aggregates. In-stream design structures, such as cross vanes, also protect bridges and culverts. Wetlands and other buffers also can be specifically designed and constructed or restored to capture road ditch runoff to reduce energy, capture sediments and provide opportunity to denitrify atmospheric and automobile exhaust sources of nitrogen (NYSDEC 2019).

Recently, NYS DEC has started to collaborate with NYS SWCC, NYS DAM, SWCDs, and Cornell Local Roads Program to develop a state-wide Rural Roads Program, modeled after the Rural Roads Active Management Program developed by Champlain Watershed Improvement Coalition of New York for the municipalities located in the Lake Champlain watershed. If roadside ditch BMPs are approved by the Bay Program partnership for inclusion in the Watershed Model, NYS DEC will evaluate the overlap with the developing state-wide program (NYSDEC 2019).

7.5.6 BMP's for Septic Wastewater

There are currently no Chesapeake Bay Program or NY State DEC accredited practices to remediate for septic systems. The NY Department of Health or county health departments regulate these systems. New residential systems less than 1,000 gallons per day are required to achieve specific design criteria in NYS DOH regulations. While New York State does not routinely inspect residential septic systems, several watershed-based programs have been developed. The New York Onsite Wastewater Treatment Training Network (OTN)27 is a largely volunteer industry group that provides professional trainings on soil analysis, inspection, and installation of onsite septic systems. In addition, for systems that are failing, the New York Clean Water Infrastructure Act of 2017 established the State Septic System Replacement Fund. The purpose of this fund is to replace existing cesspools and septic systems that are having significant and quantifiable environmental and/or public health impacts to groundwater used for drinking water, or a threatened or impaired waterbody. The State Septic System Replacement Fund is administered by the New York Environmental Facilities Corporation (EFC) and is authorized to reimburse property owners for up to 50% of the eligible costs incurred for eligible septic system projects, up to $10,000. Additionally, financing is also available from the Clean Water State Revolving Fund for projects to construct municipally owned decentralized wastewater treatment systems. The fund provides low-interest funding for new projects or upgrades to address inadequate or failing systems, or to help establish sewer districts and alternative centralized treatment systems, where appropriate. However, properly functioning onsite systems typically provide effective wastewater treatment at a lower cost than centralized treatment plants, particularly in non-urban areas (NYSDEC 2019).

8 Chesapeake Assessment Scenario Tool (CAST)

The Chesapeake Assessment Scenario Tool (CAST) is a web-based model that was developed to aid in watershed planning. The model estimates nitrogen, phosphorus, and sediment loads from the surrounding land to surface water in an area and delivered loads to the Chesapeake Bay. The importance of CAST is that it allows managers to see current loading levels and determine possible best management practices to improve water quality. The tool allows managers to input data regarding location, size and scope of a best management practice and provides estimates of nitrogen, phosphorus, and sediment load reductions for that practice. The tool also provides cost estimates for various best management practices so managers can assess which practice will be most cost effective while achieving the best load reductions and improvements to water quality. The plan therefore allows managers to develop a plan for meeting nutrient and sediment reduction targets (total daily maximum load (TMDL) requirements) for their watershed.

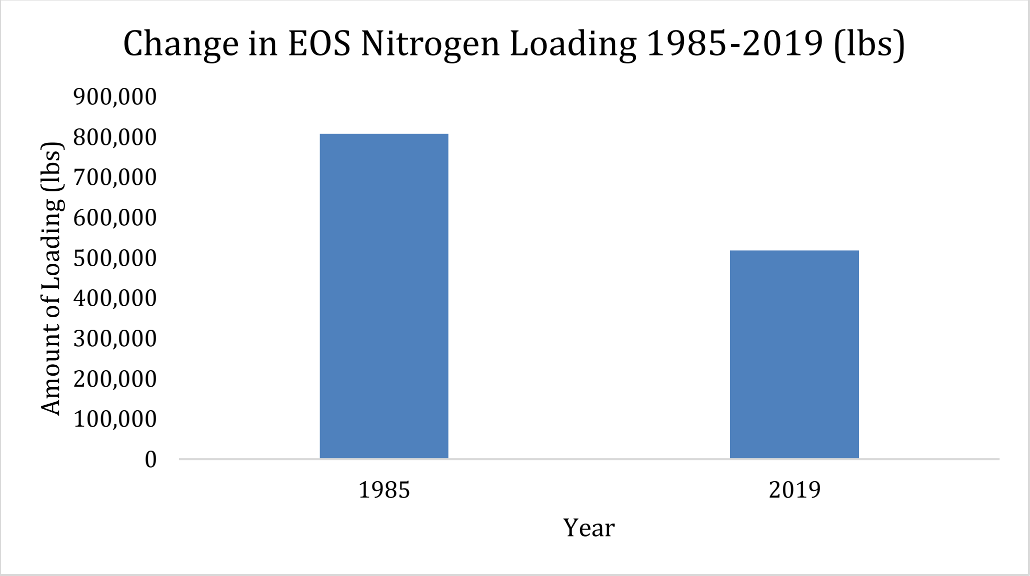
The Chesapeake Assessment Scenario Tool (CAST) was first developed in 2011 by Jessica Rigelman of J7 LLC and Olivia H. Devereux of Devereux Consulting, Inc., with funding provided by U.S. EPA. The purpose of the tool was to offer local planners within the Chesapeake Bay Watershed a tool to provide input into the TMDL Watershed Implementation Plan development process. With continued funding from the U.S. EPA, the functionality of CAST has been expanded to serve multiple needs for environmental planning in the Chesapeake Bay Watershed. As future needs change and the watershed planning process ensues, CAST will continue to evolve to meet the needs of users across the watershed. For more information on the CAST model, see CAST - Home Page (chesapeakebay.net).

8.1 CAST Model Data for the Butternut Creek Watershed

The CAST model measures nitrogen, phosphorous, and sediment loading levels in two ways:

- **Edge of Stream:** the amount of pollutant load (lbs./year) discharged at the edge of a stream or other waterbody; and
- **Edge of Tide**: the proportion of pollutant load (lbs./year) that reaches the Chesapeake Bay

Water quality data for the original CAST model was from 1985. In the Butternut Creek watershed (River Segment (N36077SU1_0080_0300), the 1985 data show total nitrogen loading measured at the Edge of Stream level at 808,023 lbs./year, total phosphorus loadings at 48,203 lbs./year, and total sediments loading at 72,662,856 lbs./year. As of 2019, total nitrogen loadings were 517,594 lbs./year, total phosphorus loading were 22,100 lbs./year, and total sediment loadings were 50,630,156 lbs./year. During this time period, there were two watershed implementation plans in place with multiple best management practices being installed. Overall reductions in edge of stream nutrient and sediment loads are as follows: total nitrogen – 290,429 lbs./year, total phosphorus – 26,103 lbs./year, total sediment – 22,032,700 lbs./year. The current Phase III Watershed Implementation Plan calls for further reductions to be met. These targets are: total nitrogen - 534,198 lbs./year, total phosphorus – 21,783 lbs./year, and total sediment – 51,085, 780 lbs./year. Figures 41 and 42 illustrate the change in Edge of Stream loading in the Butternut Creek Watershed between 1985 and 2019.



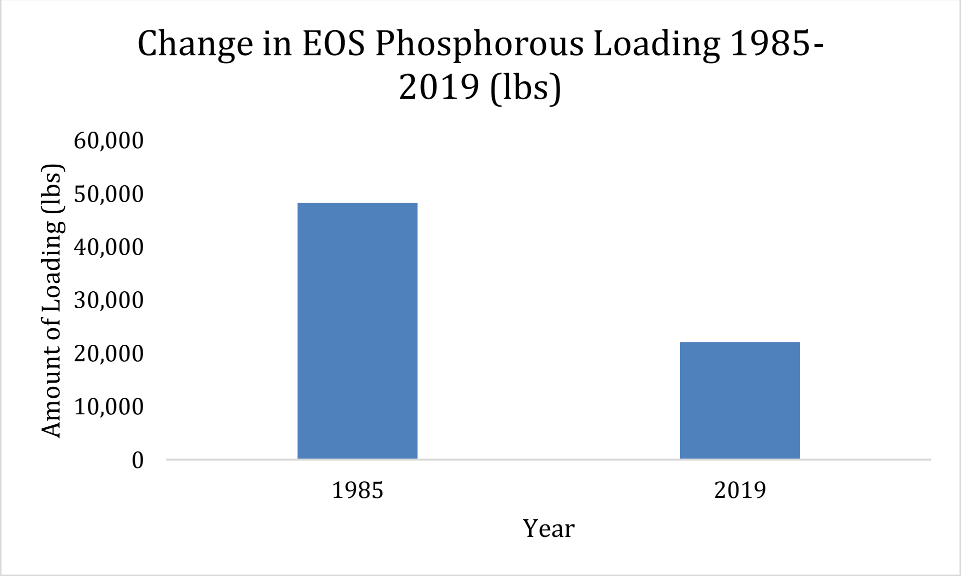


Figure 41 and 42: Change in Edge of Stream Nitrogen and Phosphorous Loading between 1985-2019

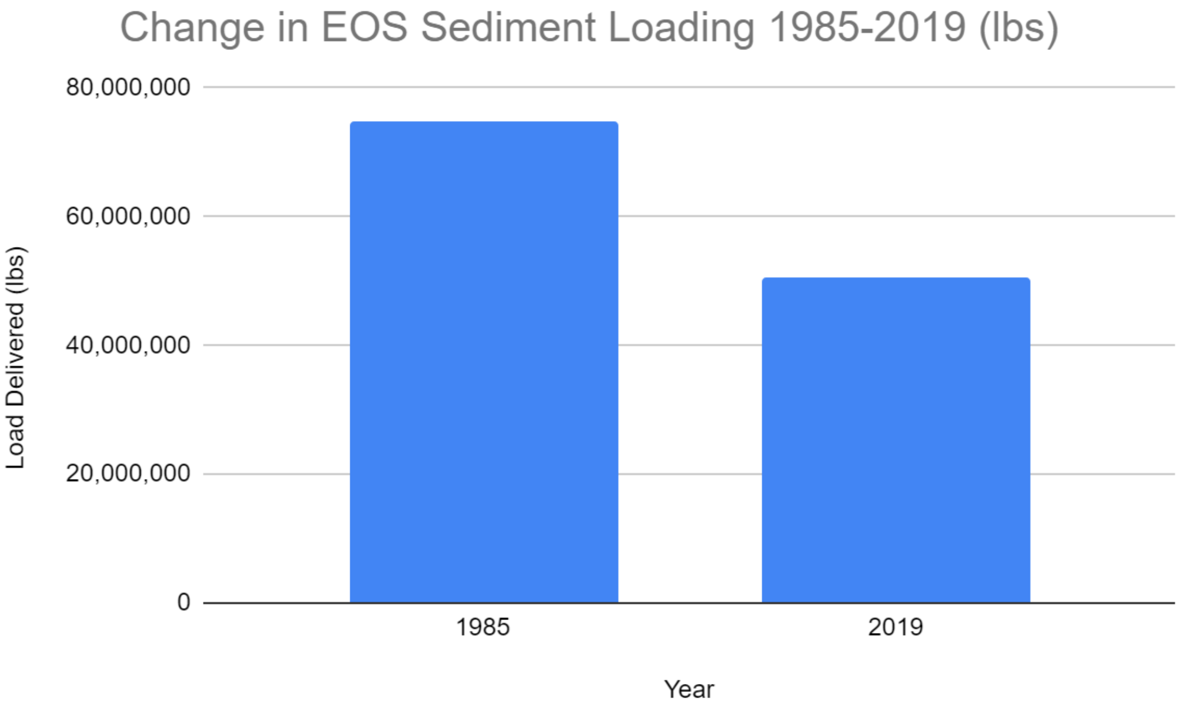


Figure 42: Change in Edge of Stream Sediment Loading between 1985-2019

To evaluate the change in nutrient and sediment loading delivered at the “edge of tide” scale between 1985-2019, OCCA used the CAST model to visualize progress made to date. As shown in the figures below, there have been substantial reductions in nitrogen, phosphorous, and sediment loading at the edge of tide scale. It can be argued that a large part of the reduction in loading can be equated to the increased amount of implemented water quality best management practices and the consolidation of the local agricultural industry--in particular the sharp decline in the dairy industry experienced over the past 30 years.

Loading from non-regulated agriculture constituted the majority of the load measured at the edge of tide scale (70.47% in 1985 and 54.97% in 2019 respectively). Of note is the 50% decline in nitrogen loading from the non-regulated agriculture sector. It can be argued that the consolidation of the agricultural sector coupled with the increased implementation of water quality best management practices contributed to the decline in nitrogen loading from this sector. Also of note is the substantial percentage of loading coming from the natural sector. In 2019, nitrogen loading from the natural sector accounted for 30% of the total load measured at the edge of tide scale. Figure 43 provides an overview of nitrogen loading at the edge of tide scale between 1985 and 2019.

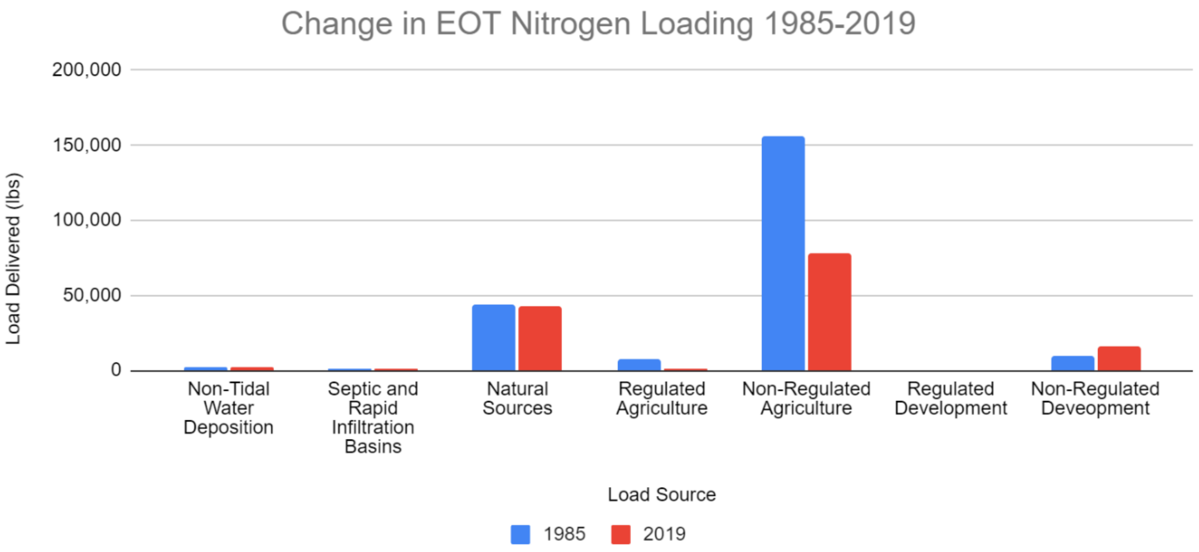


Figure 43: Change in Edge of Tide Nitrogen Loading 1985-2019

Trends related to phosphorous loading measured at the edge of tide scale are similar to the changes in nitrogen loading discussed above. Phosphorous loading from non-regulated agriculture and natural sources accounted for 92.89% (1985) and 83.42% (2019) respectively. The load share of non-regulated development increased by 62.09% between 1985 and 2019. While the relative amount of phosphorous loading is small, the increase in loading from non-regulated development merits additional scrutiny. Changes in phosphorous loading measured at the edge of tide scale are shown in Figure 44.

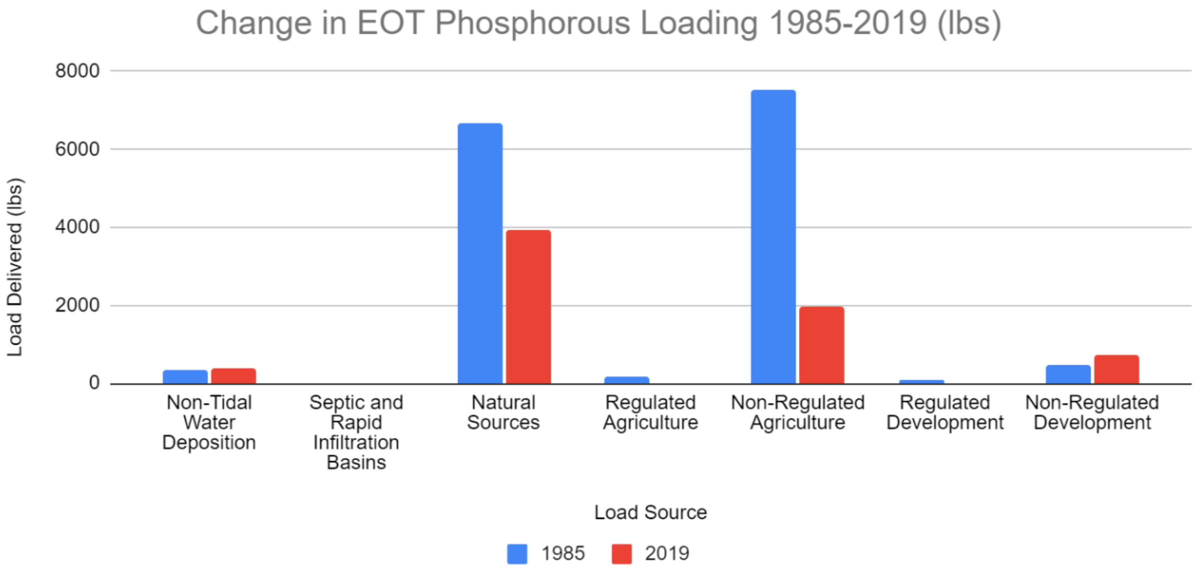


Figure 44: Change in Edge of Tide Phosphorus Loading 1985-2019

Natural sources and non-regulated agriculture contributed the majority of edge of tide sediment loading in the Butternut Creek Watershed between 1985 and 2019 (92.17% in 1985 and 83.96% in 2019). It is worth noting that there was a 68.17% decline in sediment loading from non-regulated agriculture. Of concern is the 71.74% increase in sediment loading from non-regulated development. It is recommended that further study be done to evaluate the percentage of properties in the watershed with an adopted Stormwater Pollution Prevention Plan (SWPPP). Figure 45 shows the change in sediment loading levels at the edge of tide scale between 1985 and 2019.

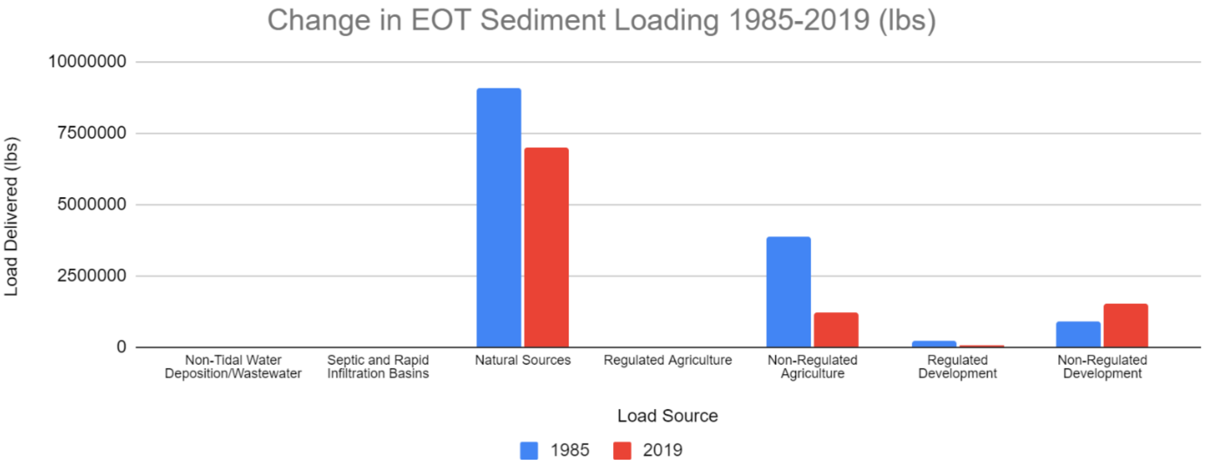


Figure 45: Change in Edge of Tide Sediment Loading 1985-2019

In addition to gathering data on nutrient loading levels in the Butternut Creek Watershed, the Steering Committee utilized CAST to evaluate the extent of credited BMP implementation and to gather the annualized cost data for each BMP. According to Devereaux and Rigelman (2011), there are three factors which help guide BMP selection:

1) Effectiveness in reducing total pollutants
2) Cost-effective unit cost of pollutant reduction
3) The presence of co-benefits that meet local TMDLs and priorities, or not

Cost effectiveness data were also gathered given the limited available funding for environmental improvement projects in general. Annualized cost data or, the annual average cost, were gathered as well. This data are intended to inform policymakers on the maintenance needs of existing BMPs and present a need for sustained funding to ensure their longevity.

Cost data gathered from CAST are estimated in 2018 dollars (Devereaux & Rigelman, 2021). With respect to total annualized cost, capital and opportunity costs are amortized over the BMP's lifespan and added to operation and maintenance costs. The interest rate for capital and opportunity costs is 5%. It is important to note that costs represent a single year of cost rather than the cost over the entire lifespan of the practice. Devereaux & Rigelman (2021) note that the reason for this is two-fold. First, once the Bay TMDL deadline of 2025 is met, BMPS will need to remain in place and new BMPs will need to be implemented to offset future growth. Second, it is difficult to predict when a BMP is going to be implemented. The use of annualized cost data makes the comparison off various loading scenarios more comparable. Tables 23 and 24 show a comparison of annualized cost data for 2019 and estimated annualized cost data for 2025 based on environmentally optimistic conditions. Table 25 shows the cost-effectiveness data for BMPs implemented in the Butternut Creek Watershed in 2019.

Best Management Practice	Lifespan (Years)	Capital Cost ($)	Capital Unit	O&M	O&M Units	Opportunity Cost	Total Annualized Cost Per Unit	Units Implemented	Total Cost
Nutrient Application Management Core Nitrogen	5	$8.86	$/acre	$3.60	$/acre/year	$0.00	$5.65	425.02	$2,401.36
Nutrient Application Management Rate Nitrogen	1	$8.39	$/acre	0	$/acre/year	0	$8.81	425.02	$3,744.43
Nutrient Application Management Placement Nitrogen	1	$8.39	$/acre	0	$/acre/year	0	$8.81	425.02	$3,744.43
Nutrient Application Management Timing Nitrogen	1	$8.39	$/acre	0	$/acre/year	0	$8.81	238.77	$2,103.59
Nutrient Application Management Core Phosphorus	5	$8.86	$/acre	$4.20	$/acre/year	$0.00	$6.25	425.02	$2,656.38
Nutrient Application Management Rate Phosphorus	1	$8.39	$/acre	0	$/acre/year	0	$8.81	425.02	$3,744.43
Nutrient Application Management Placement Phosphorus	1	$8.39	$/acre	0	$/acre/year	0	$8.81	425.02	$3,744.43
Nutrient Application Management Timing Phosphorus	1	$8.39	$/acre	0	$/acre/year	0	$8.81	330.34	$2,910.30
Conservation Tillage	1	$0.00	$/acre	$0.00	$/acre/year	$0.00	$0.00	42.03	$0.00
Low Residue Tillage	1	$0.00	$/acre	$0.00	$/acre/year	$0.00	$0.00	30.02	$0.00
High Residue Tillage	1	0	$/acre	0	$/acre/year	0	0	150.11	$0.00
Cover Crop	1	$75.44	$/acre	$0.00	$/acre/year	$0.00	$79.21	16.81	$1,331.66
Cover Crop with Fall Nutrients	1	75.44	$/acre	0	$/acre/year	0	79.21	3.60	$285.36
Prescribed Grazing	1	$64.88	$/acre	$0.00	$/acre/year	$0.00	$68.12	173.23	$11,800.65
Horse Pasture Management	5	$297.89	$/acre	$2.98	$/acre/year	$0.00	$71.79	3.76	$270.19
Forest Buffers on Fenced Pasture Corridor	30	$7,396	$/acre	$244.88	$/acre/year	$472.73	$749.70	56.57	$42,411.78
Grass Buffers on Fenced Pasture Corridor	18	$4,134.62	$/acre	$197.70	$/acre/year	$472.73	$575.04	29.46	$16,942.60
Forest Buffers	40	$4,165.54	$/acre	$83.31	$/acre/year	$1,096.76	$380.91	7.31	$2,784.00
Wetland Restoration	15	$582.65	$/acre	$52.11	$/acre/year	$1,096.76	$163.08	3.28	$535.22

Land Retirement	10	$498.83	$/acre	$14.96	$/acre/year	$1,096.76	$134.40	8.18	$1,099.09
Soil and Water Conservation Plan	1	$28.52	$/acre	$0.00	$/acre/year	$0.00	$29.95	1439.96	$43,126.84
Non-Urban Stream Restoration	20	$513.24	$/foot	$64.16	$/foot/year	$0.00	$105.34	3.53	$371.68
Livestock Waste Management Systems	15	$995.12	$/animal unit	$29.85	$/animal unit/year	$0.00	$125.72	684.69	$86,079.45
Barnyard Runoff Control	15	$6,802.42	$/acre	$0.68	$/acre/year	$0.00	$656.04	0.06	$39.36
Loafing Lot Management	10	$154,966.60	$/acre	$25.00	$/acre/year	$0.00	$20,093.89	0.06	$1,205.63
Infiltration Practices	35	$28,328.71	$/acre treated	$1,291.43	$/acre treated/year	$1,757.80	$3,109.40	0.67	$2,088.76
Erosion and Sediment Control	1	$1,439.26	$/acre	$0.00	$/acre/year	0	$1,511.22	0.17	$263.46
Urban Forest Buffers	40	$4,165.55	$/acre	$0.00	$/acre/year	0	$242.76	0.24	$57.96
Urban Tree Planting	40	$1,448.25	$/acre	$21.72	$/acre/year	0	$106.12	0.03	$2.87
TOTAL ANNUALIZED COST PER YEAR									**$235,745.91**

Table 23: Total Annualized Cost of BMPs Implemented in the Butternut Creek Watershed

Best Management Practice	Lifespan (Years)	Capital Cost ($)	Capital Unit	O&M	O&M Units	Opportunity Cost	Opportunity Cost Units	Total Annualized Cost Per Unit	Units Implemented	Total Cost
Nutrient Application Management Core Nitrogen	5	$8.86	$/acre	$3.60	$/acre/year	$0.00	$/acre	$5.65	3098.98	$17,509.21
Nutrient Application Management Rate Nitrogen	1	$8.39	$/acre	0	$/acre/year	0	$/acre	$8.81	3098.98	$27,301.97
Nutrient Application Management Placement Nitrogen	1	$8.39	$/acre	0	$/acre/year	0	$/acre	$8.81	3098.98	$27,301.97
Nutrient Application Management Timing Nitrogen	1	$8.39	$/acre	0	$/acre/year	0	$/acre	$8.81	3098.98	$27,301.97
Nutrient Application Management Core Phosphorus	5	$8.86	$/acre	$4.20	$/acre/year	$0.00	$/acre	$6.25	3098.98	$19,368.60
Nutrient Application Management Rate Phosphorus	1	$8.39	$/acre	0	$/acre/year	0	$/acre	$8.81	3098.98	$27,301.97
Nutrient Application Management Placement Phosphorus	1	$8.39	$/acre	0	$/acre/year	0	$/acre	$8.81	3098.98	$27,301.97
Nutrient Application Management Timing Phosphorus	1	$8.39	$/acre	0	$/acre/year	0	$/acre	$8.81	3098.98	$27,301.97
Conservation Tillage	1	$0.00	$/acre	$0.00	$/acre/year	$0.00	$/acre	$0.00	26.28	0
Low Residue Tillage	1	$0.00	$/acre	$0.00	$/acre/year	$0.00	$/acre	$0.00	24.33	0
Cover Crop	1	$75.44	$/acre	$0.00	$/acre/year	$0.00	$/acre	$79.21	17.03	$1,348.95
Prescribed Grazing	1	$64.88	$/acre	$0.00	$/acre/year	$0.00	$/acre	$68.12	101.88	$6,940.07
Horse Pasture Management	5	$297.89	$/acre	$2.98	$/acre/year	$0.00	$/acre	$71.79	7.6	$545.60
Forest Buffers on Fenced Pasture Corridor	30	$7,396	$/acre	$244.88	$/acre/year	$472.73	$/acre	$749.70	10.94	$8,201.72
Grass Buffers on Fenced Pasture Corridor	18	$4,134.62	$/acre	$197.70	$/acre/year	$472.73	$/acre	$575.04	2.34	$1,345.59
Forest Buffers	40	$4,165	$/acre	$83.3	$/acre/year	$1,096.76	$/acre	$380.91	12.9	$4,913.74

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Wetland Restoration	15	$582.65	$/acre	$52.11	$/acre/year	$1,096.76	$/acre	$163.08	6.63	$1,081.21
Land Retirement	10	$498.83	$/acre	$14.96	$/acre/year	$1,096.76	$/acre	$134.40	3.48	$467.71
Soil and Water Conservation Plan	1	$28.52	$/acre	$0.00	$/acre/year	$0.00	$/acre	$29.95	179.67	$5,381.12
Non-Urban Stream Restoration	20	$513.24	$/foot	$64.16	$/foot/year	$0.00	$/foot	$105.34	7.06	$743.70
Livestock Waste Management Systems	15	$995.12	$/animal unit	$29.85	$/animal unit/year	$0.00	$/animal unit	$125.72	221.56	$27,854.52
Barnyard Runoff Control	15	$6,802.42	$/acre	$0.68	$/acre/year	$0.00	$/acre	$656.04	0.06	$39.36
Loafing Lot Management	10	$154,966.60	$/acre	$25.00	$/acre/year	$0.00	$/acre	$20,093.89	0.06	$1,205.63
Dairy Precision Feeding	1	$0.00	$/animal unit	($43.99)	$/animal unit	$0.00	$/animal unit	($43.99)	220.43	-$9,696.72
Wet Ponds & Wetlands	32	$13,879.63	$/acre treated	$436.15	$/acre treated/year	$703.12	$/acre treated	$1,349.61	159.77	$215,627.19
Infiltration Practices	35	$28,328.71	$/acre treated	$1,291.43	$/acre treated/year	$1,757.80	$/acre treated	$3,109.40	479.32	$1,490,388.44
Filtering Practices	22	$31,087.00	$/acre treated	$921.07	$/acre treated/year	$439.45	$/acre treated	$3,304.76	159.77	$528,009.26
BioRetention	22	$47,507.00	$/acre treated	$3,445.66	$/acre treated/year	$1,054.68	$/acre treated	$7,107.56	479.32	$3,406,774.71
Permeable Pavement	22	$199,521.40	$/acre treated	$14,170.16	$/acre treated/year	$17,578.00	$/acre treated	$30,206.80	15.98	$482,621.11
Vegetated Open Channel	20	$53,794.64	$/acre treated	$2,740.84	$/acre treated/year	$703.12	$/acre treated	$7,092.62	31.95	$226,640.90
Urban Filter Strips	10	$13,825.87	$/acre treated	$316.65	$/acre treated/yea	$7,031.20	$/acre treated	$2,458.72	31.95	$78,567.09

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Erosion and Sediment Control	1	$1,439.26	$/acre	$0.00	$/acre/year	0	$/acre	$1,511.22	0.17	$256.18
Urban Forest Buffers	40	$4,165.55	$/acre	$0.00	$/acre/year	0	$/acre	$242.76	19.03	$4,620.24
Urban Tree Planting	40	$1,448.25	$/acre	$21.72	$/acre/year	0	$/acre	$106.12	12.31	$1,306.51
Urban Nutrient Management	1	$1.90	$/acre	$0.00	$/acre/year	0	$/acre	$1.99	123.12	$245.00
Street Sweeping	5	$1,894.10	$/acre	$6,182.33	$/acre/year	0	$/acre	$6,619.82	15.79	$104,502.04
Forest Harvesting Practices	1	56.45	$/acre	0	$/acre/year	0	$/acre	59.27	801.05	$47,478.23
TOTAL ANNUALIZED COST										**$6,838,098.75**

Table 24: Estimated Annualized Cost in 2025 for BMPs implemented in the Butternut Creek Watershed under Environmentally Optimistic Conditions

According to the data presented in Table 25, in 2019, the total annualized cost for BMPs implemented in the Butternut Creek Watershed totaled $235,745.91. BMPs with high annualized costs included livestock waste management systems, loafing lot management, and fenced forested buffers on pasture corridors. Under environmentally optimistic conditions in 2025, the estimated total annualized cost of BMPs implemented in the watershed jumped sharply to $6,838,098.97. It is important to note that the large figure in Table 25 may not represent actual conditions on the ground or adequately account for the ability of state and local agencies to meet the estimated level of BMP implementation. Rather, this comparison is intended to show the significant costs associated with maintaining existing practices and the need to secure additional funding for BMP maintenance and evaluation. It is worth noting that the limited financial capacity of municipalities in the watershed to contribute funds to BMP maintenance projects will require fiscal support from state, private, and/or federal sources in the future.

Best Management Practice	Unit	$/Unit BMP	TN Lbs. Reduced Per Unit	Nitrogen $/lb. reduced/year	TP Lbs. Reduced Per Unit	Phosphorus $/lb. reduced/year	TSS Lbs. Reduced Per Unit	Sediment $/lb. reduced/year
Nutrient Application Management Core Nitrogen	Acres	5.65	0.22036	$25.64	-9.00E-05	-$66,111.07	0	$0.00
Nutrient Application Management Rate Nitrogen	Acres	8.81	0.14994	$58.76	0	$0.00	0	$0.00
Nutrient Application Management Placement	Acres	8.81	0.12024	$73.27	0	$0.00	0	$0.00

Nitrogen								
Nutrient Application Management Timing Nitrogen	Acres	8.81	0.22491	$39.17	0	$0.00	0	$0.00
Nutrient Application Management Core Phosphorus	Acres	6.25	0	$0.00	0.00996	$627.74	0	$0.00
Nutrient Application Management Rate Phosphorus	Acres	8.81	0	$0.00	0.00389	$2,262.17	0	$0.00
Nutrient Application Management Placement Phosphorus	Acres	8.81	0	$0.00	0.01022	$861.78	0	$0.00
Nutrient Application Management Timing Phosphorus	Acres	8.81	0	$0.00	0.00243	$3,619.47	0	$0.00
Conservation Tillage	Acres	0.00	0.88756	$0.00	0.06798	$0.00	202.84116	$0.00
Low Residue Tillage	Acres	0.00	0.44378	$0.00	0.017	$0.00	89.05424	$0.00
High Residue Tillage	Acres	0.00	1.24258	$0.00	0.09631	$0.00	390.83555	$0.00
Cover Crop	Acres	79.21	0.64786	$122.26	0	$0.00	0	$0.00
Cover Crop with Fall Nutrients	Acres	79.21	0.53254	$148.74	0	$0.00	0	$0.00
Prescribed Grazing	Acres	68.12	0.35259	$193.20	0.03711	$1,835.40	0.26599	$244.72
Horse Pasture Management	Acres	71.79	0	$0.00	0.03093	$2,321.14	0.35259	$211.01
Forest Buffers on Fenced Pasture Corridor	Acres in Buffers	1,575.67	16.25951	$96.91	6.77689	$232.51	3062.96432	$0.51
Grass Buffers on Fenced Pasture Corridor	Acres in Buffers	1,422.03	15.38265	$92.44	6.48877	$219.15	3068.4635	$0.46
Forest Buffers	Acres in Buffers	380.91	14.9687	$25.45	0.25724	$1,480.73	316.86185	$1.20
Wetland Restoration	Acres	163.08	8.22339	$19.83	0.23176	$703.66	215.22907	$0.76
Land Retirement	Acres	134.40	3.72106	$36.12	-0.19463	-$690.56	144.51876	$0.93
Soil and Water Conservation Plan	Acres	29.95	0.20313	$147.44	0.01403	$2,134.21	23.52649	$1.27
Non-Urban Stream Restoration	Feet	105.34	0.03081	$3,419.13	2.97E-02	$3,548.66	80.20984	$1.31
Livestock Waste Management	Animal	125.7	3.6375	$34.56	0.17719	$709.52	0	$0.00

Systems	Units	2						
Barnyard Runoff Control	Acres	656.04	143.49884	$4.57	6.76058	$97.04	2498.14465	$0.26
Loafing Lot Management	Acres	20,093.89	143.49884	$140.03	6.76058	$2,972.21	2498.14465	$8.04
Infiltration Practices	Acres Treated	2,939.98	4.27106	$688.35	0.2578	$11,404.15	1058.27496	$2.78
Erosion and Sediment Control	Acres	1,511.22	0	$0.00	0	$0.00	4226.9903	$0.36
Urban Forest Buffers	Acres in Buffers	242.76	4.65676	$52.13	0.38101	$637.15	879.00232	$0.28
Urban Tree Planting	Acres	46.66	3.42484	$13.62	0.24554	$190.03	401.5824	$0.12

Table 25: Cost Effectiveness of Implemented BMPs in the Butternut Creek Watershed in 2019

According to the data gathered from Table 25, buffering, loafing lot management, and barnyard runoff control represented the most cost effective BMPs with respect to the total amount of N, P, and S reduced per unit implemented. Additional outreach should be conducted to landowners with eligible sites for buffer projects and to farmers who have expressed interest in barnyard runoff control projects or loafing lot management practices.

8 Priority Projects

Given the large geographic area within the Butternut Creek Watershed coupled with the limited resources of the municipalities and organizations operating in the watershed, the Steering Committee identified eight priority projects designed to increase BMP implementation, protect water quality, and increase the technical capacity of local governments to manage their local watershed. The Priority Projects are intended to be dynamic in nature. Projects can be amended, replaced, or revised to reflect watershed priorities. As of May 2021, the eleven priority projects are:

- Develop the capacity to implement the Butternut Creek Watershed Management Plan
- Develop a County-Wide Stream Restoration Program
- Right-Size High Priority Culverts in the Butternut Creek Watershed
- Create and implement a Riparian Buffer Survivability Program
- Identify high-priority bridges for repair and replacement using best available technology to protect water quality
- Create a One-Stop Shop for Data in Butternut Creek Watershed
- Increase the Number of Certified Nutrient Management Planners Serving Otsego County
- Increase Attendance and Stakeholder Participation at the SWCD Highway Superintendent Training Programs
- Increase and Conserve Existing Public Access to the Butternut Creek
- Increase capacity of the Otsego County Conservation Association's Citizen Science Monitoring Program
- Identify and secure funding to implement key habitat restoration projects throughout the Butternut Creek Watershed

Each priority project contains several action steps intended to provide an achievable path to implementation. A more in-depth Implementation Strategy is included in Section 9.

I. Priority Project 1: Develop the Capacity to Implement the Butternut Creek Watershed Management Plan

- **Rationale:** There are several entities working in the Butternut Watershed in the field of watershed management including the Upper Susquehanna Coalition, Otsego County SWCD, OLT, BVA, DEC, OCCA, and the Wetlands Trust. In addition, each of the nine municipalities in the watershed have their own respective Town/Planning Boards each having their own priorities. As such, it is imperative that watershed management activities are implemented in a coordinated manner.

- **Action Step #1:** Reactivate the Otsego County Water Quality Coordinating Committee.

- **Action Step #2:** Hire a Watershed Coordinator to identify and leverage State and Federal funding sources to implement water quality projects in the Butternut Creek.

- **Action Step #3**: Work with area nonprofits such as BVA to integrate plan-related information into annual newsletters.

- **Action Step #4:** Regularly attend local government meetings to keep elected officials apprised of progress related to the implementation of the Butternut Creek Watershed Management Plan.

II. Priority Project 2: Design and Implement a Streambank Restoration Program Serving Otsego County

- **Rationale:** Streambank restoration projects, if designed and implemented correctly, can yield substantial water quality benefits. The 2020 Butternut Creek Physical Assessment identified 192 active streambank erosion sites and 241 potential areas where riparian buffers could be installed.

  Currently, limited municipal resources, limited engineering and design capacity, and limited staff capacity at the Otsego County SWCD have contributed to a backlog of stream restoration projects. The proposed Otsego County Stream Program, modeled after successful efforts in Chemung and Steuben County New York, can create a self-sustaining, efficient, and versatile approach to streambank restoration projects in the Butternut Creek Watershed and throughout Otsego County.

- **Action Step #1:** Otsego County SWCD shall work with partner agencies to review, redesign, and secure municipal cooperation to participate in the Otsego County Streambank Restoration Program.

- **Action Step #2:** Secure funding from state and federal sources to increase the capacity of the Otsego County SWCD to implement the Otsego County Streambank Restoration Program.

- **Action Step #3**: Design project prioritization system to rank high-priority streambank restoration projects for implementation.

- **Action Step #4:** Identify and implement pilot streambank restoration projects and develop project evaluation framework intended to improve project efficiency and service delivery.

III. Priority Project #3: Right-Size High Priority Culverts in the Butternut Creek Watershed

- **Rationale:** Culverts provide numerous benefits to humans and wildlife alike. They allow humans to cross water while fish and other wildlife species cross underneath. Poorly designed culverts can lead to numerous issues which result in increased flood damaged, negative water quality impacts, and reduced habitat connectivity. Between 2016 and 2020, the Otsego County SWCD evaluated the condition of 462 stream crossings in the Butternut Creek Watershed as part of the Butternut Creek Watershed Physical Assessment and found that 56% of the crossings had either severe or significant barriers limiting water flow, habitat connectivity, and increasing the potential for flood damage during extreme weather events. Limited staff and financial capacity of local highway departments have created a need to engineer and design, fund, and implement culvert replacements and repairs throughout the watershed.

- **Action Step #1:** The Butternut Creek Watershed Coordinator will work with local Highway Superintendents to apply for and secure state/federal funding to implement culvert replacement projects.

- **Action Step #2:** The Otsego County SWCD and partner organizations will create a training program for local college students to monitor and evaluate the conditions of culverts in the Butternut Creek Watershed.

- **Action Step #3:** The Otsego County SWCD and partner organizations will regularly conduct public outreach activities and trainings to municipalities throughout the watershed to demonstrate the importance of culvert rightsizing following the guidelines of the North Atlantic Aquatic Connectivity Collaborative (NAACC).

- **Action Step #4:** The Otsego County SWCD and partner organizations shall identify and secure funding to sustain outreach efforts surrounding culvert replacement and rightsizing. Priority shall be given to crossings classified as “severe or significant” during the 2020 Butternut Creek Physical Assessment.

IV. Priority Project #4: Create and Implement a Riparian Buffer Survivability Program

- **Rationale:** Riparian buffers provide critical water quality, streambank stabilization, habitat, and flood mitigation benefits. According to the CAST Model, as of 2019, 7.31 acres of forest buffers have been installed in the Butternut Creek Watershed. Additionally, the Butternut Creek Physical Assessment identified 241 potential sites within the watershed where riparian buffers could be installed. However, it is important to ensure that newly planted buffers are carefully monitored to ensure their survivability and to ensure that critical watershed restoration resources are not used in vain.

- **Action Step #1:** The Otsego County Soil and Water Conservation District shall work with the Upper Susquehanna Coalition, the Wetlands Trust, the New York State Department of Environmental Conservation, and other partners to develop a protocol for monitoring riparian buffer survivability.

- **Action Step #2:** The Otsego County Soil and Water Conservation District and its partners will develop volunteer and/or student capacity to regularly monitor buffer sites and catalog survivability data as per established protocols.

- **Action Step #3:** The Otsego County Soil and Water Conservation District will integrate data regarding buffer survivability into shapefiles for storage in the Butternut Creek Watershed Geospatial Data Hub.

V. Priority Project #5: Identify High Priority Bridges for Repair and Replacement Using Best Available Technology to Protect Water Quality

- **Rationale:** Many of the municipalities that lie within the Butternut Creek watershed have bridges and other stream crossings which are in dire need of replacement and/or repair. As shown above, the 2020 Butternut Creek Physical Assessment identified 259 crossings with either significant or severe barriers to aquatic connectivity. Bridge repairs are typically implemented by local highway departments with assistance from the New York State Department of Transportation and, in some cases, engineering consultants. Improper bridge design and installation has the potential to alter streambanks and floodplains alike while threatening habitat connectivity.

- **Action Step #1:** The Otsego County Soil and Water Conservation District, in partnership with the Otsego County Highway Department, should schedule regular training events for Town/Village-level Highway Superintendents on bridge design following U.S. Environmental Protection Agency and/or U.S. Fish and Wildlife Guidelines.

- **Action Step #2:** The Watershed Coordinator will work with the Otsego County Highway Department and Town/Village Highway Departments to identify high-priority bridge projects for repair and replacement using geospatial technology.

- **Action Step #3:** Technical Assistance Providers like OCCA, BVA, and the USC should hold regular trainings on the Consolidated Funding Application process and other grant programs for Town/Village-level Highway Superintendents to acquire funding for key bridge replacement/repair projects.

- **Action Step #4:** The Otsego County Water Quality Coordinating Committee will coordinate a “Resilient Infrastructure Tour” designed to educate Town/Village Highway Superintendents about the benefits of infrastructure projects designed to fully mitigate environmental impacts.

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VI. Priority Project #6: Create a One-Stop Shop for Data in the Butternut Creek Watershed

- **Rationale:** Given the number of local agencies, nonprofit organizations, local, and regional organizations working in the Butternut Creek Watershed, it is imperative that data including geospatial data layers, reports and studies, local plans and regulations, and other relevant materials concerning its natural and built environment are kept in a central digital location. The BVA is in the process of creating a one-stop shop for data related to the Butternut Creek Watershed and, as such, BVA would be an ideal agency to implement this recommendation.

- **Action Step #1:** The Watershed Coordinator will work the BVA to strengthen its existing library of data related to the Butternut Creek Watershed.

- **Action Step #2:** The Watershed Coordinator will ensure that geospatial data layers pertaining to the Butternut Creek Watershed are stored on the New York State Geospatial Clearinghouse and are publicly available.

- **Action Step #3:** The Watershed Coordinator will maintain contact with local higher education institutions to ensure that newly published academic research pertaining to the Butternut Creek is available for download upon request.

VII. Priority Project #7: Increase the number of certified nutrient management planners serving Otsego County

- **Rationale:** Comprehensive Nutrient Management Plans (CNMPs) are designed to develop an economically sustainable approach to balancing the storage of manure and application of fertilizer along with the preservation of natural resources on the farm. CNMPs play a crucial role in limiting the environmental impacts associated with fertilizer application while also maximizing crop productivity. CNMPs also help farmers make appropriate land management decisions that protect natural resources onsite. Currently, in Otsego County there is only one Certified Nutrient Management Planner. Given the high frequency of livestock operations in the County and in the Butternut Creek Watershed, increasing the capacity of service providers to assist area farmers with nutrient management issues is a top priority.

- **Action Step #1:** Explore the feasibility of cost-share agreements with the Upper Susquehanna Coalition, Otsego County, and town/village governments in Otsego County that would allow SWCD to hire additional nutrient management planners.

- **Action Step #2:** Seek funding and training opportunities to assist current SWCD staff with the training and examination requirements associated with achieving certification as a Nutrient Management Planner.

- **Action Step #3:** The Watershed Coordinator will work with the SWCD to conduct regular outreach to area farmers, agricultural organizations, and municipalities to educate potential stakeholders on the importance of on-farm nutrient management planning.

VIII. Priority Project #8: Increase attendance and stakeholder participation levels at the SWCD's Highway Superintendent Training Program

- **Rationale:** In the Butternut Creek watershed, there are 12 different highway departments managing its road networks. This figure includes the highway departments serving the 10 municipalities within the Butternut Creek Watershed, the Otsego County Highway Department who manages County roads, and the New York State Department of Transportation who manages State Route 51. Each of these departments may take differing approaches to managing ditches, culverts, and other crossings. Improper ditching and road management can lead to increase sediment and pollutant loading in the mainstem creek and its tributaries. Creating a successful educational platform to promote environmentally mindful road management could have substantial water quality benefits.

- **Action Step #1:** The SWCD, OCCA, and OPD will use social media channels and other forms of marketing to advertise and promote SWCD's annual Highway Superintendent Training Program.

- **Action Step #2:** The Watershed Coordinator will utilize technical assistance available through the Cornell Local Roads Program to further assist area highway departments with infrastructure management efforts.

- **Action Step #3:** The Watershed Coordinator will work with the Otsego County Highway Department to identify high priority roads for repair through the County's Highway Asset Management Program. Repairs should utilize best available technology to minimize stormwater runoff and other negative environmental impacts.

IX. Priority Project #10: Increase the Capacity of OCCA's Citizen Science Water Quality Monitoring Program

- **Rationale:** OCCA, in partnership with the Alliance for Aquatic Resource Monitoring (ALLARM), OLT, SWCD, the SUNY Oneonta BFS, SUNY Oneonta, BVA and the Dave Brandt Chapter of Trout Unlimited initiated the first county-wide stream monitoring program carried out by citizen volunteers in New York's portion of the Chesapeake Bay watershed. Citizen science monitoring represents an effective way to collect water quality data that might not otherwise be collected, and can help inform environmental policy, provide baseline water quality conditions, and track long-term changes across the landscape. Currently two of the nine sites being actively monitored are in the Middle Butternut Creek watershed. However, there are no monitoring sites in the Upper or Lower watershed. Increasing citizen participation in this program can contribute higher resolution data to decisionmakers in the watershed and beyond.

- **Action Step #1:** OCCA and its partners will recruit additional volunteers to act as citizen stream monitors in the Upper and Lower Butternut Creek watershed.
- **Action Step #2:** OCCA and its partners will work with the Otsego County Planning Department to create an ArcGIS Story Map which contains links to the datasets uploaded by citizen stream monitors.

Action Step #3: OCCA should work with area educators to integrate water quality monitoring activities into K-12 academic curricula.

X. Priority Project #11: Identify and Secure Funding for Habitat Restoration Projects in the Butternut Creek Watershed

- **Rationale:** One of the key goals of the Chesapeake Bay Watershed Agreement involves protecting and restoring the network of terrestrial and aquatic habitat throughout the watershed. In the Butternut Creek Watershed, there are numerous species who act as indicators of a healthy watershed such as the Eastern Hellbender *Cryptobranchus alleganiensis*. At the same time, there are several entities working in the realm of habitat restoration such as the Wetlands Trust, the USC, and SUNY Oneonta. Identifying and securing funding for these entities to continue their work in the watershed will provide tangible benefits for the overall health of the Butternut Creek Watershed. Possible projects could include but are not limited to, riparian zone restoration, wetland creation and restoration, wildlife corridor creation and maintenance, and instream habitat restoration.

- **Action Step #1:** Using ArcGIS or other applicable geospatial software, the Watershed Coordinator will identify and map high priority areas for habitat conservation/restoration in the Butternut Creek Watershed.

- **Action Step #2:** The Watershed Coordinator will work with SUNY Oneonta, the Wetlands Trust, OLT, and the USC to identify, apply for, and secure funding for habitat restoration work within the watershed.

- **Action Step #3:** The Watershed Coordinator will conduct regular outreach activities to municipalities within the watershed to educate them about sensitive habitat areas within their respective jurisdictions.

XI. Priority Project #11: Increase Public Access to the Butternut Creek

- **Rationale:** Currently, there are two fishing access point two the Butternut Creek north of Turnbull Road in the Town of Burlington and one in the Town of New Lisbon. Those sites are only open to fishing and do not allow other types of active recreation. There are no public boat launch sites along the Butternut Creek or its tributaries. Increasing public access to local waterways for fishing, swimming, boating, and other activities fosters a shared sense of responsibility and increased stewardship that supports watershed restoration goals.

- **Action Step #1**: OLT, BVA, and OCCA should utilize ArcGIS and other mapping technology to identify suitable pieces of land for public access points to the Butternut Creek.

- **Action Step #2**: The Watershed Coordinator will work with OLT and BVA to conduct landowner outreach to gauge interest in securing easements for public access points.

- **Action Step #3:** OCCA, BVA, and OLT will identify and secure funding to construct public access points along the Butternut Creek.

- **Action Step #4:** OCCA, BVA, and OLT should reach out to nonprofit legal entities like the Chesapeake Legal Alliance to assist with potential land ownership challenges associated with the construction of public rights of way.

- **Action Step #5:** The Watershed Coordinator will work with the BVA, DEC, USC, the Wetlands Trust, and other applicable organizations/agencies to map sensitive habitat areas and post signage encouraging the public to avoid disturbing said areas.

9 Implementation Strategy

The Implementation Matrix presented on the following pages is intended to support the Butternut Creek Watershed Management Plan. The matrix organizes recommendations by Priority Project and their associated Action Steps. Each Action Step has been assigned a Responsible Party, potential partners, and where applicable, potential funding sources that can be accessed by interested parties. Finally, the Implementation Matrix sets a priority level for each action step—High, Medium, or Low. The recommendations are given an anticipated timeframe for implementation:

- Short-Term: 1-3 years
- Medium-Term: 4-6 years
- Long-Term: 7-10 years
- Ongoing: activities that are intended to be in place indefinitely

The Implementation Matrix is not intended to be a static creation, it is meant to be updated regularly. Priority projects should be regularly evaluated for relevance, feasibility, and need. If local agencies deem it necessary, Priority Projects can be modified, removed, or added to the Plan. It is recommended that the Watershed Coordinator review and update the Implementation Matrix annually with the assistance of partner organizations.

Priority Projects and Action Steps	Project Champion	Potential Partners	Potential Funding Sources	Immediate	Short-Term	Medium-Term	Long-Term	Ongoing
Priority Project #1: Develop the Capacity to Implement the Butternut Creek Watershed Management Plan								
Reactivate the Otsego County Water Quality Coordinating Committee	OCCA	SWCD, BVA, OLT, DEC	NFWF, Staff Time/In-Kind hours, SWCD					✓
Hire a Watershed Coordinator to identify and leverage State and Federal funding sources to implement water quality projects in the Butternut Creek Watershed	BVA/SWCD	NFWF, USC, DEC, Otsego County	Otsego County, NFWF, DEC, USC, Town/Village Governments		✓			
Work with area nonprofits such as BVA to integrate plan-related information into area newsletters	BVA	OCCA, SWCD, OLT, OPD	Staff Time/In-Kind hours					✓
Regularly attend local government meetings to keep elected officials apprised of progress related to the implementation of the Butternut Creek Watershed Management Plan.	BVA	OCCA, SWCD, OLT, OPD	Staff Time/In-Kind hours					✓
Priority Project #2: Design and Implement a Streambank Restoration Program Serving Otsego County								
Otsego County SWCD shall work with partner agencies to review, redesign, and secure municipal cooperation to participate in the Otsego County Streambank Restoration Program	SWCD	BVA, OCCA, DEC, USC	Otsego County, NYS Dormitory Authority, DEC, NFWF, U.S. EPA, NYS EFC			✓		
Secure funding from State and Federal Sources to increase the capacity of the Otsego County SWCD to implement the Streambank Restoration Program	SWCD	BVA, OCCA, DEC, USC	Staff Time/In-Kind Hours		✓			

Design a project prioritization system to rank high-priority streambank restoration projects for implementation	SWCD	BVA, OCCA, DEC, USC	NFWF, DEC		✓			
Identify and implement pilot streambank restoration projects and develop a project evaluation framework intended to improve project efficiency/service delivery	SWCD	OCCA, DEC, BVA	Staff Time/In-Kind Hours			✓		
Priority Project #3: Right-Size High Priority Culverts in the Butternut Creek Watershed								
The Butternut Creek Watershed Coordinator will work with local Highway Superintendents to apply for and secure state/federal funding to implement culvert replacement projects	SWCD	Otsego County Highway Department, NYS DOT, Local Highway Department	BRIDGE NY, NFWF, EFC		✓			
The Otsego County SWCD and partner organizations will create training program for local college students to monitor and evaluate the conditions of culverts in the Butternut Creek Watershed	SWCD	OCCA, BVA, SUNY Oneonta, Hartwick College	Scriven Foundation, NOAA, NFWF		✓			
The Otsego County SWCD and partner organizations will regularly conduct public outreach activities and trainings to municipalities throughout the watershed to demonstrate the importance of culvert rightsizing following NAACC guidelines	SWCD	OCCA, BVA, OLT	Staff Time/In-Kind Hours					✓
The Otsego County SWCD and partner organizations shall identify and secure funding to sustain outreach efforts surrounding culvert replacement and right-sizing	SWCD	Otsego County Highway Department, Otsego County Board of Representatives	BRIDGE NY, NFWF, EFC	✓				
Priority Project #4: Create and Implement a Riparian Buffer Survivability Program								
The Otsego County SWCD shall work with the USC, the Wetlands Trust, the DEC, and other partners to develop a protocol for monitoring riparian buffer survivability	SWCD	USC, the Wetlands Trust, DEC, OCCA	USDA, NFWF, EPA, DEC		✓			
The Otsego County SWCD and its partners will develop volunteer and/or student capacity to regularly monitor buffer sites and catalog survivability data as per established protocols	SWCD	SUNY Oneonta, Hartwick College, the Wetlands Trust, DEC	NFWF, USDA, EPA, DEC					✓
The Otsego County SWCD will integrate data regarding buffer survivability into shapefile form for storage in the Butternut Creek Watershed Geospatial Data Hub	SWCD	OCCA, OLT	Staff Time/In-Kind Hours					✓
Priority Project #5: Identify High Priority Bridges for Repair and Replacement Using Best Available Technology to Protect Water Quality								
The Otsego County SWCD, in partnership with the Otsego County Highway Department, should schedule regular training events for Town/Village-level Highway	SWCD	Local Highway Departments, Otsego County Highway Department,	BRIDGE NY, Community Foundation of Otsego County, EFC		✓			

Superintendents on bridge design following U.S. EPA and/or U.S. Fish and Wildlife guidelines								
The Watershed Coordinator will work with the Otsego County Highway Department and Town/Village Highway Departments to identify high-priority bridge projects for repair and replacement using geospatial technology	SWCD	OCCA, OPD, Otsego County Highway Department	NYS LGE Program, BRIDGE NY					✓
Technical assistance providers like OCCA, BVA, and the USC should hold regular trainings on the Consolidated Funding Application process and other grant programs related to bridge repair/replacement projects	OCCA	SWCD, Otsego County Highway Department, BVA	Staff Time/In-Kind Hours					✓
The Otsego County WQCC will coordinate a “Resilient Infrastructure Tour” designed to educate Town/Village Highway Superintendents about the benefits of infrastructures which incorporate resilient design principles	Otsego County WQCC	Otsego County Board of Representatives, municipal governments	Otsego County, SWCD			✓		
Priority Project #6: Create a One-Stop Shop for Data in the Butternut Creek Watershed								
The Watershed Coordinator will work with partner agencies to identify a party willing to host data on the Butternut Creek Watershed on their respective website	BVA	USCA, OPD, OCCA, BVA	Staff Time/In-Kind Hours	✓				
The Watershed Coordinator will ensure that geospatial data layers pertaining the Butternut Creek are stored on the New York State Geospatial Clearinghouse and are publicly available	BVA	USCA, OPD, OCCA, BVA	Staff Time/In-Kind Hours					✓
The Watershed Coordinator will maintain contact with local higher education institutions to ensure that newly published academic research pertaining to the Butternut Creek is available for download upon request	BVA	SUNY Oneonta, Hartwick College, USCA	Staff Time/In-Kind Hours					✓
Priority Project #7: Increase the number of certified nutrient management planners serving Otsego County								
Explore the feasibility of cost-share agreements with the USC, Otsego County, and town/village governments in Otsego County that would allow SWCD to hire additional nutrient management planners	SWCD	NYSDAM, EPA, municipal governments, USC, Otsego County	NYSDAM, U.S. EPA, municipal governments, Otsego County			✓		
Seek funding and training opportunities to assist current SWCD staff with the training and examination requirements associated with achieving certification as a Nutrient Management Planner	SWCD	NYSDAM, EPA, municipal governments, USC	Staff Time/In-Kind Hours		✓			
The Watershed Coordinator will work with the SWCD to conduct regular outreach to area farmers, agricultural organizations, and municipalities to	BVA	NYSDAM, EPA, municipal governments, USC	Staff Time/In-Kind Hours					✓

educate potential stakeholders on the importance of on-farm nutrient management planning								
Priority Project #8: Increase attendance and stakeholder participation levels at the SWCD's Highway Superintendent Training Program								
The SWCD, OCCA, and OPD will use social media channels and other forms of marketing to advertise and promote SWCD's annual Highway Superintendent Training Program	SWCD	OCCA, OPD, BVA	Staff Time/In-Kind Hours					✓
The Watershed Coordinator will utilize technical assistance available through the Cornell Local Roads Program to further assist area highway departments with infrastructure management efforts	SWCD/BVA	OCCA, Otsego County Highway Department	Staff Time/In-Kind Hours					✓
The Watershed Coordinator will work with the Otsego County Highway Department to identify high priority roads for repair through the County's Highway Asset Management Program. Repairs should utilize best available technology to minimize stormwater runoff and other negative environmental impacts	SWCD/BVA	OPD, Otsego County Highway Department	Staff Time/In-Kind Hours		✓			
Priority Project #9: Increase the Capacity of OCCA's Citizen Science Water Quality Monitoring Program								
OCCA and its partners will recruit additional volunteers to act as citizen stream monitors in the Upper and Lower Butternut Creek watershed	OCCA	OLT, BVA	NFWF, ALLARM, DEC		✓			
OCCA and its partners will work with the Otsego County Planning Department to create an ArcGIS Story Map which contains links to the datasets uploaded by citizen stream monitors	OCCA	OPD, SWCD, ALLARM, SUNY Oneonta	Staff Time/In-Kind Hours		✓			
OCCA should work with area educators to integrate water quality monitoring activities into K-12 academic curricula	OCCA	Local School Districts, ALLARM, SWCD	NOAA			✓		
Priority Project #10: Identify and Secure Funding for Habitat Restoration Projects in the Butternut Creek Watershed								
Using ArcGIS or other applicable geospatial software, the Watershed Coordinator will identify and map high priority areas for habitat conservation/restoration in the Butternut Creek Watershed	BVA/SUNY Oneonta	SUNY Oneonta, DEC, USC, OLT, OCCA	NFWF, EPA, USFWS, DEC		✓			
The Watershed Coordinator will work with SUNY Oneonta, the Wetlands Trust, OLT, and the USC to identify, apply for, and secure funding for habitat restoration work with the watershed	BVA	SUNY Oneonta, DEC, USC, OLT, OCCA	Staff Time/In-Kind Hours			✓		
The Watershed Coordinator will conduct regular outreach activities to municipalities within the watershed to educate them about sensitive habitat areas within their respective jurisdictions	BVA	SUNY Oneonta, OCCA	NFWF, EPA, USFWS, DEC					✓

Priority Project #11: Increase Public Access to the Butternut Creek								
OLT, BVA s, and OCCA should utilize ArcGIS and other mapping technology to identify suitable pieces of land for public access points to the Butternut Creek	BVA/OLT	OCCA, OPRHP, DEC, SWCD	USFWS, OPRHP, DEC, EFC	✓				
The Watershed Coordinator will work with OLT and BVA to conduct landowner outreach to gauge interest in securing easements for public access points	OLT	BVA, OCCA, SWCD	Staff Time/In-Kind Hours		✓			
OCCA, BVA, and OLT will identify and secure funding to construct public access points along the Butternut Creek	BVA/OLT	SWCD, OCCA, OPD	Staff Time/In-Kind Hours			✓		
OCCA, BVA, and OLT should reach out to nonprofit legal entities like the Chesapeake Legal Alliance to assist with potential land ownership challenges associated with the construction of public Rights-of-Way (ROW)	BVA/OLT	SWCD, OCCA, DEC	Scriven Foundation, Private Fundraising, Community Foundation of Otsego County			✓		
The Watershed Coordinator will work with the BVA, DEC, USC, the Wetlands Trust, and other applicable organizations/agencies to map sensitive habitat areas and post signage encouraging the public to avoid disturbing said areas.	BVA	DEC, TWT, USC, SUNY Oneonta	DEC, EPA, NFWF					✓

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