Watershed Needs Assessment

Buttermilk Creek
Tompkins County, New York

March 2013

MMI #4395-03

Prepared for:

Tompkins County Planning Department
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1.0 Introduction

1.1 Background

The Tompkins County Soil & Water Conservation District has retained Milone & MacBroom, Inc. (MMI) to conduct a Watershed Needs Assessment for the Buttermilk Creek watershed. Tompkins County encompasses the City of Ithaca as well as the Towns of Ithaca, Lansing, Groton, Dryden, Caroline, Danby, Newfield, Enfield, and Ulysses. Figure 1-1 is a location plan of the county.

Buttermilk Creek is a sub-watershed of the Cayuga Inlet basin. It is located within the Towns of Danby and Ithaca. The creek flows from south to north. It begins at the outlet of Jennings Pond in the Town of Danby and flows approximately 9.6 miles through primarily agricultural and low density residential land and finally through Buttermilk Falls State Park before discharging into Cayuga Inlet, which in turn empties into Cayuga Lake. Cayuga Lake is listed on the 303(d) list of water quality impaired waterbodies associated with sediment loading from the contributing watersheds, including the Buttermilk Creek watershed. Figure 1-2 is a watershed map of Cayuga Lake.

1.2 Study Objectives

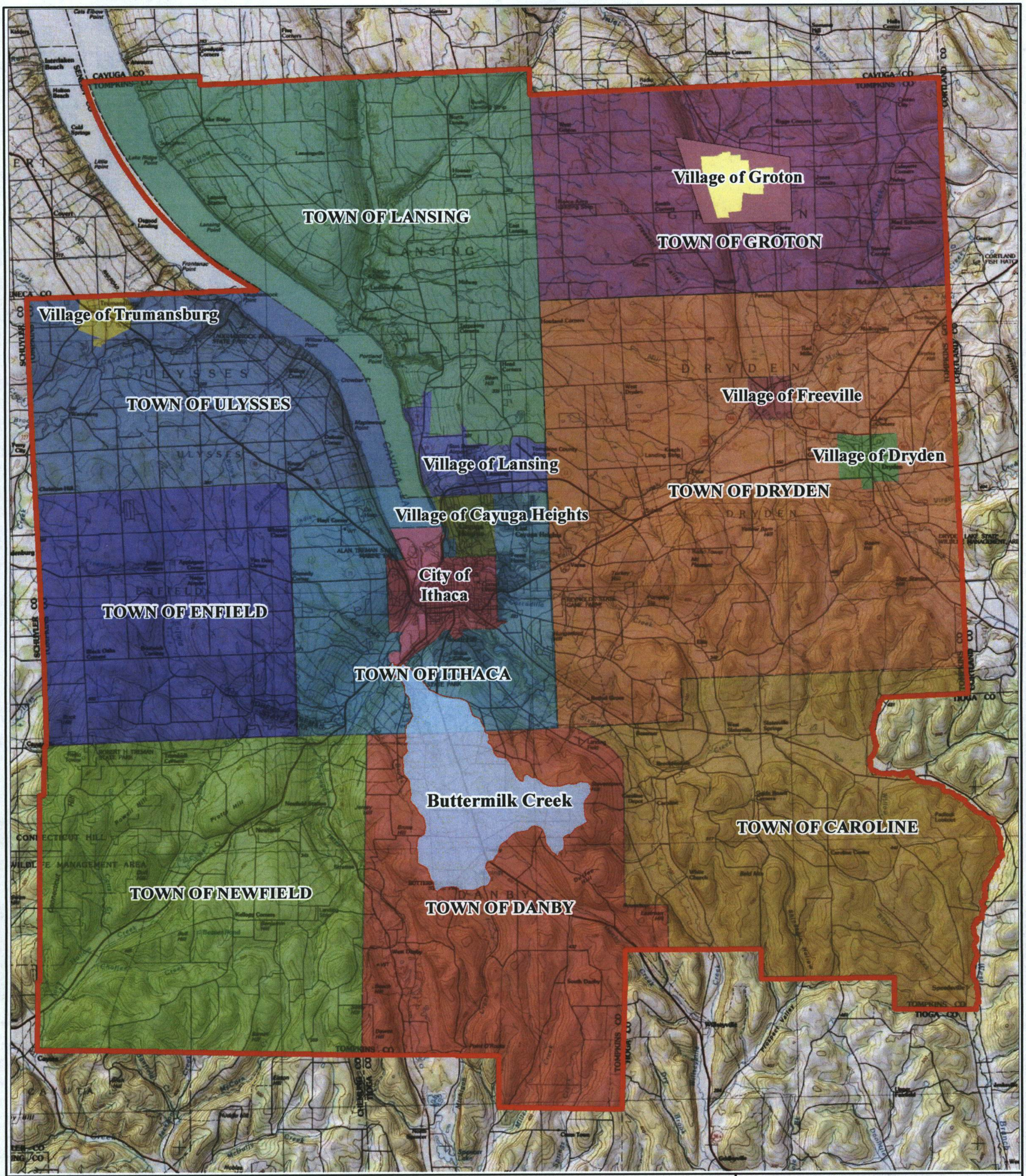
The purpose of the subject study is to evaluate the condition of Buttermilk Creek and its riparian corridor, and develop recommendations to stabilize the stream channel and maintain a healthy, viable system. The following specific objectives have been identified for the subject planning initiative:

- Identify and document existing issues, instability and/or degradation along the Buttermilk Creek corridor;
- Identify vulnerabilities in the creek, along the riparian corridor, and in the watershed;
- Explore, evaluate and recommend management strategies and restoration measures to correct problem areas and prevent future failures.

Stakeholders in this needs assessment include the Tompkins County Planning Department, Tompkins County Soil & Water Conservation District, the Tompkins County Highway Division, and the Town of Danby Highway Department.

1.3 Overview of Buttermilk Creek

For purposes of this study, Buttermilk Creek was split into eight segments within the study reach from Jennings Pond to the Danby municipal border at the southern edge of Buttermilk Falls State Park. Table 1-1 lists the segment boundaries. These are graphically depicted in Figure 1-3.



SOURCE(S):

USGS Topographic Quadrangle Map

DEP Bulletin No.40

Figure 1-1: Location Plan - Tompkins County

LOCATION:

Tompkins County, NY

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Buttermilk Creek Watershed Needs Assessment

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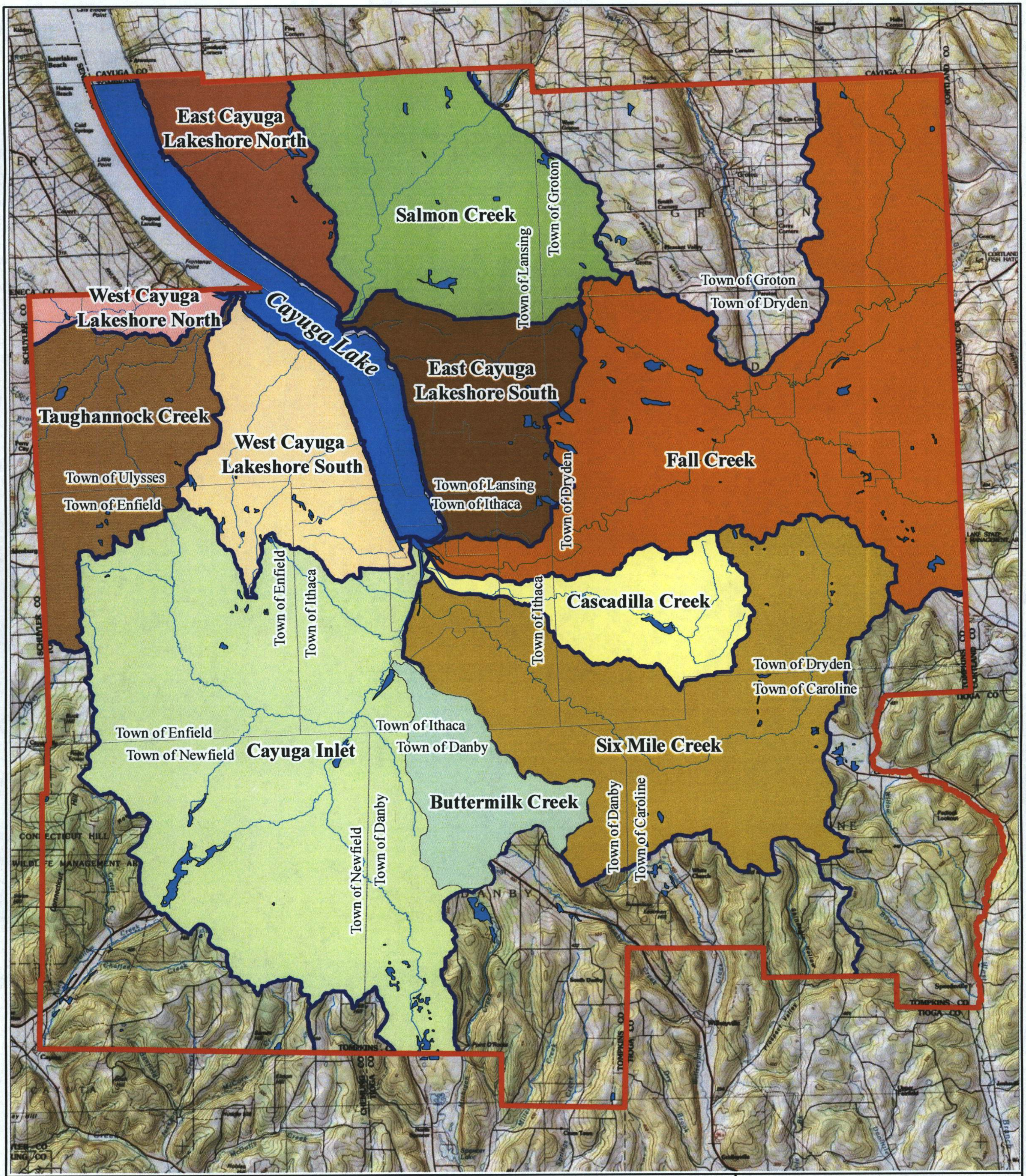

SOURCE(S):

USGS Topographic Quadrangle Map

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Figure 1-2: Cayuga Lake Watershed Map

LOCATION:

Tompkins County, NY

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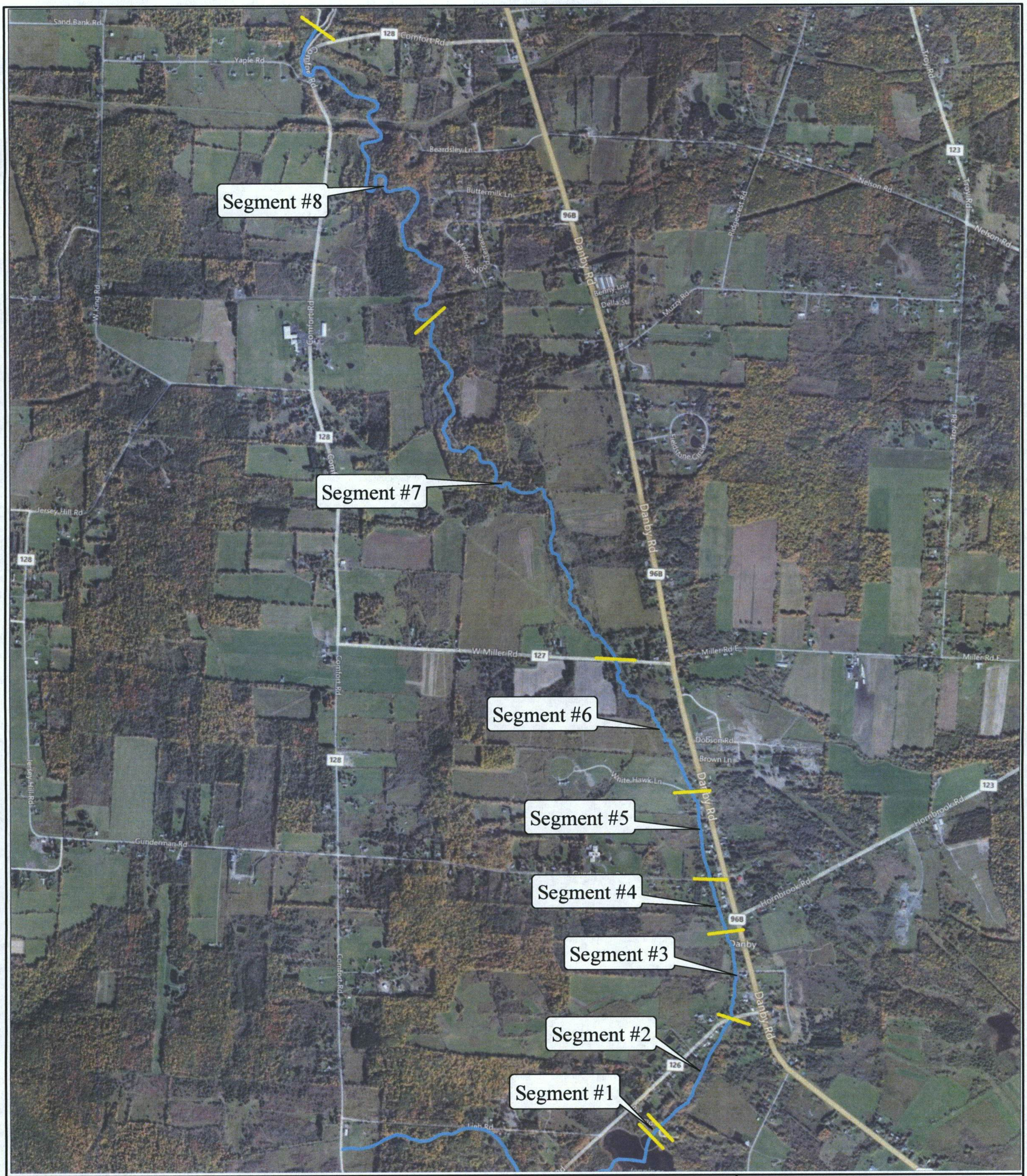

SOURCE(S):	Figure 1-3: Reach Segments	LOCATION: Danby, NY
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Segmentation considered major crossings and key areas of investigation. The brook has been stationed for reference purposes from upstream to downstream, beginning at Station 61+50 at the upper end at Jennings Pond to Station 307+40 upstream of Buttermilk Falls State Park, a distance of approximately six miles.

TABLE 1-1
Summary of Stream Segment Designations

Segment	Description of Geographic Limits	Length	Description of Conditions	Station
1	Jennings Pond Dam Spillway to Pond Road Crossing	200 ft	Wooded corridor with buffer, controlled by dam outlet	61+50 to 63+50
2	Pond Road Crossing to Bald Hill Road Bridge	2,100 ft	Confined	63+50 to 84+50
3	Bald Hill Road Bridge to double culvert near Hornbrook Road	1,450 ft	Confined and incised, unstable, dense Japanese knotweed, buffer throughout	84+50 to 99+00
4	Double culvert near Hornbrook Road to Gunderman Road Bridge	900 ft	Floodplain access, stable, buffer throughout	99+00 to 108+00
5	Gunderman Road Bridge to White Hawk Lane Crossing	1,450 ft	Floodplain access throughout, wetland-like area near White Hawk Lane	108+00 to 122+50
6	White Hawk Lane Crossing to West Miller Road Bridge	2,700 ft	Floodplain access through most, some terraces limit access in areas.	122+50 to 149+50
7	West Miller Road Bridge to 600' Upstream of Utility/Gas line crossing	7,650 ft	Floodplain access, stable, buffer throughout much agricultural area through segment	149+50 to 226+00
8	600' Upstream of Utility/Gas line crossing to Town property line	8,140 ft	Limited floodplain access, incised gorged section of creek, sharp meanders, erosion	226+00 to 307+40

Appended Figures I and II depict Buttermilk Creek through the study area. The headwaters of the creek are located to the east of Jennings Pond in the Town of Danby near Leib Road and Comfort Road. The creek flows out of Jennings Pond at Station 61+50 and then crosses Jennings Pond Road approximately 200 feet downstream of the pond outlet. It then flows through agricultural land for approximately 2,000 feet (0.4 miles) before crossing Bald Hill Road, also known as County Road 126.

After crossing Bald Hill Road, Buttermilk Creek runs parallel to Danby Road (Route 96B) for approximately 1.25 miles. Within this reach, the creek crosses at a recently installed double culvert west of Hornbrook Road near Station 99+00, Gunderman Road near Station 108+00, White Hawk Lane near Station 122+00 and then the creek trends in a northwest direction before flowing the West Miller Road (Route 127) crossing near Station 150+00. Adjacent land uses are primarily agricultural to the east of the creek and low density residential between the creek and Danby Road.

Several hundred feet below West Miller Road, Danby Creek empties into Buttermilk Creek. It flows along 2.9 miles through predominantly forested land before crossing County Road 128. The study area concludes at the approximate southern boundary of Buttermilk Falls State Park. The creek continues northerly through the park and then discharges into Cayuga Inlet.

The contributing watershed to Buttermilk Creek is approximately 12 square miles. In the upstream reaches, the terrain in the watershed is mostly broad flat expanses. The highest elevations in the watershed occur at around elevation 1,726 along the eastern perimeter.

In the lower watershed, Buttermilk Creek features sharp meanders and deep gorges with vertical walls. In the upper watershed, the riparian corridor is characterized by more vegetated floodplains along with abutting agricultural/open land. These upstream reaches show human interaction in the form of bridge crossings, along with more residential development within the floodplain along the banks of the creek.

1.4 Existing Land Uses within the Buttermilk Creek Watershed

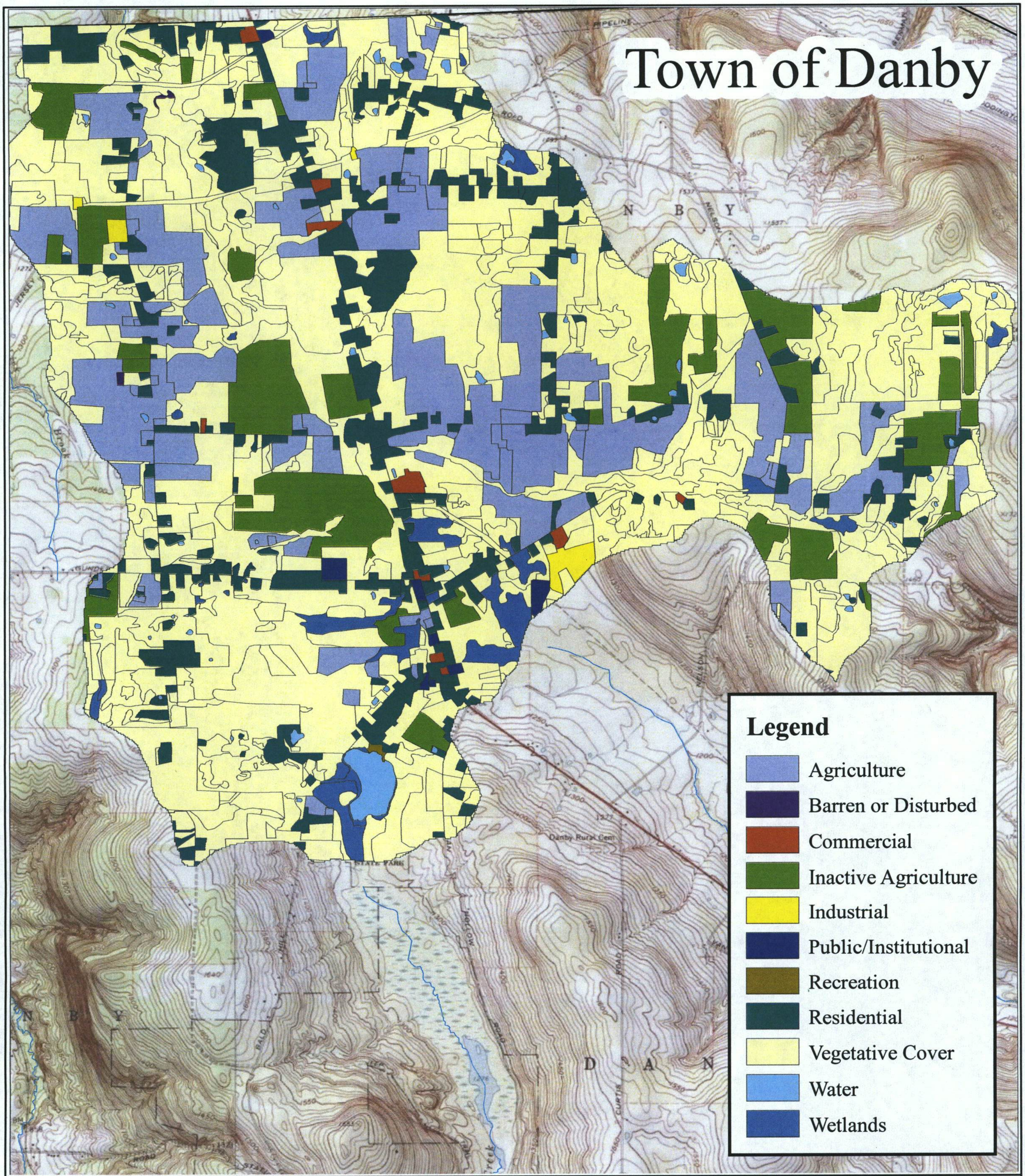
Figure 1-4 depicts land use within the Buttermilk Creek watershed in the Town of Danby. Current land use within the watershed is largely agricultural (26% watershed land) and forest cover (58% of watershed land), including three areas of protected forestland and moderate amounts of residential uses (12%). Overall, the density of development is quite low, and severe impacts caused by urbanization have not occurred in the watershed.

1.5 Hydrology of Buttermilk Creek

Surface water hydrology is the quantitative study of the presence, form, and movement of water into and through a drainage basin. The primary independent variables affecting runoff are precipitation, watershed area, surficial geology (soil characteristics), and slope. Dependent variables that change over short and intermediate time spans include vegetative cover, land use, wetland and floodplain water storage, reservoir size and volume, water diversion for irrigation or municipal use, and beaver dams.

For the purpose of studying bank erosion, sediment transport, and flooding, the primary interest is in peak stream flows due to intense precipitation, sometimes in combination with snow melt. It is the peak flood flows that shape and form river channels, scour the banks, and carry the majority of sediment. Subsequent storm runoff events, perhaps up to the mean annual flood, also convey sediment and tend to dominate the formation of the inner channel dimensions, bars, pools, and riffles. Monthly mean stream flow rates are a good indicator of seasonal flow patterns that affect water supply, habitat, and recreation.

A watershed's stream flow rate can be obtained or estimated using several different techniques including direct measurement, use of surrogate gauge data in nearby watersheds, physical deterministic computer models, statistical or stochastic analysis, or empirical techniques. There are no gauges in the Buttermilk Creek watershed. The U.S. Geological Survey's (USGS) StreamStats program was run for the Buttermilk Creek watershed for the purpose of estimating peak flows for different statistical flow events. The predicted peak event flows at the confluence of Buttermilk Creek with Cayuga Inlet are presented in Table 1-2. This data gives a relative scale to the peak flow during storm events ranging from a typical bank full event through the 500-year storm event.



SOURCE(S):

USGS Topographic Quadrangle Map

DEP Bulletin No.40

Figure 1-4: Land Use within Buttermilk Creek and Town of Danby

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Tompkins County, NY

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TABLE 1-2
USGS StreamStats – Peak Flows

Event (year)	Flow (cfs)
1.25	365
1.5	464
2	610
5	1,060
10	1,430
25	1,940
50	2,390
100	2,860
200	3,350
500	4,090

The USGS StreamStats program also provides drainage basin characteristics of Buttermilk Creek at its confluence with Cayuga Inlet as presented in Table 1-3.

TABLE 1-3
USGS StreamStats – Basin Characteristics

StreamStats Basin Characteristics Report	
Parameter	**Value**
Area that drains to a point on a stream	12 square miles
Main-channel 10-85 slope	80.3 ft/mile
Main-channel stream length	9.63 miles
10-85 slope of lower half of main channel	93.3 ft/mile
10-85 slope of upper half of main channel	137 ft/mile
Total length of all elevation contours in drainage area	45.33 miles
Average basin slope	377 ft/mile
Slope ratio (ratio of main channel slope to basin slope)	0.21
Basin Lag factor	0.0843
Percentage of basin at or above 1200 feet in elevation	71.8%
Basin storage (percentage of total drainage area shown as lakes, ponds and swamps)	0.65%
Percentage of area covered by forest	56.9%
Mean annual runoff	15.6 inches
Seasonal maximum snow depth, 50th percentile	12.1 inches
Mean annual precipitation	34.3 inches
Percent Urban Land Use (1992)	1.14%

Buttermilk Creek has not been analyzed or mapped by the Federal Emergency Management Agency (FEMA).

1.6 Review of Local Regulations

Comprehensive Plan

The Town of Danby's Comprehensive Plan was adopted in 2011. It is an update of the previous plan adopted in 2003. The Plan supports the town's vision to preserve the rural character, while providing guidelines for its residential and economic development. It is also intended to guide planning for public facilities, infrastructure, and community service programs, provide information to support funding, and educate agencies, governments, potential developers and residents about Danby's goals and objectives.

Section II of the Comprehensive Plan presents a list of current conditions and goals for the future. Part B of Section II is dedicated to the protection of natural resources. Danby strives to protect water resources from sedimentation, run-off from erosion, drainage, contamination, and flooding. The Town's strategies to accomplish this include the following:

- Enhance the study of drainage, runoff, and water use in the review of development applications and require drainage planning or improvements and erosion and sedimentation control as needed.
- Develop a funding program for a Town salt shed that adequately protects the surrounding wetlands.
- Participate in the activities of other agencies and organizations in water resource planning, such as the County Water Resources Board and the Cayuga Lake Watershed Association.
- Support the wetlands protection enforcement efforts of State and Federal agencies.
- Encourage residents to obtain assistance from the County Soil and Water Conservation District for wetlands restoration and pond construction. Maintain informational materials at the Town Hall to encourage resident use.
- Identify properties outside the 100-year flood plain that are, frequently subject to flooding and develop plans for flood hazard mitigation. Consider applying to FEMA for related hazard mitigation funding.
- Discourage development in aquifer recharge areas, when these areas have been identified.

- Discourage development on erosion-prone steep slopes.

One important recommendation of the Comprehensive Plan is to enhance the study of drainage, runoff, and water use in the review of development applications and require drainage planning or improvements and erosion and sedimentation control as needed. This is essential to the future of Buttermilk Creek. It is necessary to provide proper drainage, which will lessen the effects of flooding. It is also vital to discourage development on erosion-prone steep slopes.

Zoning and Subdivision Regulations

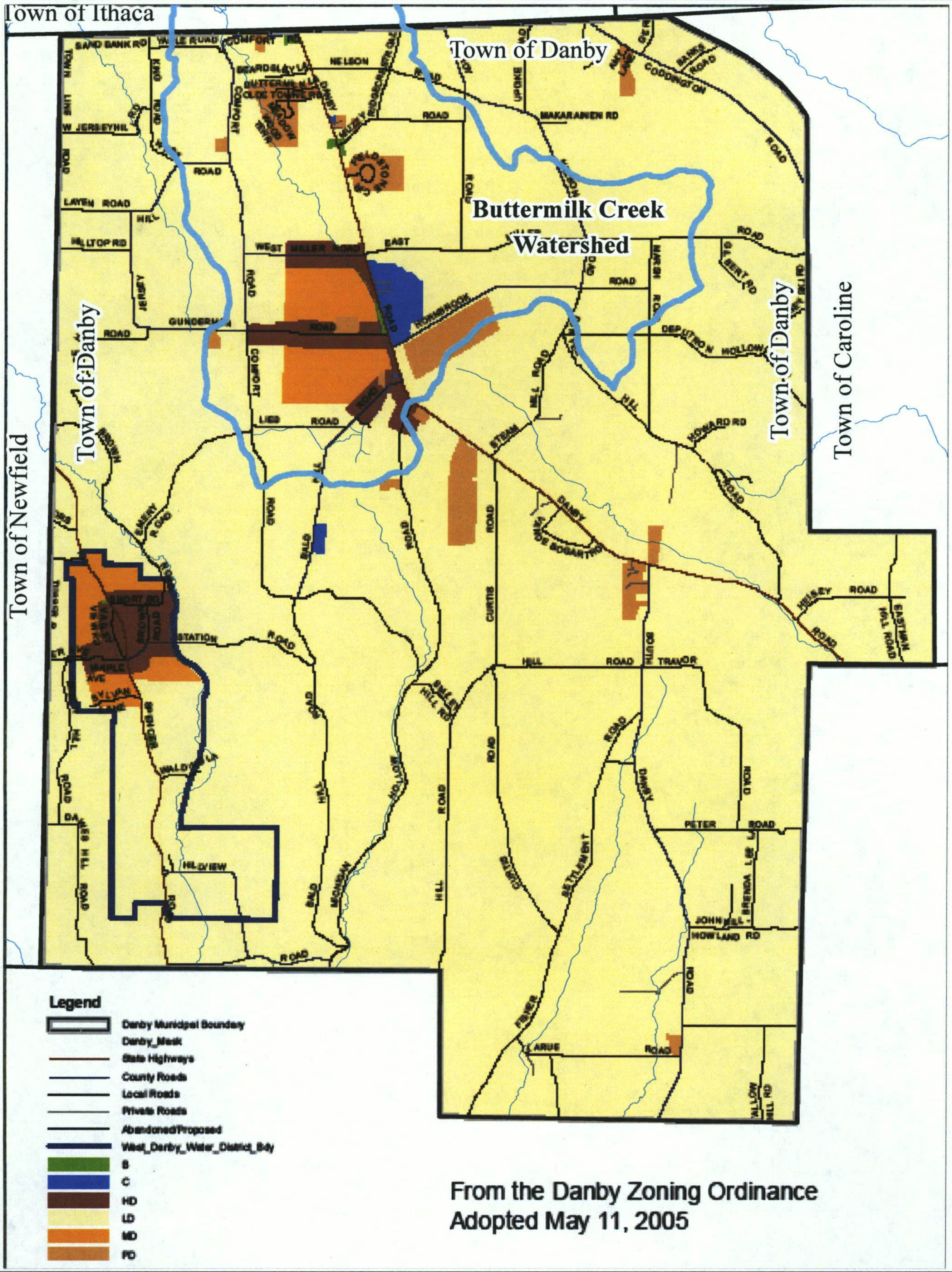
The Town of Danby Zoning Ordinance was drafted in 2011 and is an update of the previous plans adopted in 2005 and 1991. Certain elements of these regulations are of interest with regard to watershed management. Figure 1-5 is a zoning map of the Town of Danby. Relevant sections of the Special Regulations article of the Zoning Ordinance are as follows:

- Section 703 in the Zoning Ordinance states that if quarry is abandoned all steep sides shall be sloped to a slope of not greater than one vertical foot of slope in each three lineal feet, and the entire area is to be adequately seeded or otherwise landscaped to prevent erosion.

- Section 709 of the Zoning Ordinance states that no construction shall occur within an area governed by the Town of Danby local law relating to flood damage protection except as the same is permitted and occurs in accordance with the terms of such local law.

- Section 805 states that the Planning Board needs to review a general, preliminary, or final site plan that includes the adequacy of storm water, drainage, water supply, and sewage disposal facilities as well as the effect of the proposed development on environmentally sensitive areas including but not limited to wetlands, flood plains, woodlands, steep slopes, and water courses, and on other open space areas of importance to the neighborhood or community.

- Section 901 states that no Special Permit will be granted by the Planning Board unless the site plan meets the requirements for approval unless natural surface water drainage ways are not adversely affected, water and sewerage or waste disposal facilities are adequate, and the general environmental quality of the proposal, in terms of site planning, architectural design, and landscaping, is compatible with the character of the neighborhood.



SOURCE(S):
USGS Topographic Quadrangle Map

DEP Bulletin No.40

Figure 1-5: Town of Danby Zoning Map

LOCATION:
Tompkins County, NY

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The Town of Danby is divided into the following zones:

- Low Density Residential Zone
- Medium Density Residential Zone
- High Density Residential Zone
- Commercial Zones "A", "B", and "C"
- Planned Development Zone
- Mobile Home Park Zone

Buttermilk Creek flows through most multiple zoning districts including Low Density Residential, Medium Density Residential, High Density Residential, Planned Development, and Commercial. This implies that the zoning regulations listed above apply to the areas surrounding Buttermilk Creek.

Subdivision and Land Division Regulations

The Town of Danby Subdivision and Land Division Regulations were adopted in 2007, updated from the previous regulations adopted in 1991, 1996, 2005, and 2007. These regulations are intended to guide and protect the community's physical, social, and aesthetic development in accordance with the Town of Danby Comprehensive Plan. The regulations are also intended to protect the natural, agricultural, and historical resources of the Town, and to promote responsible use of these resources. Relevant sections are noted below.

- Article I states that regulations, standards, and procedures are developed to ensure that proper provision is made for drainage, water supply, sewerage, highways, open space, and other needed improvements.

- Article VII is indented to protect the Town of Danby, its residents, and its environment from hazards associated with standards of sound and acceptable environmental and developmental practices. Section 701 lays out requirements for no build areas in the Low Density Residential Zone, which are as follows:

  - ✓ Areas of 100-year flooding as defined by the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps,
  - ✓ Wetlands, including those shown on the New York State Freshwater Wetlands Maps, and those shown in the National Wetlands Inventory,
  - ✓ Intermittent and Perennial Streams, including a 50-foot buffer from the stream centerline, and
  - ✓ Slopes greater than 15%, except that areas of less than one acre (excluding driveways) on any one lot with such slopes may be excluded from the No Build Areas when approved by the Planning Board.

There are some exceptions to the No Build Areas, which include agricultural uses and equestrian facilities, forest management, pedestrian walks and bike paths, non-residential farm structures, wells or water service lines, utility lines, driveways, farms lanes, access roads, drainage swales, and stormwater management facilities unless in areas of 100-year flooding, wetlands, classified streams, or zoning.

- Section 702 addresses the conservation guidelines that apply to all Standard Subdivisions. Areas that are unsuitable for development due to circumstances that may be harmful to the environment or potential residents, such as severe drainage problems or steep slopes, shall not be subdivided until adequate methods to alleviate the effects of such harmful circumstances are formulated by the subdivider and approved by the Planning Board. Development should be laid out to avoid such features as significant vegetation, large trees, water courses, and similar irreplaceable assets and to avoid steep slopes, erosive soils, wetlands, or similar environmentally sensitive areas.

- Section 703 pertains to Erosion Control that applies to all Standard Subdivisions.

- Sections 704 Drainage applies to all Standard Subdivisions and sets the standards for drainage. These standards address natural drainage patterns, diversions therefrom, runoff rates and control of peak runoff, drainage computations, the need for detention and retention facilities, and slope considerations.

- Section 705 applies to trees and other significant vegetation and the standards that apply to all Standard Subdivisions, including preservation of trees and vegetation.

2.0 Watershed Assessment

2.1 Overview of Field Investigations

On October 23 and 24, 2012, MMI project team members conducted a two-day field investigation of Buttermilk Creek to visually assess the properties that could influence downstream surface runoff and sediment loads. Topographic maps, aerial photographs, and geographic information system (GIS) land use/cover data were reviewed prior to the initiation of field investigations. The investigations targeted areas of previously identified problems as well as representative stream sections, natural and man-made control points (natural falls, reaches flowing over bedrock, bridges), and areas of lateral migration. MMI team members visually inspected the main stem channel with regard to pattern, slope, widths and depths, and substrate stability.

Information on specific crossings/control points was made available during an initial site walk with project stakeholders. The project team recorded the locations of this data using a Trimble GPS unit. Stream crossings, bank failures, abutment spalling, and other critical features were also photo-documented in the field. Field measurements were taken of channel slopes, bank failure heights, and other relevant dimensions using a laser range finder/inclinometer. This data was used to later evaluate channel stability, channel size, floodplain connectivity and other stream features.

2.2 Stream Profile and Control Points

Buttermilk Creek features meanders, deep gorges with vertical walls and bank erosion within the gorged section (Segment #8, Station 226+00 to 307+40). Upstream of Segment 8, the creek characteristics include more vegetated floodplains along with abutting agricultural/open land (Segment 7, Station 149+00 to 226+00). The upstream reaches (Segments 1 through 6) show more human interaction with the Creek in the forms of bridge crossings along with more residential development within the floodplain along the banks of the creek. The main stream control point is the Jennings Pond Dam at Station 61+50.

2.3 Slope

The bed slope of Buttermilk Creek was estimated for various segments based upon GIS and USGS mapping as well as aerial photography. For each reach, the valley length, stream length, and change in elevation were used to calculate slope. Estimated slopes are presented in Table 2-1. A river segment slope (i.e. change in vertical grade divided by horizontal length) is an indicator of its velocity and sediment transport capacity. The normal trend is for river segments that are "geologically young" or actively incising to be fairly steep and straight, while "mature" channels that have worn down the landscape towards an equilibrium condition have low gradients and a higher sinuosity with a curvilinear meandering pattern and fine grain sediments.

TABLE 2-1
Segment Slope Data

Segment	Description of Geographic Limits	Length	Slope
1	Jennings Pond Dam Spillway to Pond Road	200 ft	*
2	Pond Road Crossing to Bald Hill Road Bridge	2,100 ft	1.8%
3	Bald Hill Road Bridge to double culvert near Hornbrook Road	1,450 ft	2.1%
4	Double culvert to Gunderman Road Bridge	900 ft	1.1%
5	Gunderman Road Bridge to White Hawk Lane	1,450 ft	0.9%
6	White Hawk Lane to West Miller Road Bridge	2,700 ft	0.8%
7	West Miller Road Bridge to 600' Upstream of Utility/Gas line crossing	7,650 ft	1.1%**
8	600' Upstream of Utility/Gas line crossing to Town property line	8,140 ft	1.5-2.8%

*Segment too short to estimate
**Computed based upon Cornell University Geospatial Information Repository data.

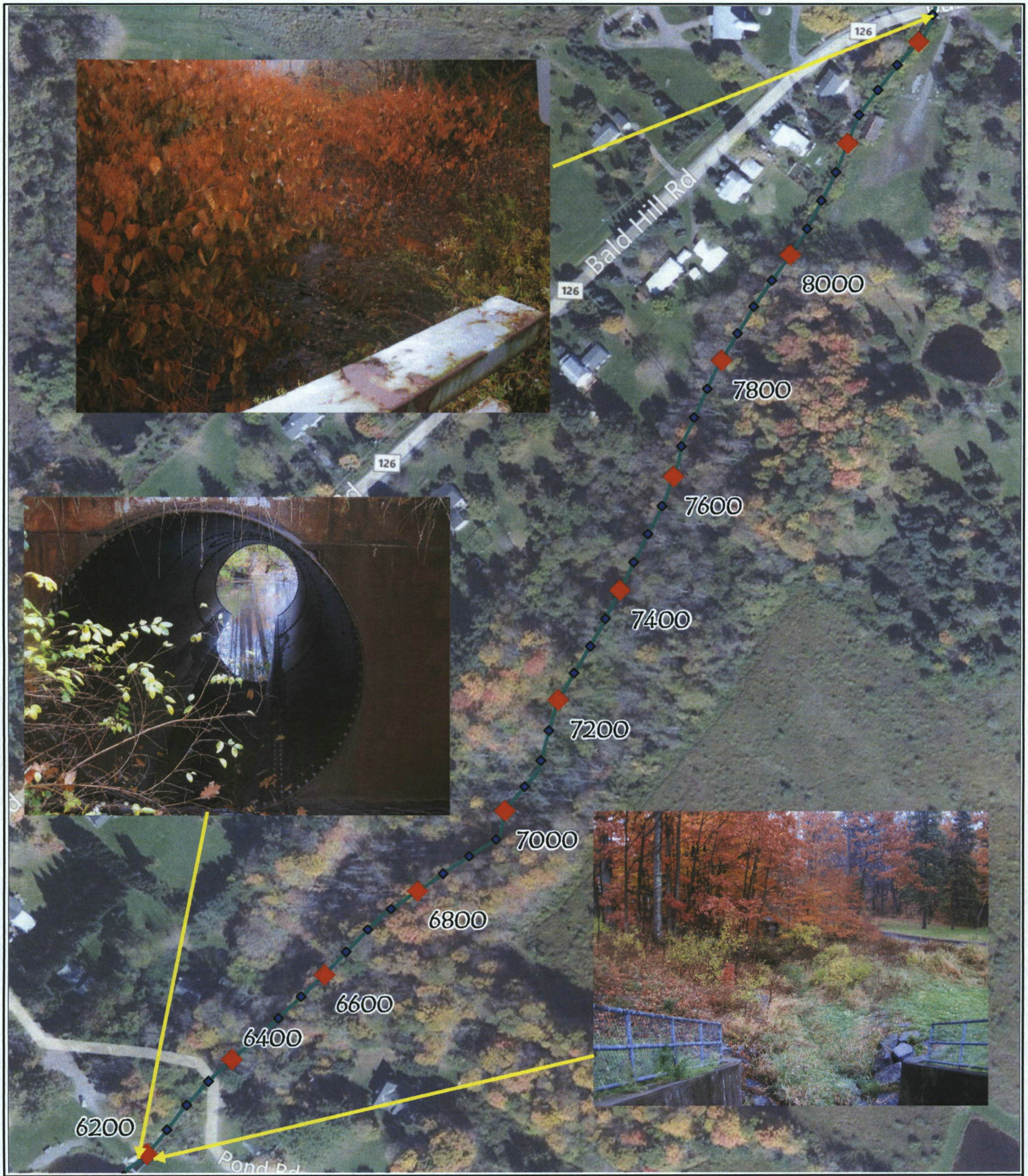
2.4 Observations by Stream Segment

Segment 1 – Jennings Pond Dam to Pond Road Crossing

Figure 2-1 depicts Segment 1. Segment 1 includes 200 feet of Buttermilk Creek extending from the Jennings Pond Dam (Station 61+50) to Pond Road Crossing (63+50). The crossing at Pond Road is a single 72-inch metal culvert. Buttermilk Creek in this segment is a single straight channel with flow that is controlled by the dam outlet. The slope of the channel in this segment is relatively flat. It is a low-energy system consisting of heavy vegetation debris build up and fine bed material. In this segment the stream has a wooded corridor with a vegetated buffer. The typical width to depth ratio of the channel is 5:1. There is limited development in the reach and little impact or risk of impact.

Segment 2 – Pond Road Crossing to Bald Hill Road Bridge

Figure 2-1 depicts Segment #2, which includes 2,100 feet of Buttermilk Creek extending from Pond Road (Station 63+50) to Bald Hill Road Bridge (Station 84+50). This segment is a single straight channel with largely uniform cobble dominated bed material. The average slope of the channel in this segment is 1.8%. The stream has a wooded corridor with a vegetated buffer until Station 79+50, where the buffer begins to deplete on both banks and the stream begins to become incised. The buffer is bordered by an open field to the east. To the west is Bald Hill Road with residential buildings on both sides of the road. The system's energy increases in this section. The typical width to depth ratio of the channel is 5:1 on the upstream section and 3:1 on the downstream section of this segment. Near Bald Hill Road there is a dense concentration of Japanese Knotweed. No active erosion was observed and no reports of nuisance flooding.



SOURCE(S):
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Figure 2-1: Segments #1 and #2

LOCATION:
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There are plans by the County to replace the aging Bald Hill Road Bridge in 2013. The span of the existing structure is 10.5 feet, with a vertical clearance of seven feet. The approach of this crossing is not ideal, as the bridge and creek do not cross perpendicular to one another but rather at an angle that alter the path of the channel. A larger span and/or different angle of approach would create a more efficient hydraulic alignment.

Segment 3 – Bald Hill Road Bridge to Double Culvert near Hornbrook Road

Figure 2-2 depicts Segment 3, which encompasses approximately 1,450 feet along Buttermilk Creek, extending from Bald Hill Road Bridge (Station 84+50) to a double culvert near Hornbrook Road (Station 99+00). This segment is a single relatively linear channel with small lateral meanders throughout the reach. The channel substrate consists of largely uniform cobble dominated bed material. The average slope of the channel in this segment is 2.1%. Dense Japanese knotweed was observed near 1800 Danby Road. The typical width to depth ratio of the channel is 2:1.

The upland land use to the east is predominately residential on both sides of Danby Road (Route 96B), with some open fields and wooded areas higher in the watershed. To the west of Buttermilk Creek is almost exclusively open fields intertwined with wooded areas, as well as some agricultural activity.

The newly constructed crossing west of Hornbrook Road is comprised of twin 50-inch corrugated plastic pipe culverts that appear to be undersized to handle significant storm events. No hydraulic computations were available to indicate that the crossing had been designed to any particular storm event. The upstream and downstream approaches are overgrown with invasives and other vegetation. No evidence of erosion was observed in this reach and no reports of flooding.

Segment 4 – Double Culvert near Hornbrook Road to Gunderman Road Bridge

Figure 2-3 depicts Segment 4, which includes 900 feet of Buttermilk Creek, extending from the double culvert near Hornbrook Road (Station 99+00) to Gunderman Road Bridge (Station 108+00). The average slope of the channel in this segment is 1.1%. This segment is a relatively straight channel with some areas that consist of multiple flow paths and minor meanderings. Cobble and some boulders make up the bed material. A decrease in slope provides better floodplain access and increases the width to depth ratio of the stream. In 2010, two residential property owners worked with Tompkins County Stream Corridor and Flood Hazard Mitigation Program to plant and formally protect a 100-foot riparian buffer to the creek. While the buffer continues to be healthy, it is bordered by Japanese Knotweed. The width of the stream increases throughout the segment, with a resulting width to depth ratio of 4:1.

SOURCE(S):
Bing Maps Hybrid

Figure 2-2: Segment #3

LOCATION:
Danby, NY

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SOURCE(S):	Figure 2-3: Segment #4	LOCATION:
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Downstream of Hornbrook Road, the watershed begins to become more populated, with fewer wooded areas and open fields. However, the majority of the surrounding land uses have not undergone extensive changes.

The Gunderman Road bridge has a span of 13 feet and a vertical clearance of nine feet. The bridge is believed to be in good condition and there are no plans for its replacement. The upstream and downstream approaches are very overgrown with invasives and other vegetation. No erosion was observed in this reach and there are no known areas of flooding.

Segment 5 – Gunderman Road Bridge to White Hawk Lane Crossing

Figure 2-4 depicts Segment 5, which includes 900 feet of Buttermilk Creek, extending from Gunderman Road Bridge (Station 108+00) to White Hawk Lane Crossing (Station 122+50). The slope of the channel in this segment is 0.9%. This segment has multiple flow paths towards its downstream end. The stream bed consists of gravel and some fines. There is a good amount of floodplain access throughout; however several residential structures to the east of the creek are encroaching on the river and are prone to flooding under certain rain events. Land area to the west is characterized primarily by open fields with small pockets of wooded area. Buttermilk Creek flows through a wetland area near White Hawk Lane. The width to depth ratio is approximately 3:1 in this segment.

The culverts at White Hawk Lane are relatively recent construction, consisting of twin 56-inch culverts that are half submerged in sediment and vegetative growth. The approach angle to the White Hawk Lane crossing is poor, with flow aligned to the east of the culverts. This crossing was designed by the developer's engineers and reviewed by the Town's consulting engineer, though it is unclear if the design was changed. The culverts appear to be under-sized and causing localized flooding.

An analysis of the existing culverts is recommended to assess the existing capacity at this crossing and to evaluate the requirements and cost of upgrading the culverts with capacity to support larger storm events. Such culvert crossings are generally designed to convey at least the 10- to 25-year storm event, and up to the 100-year storm event when the crossing is located at a point of critical ingress and egress. The appropriate design storm should be guided by the surrounding grades as well as the extent of predicted flooding. For example, if the area surrounding the culverts is predicted to become inundated during the 25-year storm, there would be no benefit of sizing the culverts to accommodate a 50-year storm. In such instance, the larger culverts would simply be under water and not capable of conveying any greater flow.

White Hawk Lane was constructed to support a development known as White Hawk EcoVillage, a community-centered development of 120 acres of land that will support approximately 30 to 40 residential dwellings. To date, five houses have been constructed.

SOURCE(S): Bing Maps Hybrid

Figure 2-4: Segment #5

LOCATION: **Danby, NY**

N

Buttermilk Creek Watershed Needs Assessment

Map By: JEP
MMI#: 4395-03
MXD: H:\4395-03\GIS\Maps\Figure 2-4.mxd
1st Version: 12/06/2012
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Scale: 1 inch = 175 feet

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SOURCE(S):
Bing Maps Hybrid

Figure 2-5: Segment #6

LOCATION:
Danby, NY

N

Buttermilk Creek Watershed Needs Assessment

Map By: JEP
MMI#: 4395-03
MXD: H:\4395-03\GIS\Maps\Figure 2-5.mxd
1st Version: 12/06/2012
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Segment 6 – White Hawk Lane Crossing to West Miller Road Bridge

Figure 2-5 depicts Segment 6, which includes 2,700 feet of Buttermilk Creek extending from White Hawk Lane (Station 122+50) to West Miller Road bridge (Station 149+50). The slope of the channel in this segment is relatively flat at 0.8%. This segment is a straight channel with multiple flow paths from Station 136+50 to 145+50. It is largely cobble dominated bed material.

Floodplain access exists through most of this segment. Some terraces limit access in areas just upstream of West Miller Road. Adjacent land use is comprised primarily of open fields and agricultural uses to the west and some residential development along Danby Road (Route 96B) to the east. Downstream of White Hawk Lane, the creek begins to trend northwest, away from Danby Road, with increasing tree cover along the eastern bank. The width to depth ratio is approximately 3:1 in this segment. No evidence of erosion was observed in this reach and no reports of flooding.

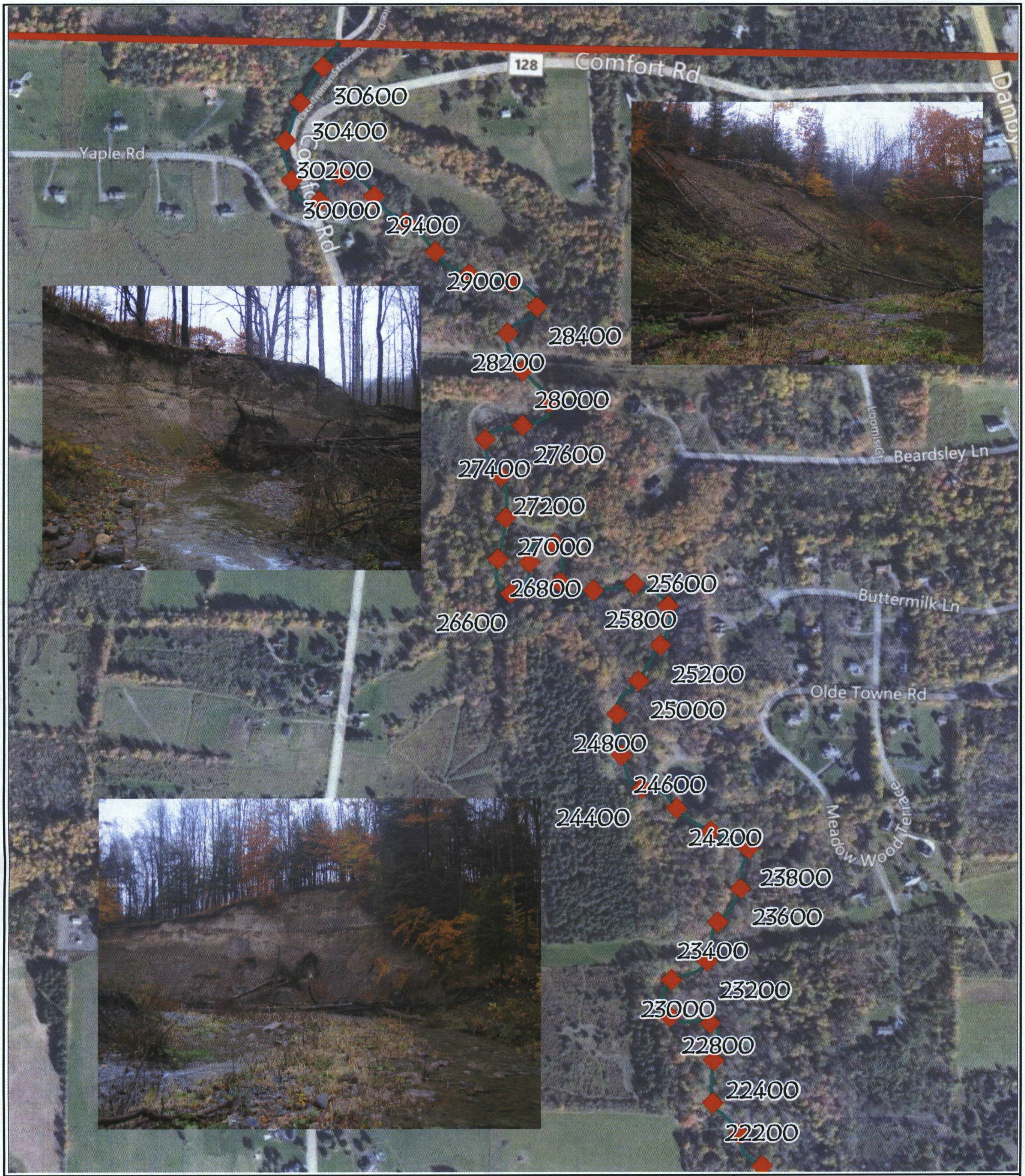
West Miller Road Bridge is planned to be replaced by the County in 2013. The existing bridge spans 19 feet, with a vertical clearance of eight feet. Large trees line the banks and appear to be stable. One house is in close proximity to the creek at the West Miller Road crossing, but believed to be on a stable terrace with limited risk to flooding.

Similar to the previous segment, the fields in the western upland area is slated for development of White Hawk EcoVillage. To the east is a more developed residential land area along Route 96B.

Segment 7 – West Miller Road Bridge to 600 Feet Upstream of Utility/Gas line Crossing

Figure 2-6 depicts Segment 7, which includes 7,650 feet of Buttermilk Creek extending from the West Miller Road Crossing (Station 149+50) to 600 feet upstream of a Dominion utility/gas line crossing at Station 226+00. Infrastructure within this reach requires periodic maintenance and mitigation. Interaction with utility companies should occur to advance any future mitigation measures.

Segment 7 is of lower priority and thus was reviewed to a lesser extent than the other segments. No infrastructure runs along the creek through this segment and little development surrounds the creek. The channel begins to meander more through this reach and bank erosion is evident at these meanders. There is an abundance of buffer with agricultural fields to the west of the creek beyond a forested buffer. Comfort Road and Route 96B run parallel to the creek towards the upper most limits of the watershed.



SOURCE(S): Bing Maps Hybrid	Figure 2-7: Segment #8	LOCATION: Danby, NY

N

Buttermilk Creek Watershed Needs Assessment

Map By: JEP
MMI#: 4395-03
MXD: H:\4395-03\GIS\Maps\Figure 2-7.mxd
1st Version: 12/06/2012
Revision: 12/21/2012
Scale: 1 inch = 600 feet

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SOURCE(S):
Bing Maps Hybrid

Figure 2-6: Segment #7

LOCATION:
Danby, NY

N

Buttermilk Creek Watershed Needs Assessment

Map By: JEP
MMI#: 4395-03
MXD: H:\4395-03\GIS\Maps\Figure 2-6.mxd
1st Version: 12/06/2012
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Segment 8 – 600 Feet Upstream of Utility/Gas Line Crossing to the Municipal Border

Figure 2-7 depicts Segment 8, which includes 8,140 feet of Buttermilk Creek extending 600 feet upstream of the utility/gas line crossing (Station 226+00) to the municipal border between Danby and Ithaca (Station 307+40). The slope of the channel in this segment steepens in the range of 1.5% to 2.8% as the channel enters into the gorged section of Buttermilk Creek (beginning at approximate Station 280+00. This segment begins to meander significantly, doubling back on itself and causing major bank erosion along the way. Bank failures range from a height of 10 feet to 60 feet and have become a significant source of sediment and turbidity under high flow conditions. Specifically, bank failures were observed at the locations indicated in Table 2-2.

TABLE 2-2
Bank Failure Locations

Bank Failure Site #	Station #	Failure Height	Failure Location (Looking Downstream)
1	230+00	30 feet	Left Bank
2	245+00 to 249+00	45 feet	Left Bank
3	254+00	54 feet	Right Bank
4	260+00	20 feet	Left Bank
5	262+00	20 feet	Right Bank
6	266+00	20 feet	Left Bank
7	274+50	25 feet	Left Bank
8	277+00	40 feet	Right Bank

Large woody debris has entered the system within this reach associated with bank failure and trees being deposited into the channel. These obstructions have caused debris dams that prevent the natural path of flow and induce localized scour. The channel has adequate floodplain connectivity in certain locations but also has choke points in this segment.

This segment contains little infrastructure impacts that would be at risk under a flood event. The upland characteristics of the segment of Buttermilk Creek are largely wooded land with some residential land well about the floodplain. There appears to be some agricultural activity in this section of the watershed as well.

3.0 Summary of Findings, Priority Issues, and Recommendations

3.1 Summary of Existing Conditions on Buttermilk Creek

Buttermilk Creek drains a watershed of approximately 12 square miles through the Towns of Danby and Ithaca within Tompkins County, New York. The creek discharges into Cayuga Inlet, which in turn empties into Cayuga Lake. Cayuga Lake is listed on the 303(d) list of water quality impaired waterbodies associated with sediment loading from the contributing watersheds, including the Buttermilk Creek watershed.

The Buttermilk Creek watershed is characterized largely by agricultural and low density residential land uses. The creek flows from south to north approximately parallel with Route 96B (Danby Road). The slope of Buttermilk Creek ranges from near 2% in its upper reaches (Segments 1 through 3), flattens to near 1% in its middle reaches (Segments 4 through 7) and then steepens to almost 3% in the lower reaches (Segment 8) upstream of Buttermilk Falls State Park.

The hydrology of Buttermilk Creek has been analyzed using the USGS StreamStats program. The approximate bankfull discharge was computed at 464 cfs. By comparison, the predicted 100-year storm event is 2,860 cfs. The stream has not been analyzed or mapped by FEMA.

Buttermilk Creek crosses numerous roadways, including Pond Road, Bald Hill Road, Gunderman Road, White Hawk Lane, West Miller Road, and Comfort Road. Several of these crossings are planned for replacement.

3.2 Priority Issues and Needs Assessment

Based on discussions and interviews with watershed stakeholders, a visual inspection of the watershed, and completion of the foregoing analysis, the highest priority concerns along Buttermilk Creek center around the following priority issues:

1. *Control of sediment to Buttermilk Falls State Park, the Gorge, and Cayuga Inlet.*

   Water quality impairment has been documented in Cayuga Lake, resulting in its placement on the 303(d) list of water quality impaired water bodies. The impairment is associated with the sediment loading from watersheds contributing to Cayuga Lake. Water quality impairment via additional turbidity can decrease aesthetic, recreational and aquatic habitat value of Buttermilk Creek.

   The upper reaches of the Buttermilk Creek study area (Segments 1 through 6) are fairly linear with localized meanders, reflective of a reasonably stable stream corridor. No large-scale evidence of bank failure was observed through these reaches. Downstream of West Miller Road in Segments 7 and 8, the creek begins to meander and the channel is actively trying to find a new equilibrium. The result has been a series of large scale bank erosion sites. The downstream gorge and waterfall in Buttermilk Falls State Park is evidence of this same trend towards equilibrium. Ongoing erosion in the creek results in elevated sediment and turbidity in Buttermilk Creek and in Lake Treman within the state park.

The movement of sediment through a river system is a complex process, often made up of many cycles of scour, movement, transport, and deposition. Sediment movement occurs when water flow exerts sufficient force to overcome the resistance produced by the weight of individual particles, their cohesion to similar particles, and their friction with the streambed. Most sediment is transported during periods of high water flows and high velocities. High flow velocities are able to erode and transport larger particles and so accelerate erosion. Similarly, long-duration floods can cause more erosion and sediment transport as compared to short-duration floods. The sediment concentrations in river water and long-term sediment loads depend on the availability of erodible soil and the ability of a river to transport it.

Degradation is the general lowering of the streambed. This occurs where the slope, discharge, and flow velocity combine to transport more sediment than is supplied to a river section. As a result, the riverbed will erode until the slope and velocity are reduced to a point of equilibrium. An entrenched channel is one that has degraded so much that its flood flow is unable to spread across its floodplain. Such channels are confined by well-defined banks that are higher than the mean annual flood level, thereby preventing inundation. Entrenched meanders occur when the channel's original pattern was preserved as the channel degraded, such as in the Grand Canyon. In other words, entrenched meanders are those that have eroded vertically but not laterally. They have steep valley walls on both sides of the meander bends.

Incised meanders occur where the channel has eroded both vertically and laterally. They move downstream by eroding the outside of the bends. They are characterized by steep banks on the outside of bends, with mild sloping banks on the inside. Active meandering channels often occur where a low-gradient river flows through highly erodible sediments, or where the stream is down-cutting through glacial deposits in its pre-glacial channel, exposing historic meander bends. This is precisely what is occurring in Buttermilk Creek.

Mass movement involves the sliding, toppling, falling, or spreading of fairly large and sometimes relatively intact masses. A slide is a relatively slow slope movement in which a shear failure occurs along a specific surface or combination of surfaces in the failure mass (Gray & Sotir, 1996). Eroding banks can contribute large volumes of sediment to downstream receiving waters. When the receiving waters are of critical value, it is important to minimize the transport of sediment to them in order to maintain water quality. This often entails using bioengineering techniques to regrade and replant the channel banks.

Concern has been voiced from private property owners along the creek with regard to the loss of land. There is a general level of discomfort associated with the eroding banks along the creek. The majority of this erosion occurs in segment 8 where the creek meanders more and steepens causing more erosion along the bends of the channel.

Many methods of stabilizing riverbanks can be employed, each with its own advantages and disadvantages. A single project site may often use multiple stabilization methods depending on site, soil, and slope conditions. In addition, the type of treatment may vary based on its position on the slope and frequency or duration of inundation. With regard to streambank erosion, critical questions are:

- Should degradation and mass failures be controlled?
- Would placement of bed controls in the creek to prevent down-cutting result in exacerbated lateral migration?
- Should the channel be relocated at the heavily eroding meanders?

Two types of strategies can be applied to protect a bank undergoing surface erosion from a river. One is instream modification of the river's flow patterns to decrease the attack on the bank, and the other is modification of the bank itself to strengthen its ability to resist the erosive forces. In cases where the velocities of the water, rather than the alignment of the river, are causing erosion, modification of the bank is appropriate.

The approach to bank stabilization can be "soft" or "hard." The softest approach relies primarily on vegetation for bank strengthening. This type of approach typically provides instream and riparian habitat value that is superior to the harder methods; however, it may not provide the level of stability required to decrease the erosion to acceptable levels. The harder approach relies primarily on structural methods, such as large riprap or concrete, to armor the riverbank. A balance of both soft and hard methods is often required, where some hard structural components are used and combined with softer habitat features to create a stable and attractive bank that provides both instream and riparian habitat.

The New York City Department of Environmental Protection (NYCDEP) is actively addressing many mass failures within the Catskills Region as part of its water filtration avoidance efforts for the New York City water supply. Numerous projects were constructed in 2011 and 2012, with engineering designs underway for multiple additional sites in 2013. Various approaches have been taken, including localized bioengineered bank treatments, relocation of rivers and streams away from the failing bank, and at the most aggressive sites, engineered systems that utilize steel sheet piling and large quantities of rock. The implications of doing nothing at these sites includes major loss of infrastructure (state and county highways, utilities, and bridges), loss of property (including yards, out-buildings, and residential structures), and contribution of significant amounts of sediment to the City's water supply reservoirs. Project construction costs range from several hundred thousand dollars to multi-million dollars for an individual site.

Controlling degradation for the entire Buttermilk Creek watershed through highly engineered means (i.e. structural walls, etc.) can be a daunting and cost prohibitive venture. This highly dynamic system has not reached equilibrium and is likely to see numerous additional bank failures through many decades and beyond. Repairing individual bank failures may prove to be temporary measures as new erosion sites emerge. Accordingly, bank stabilization techniques or flow deflection techniques should be judiciously applied in priority areas to protect existing structures, private property, and infrastructure (i.e. bridges and roads).

In other instances, erosion sites and bank failures may self-stabilize in time. One site on Buttermilk Creek that can be used as a template for self-healing bank stabilization occurs near Station 277+00. The bank has hit an angle of repose (i.e. has become stable) and has begun to vegetate itself. A lower floodplain bench at the toe of the bank has naturally formed. Additional armoring of the toe of this bank would further stabilize the site against high flow events. The use of a combination of low stone and log revetments can serve as a more natural reinforcement to the bank.

The concept of managing the watershed and corridor as well as the river channel itself provides an alternate approach that allows each river function to be managed at the appropriate level. Additionally, alternate methods of water quality renovation should be considered, such as construction of a sediment forebay upstream of Lake Treman and/or off-line detention/settling basins.

2. *Proper Sizing of Stream Crossings and Protection from Flooding*

Much of the land development and infrastructure along Buttermilk Creek is located at elevations such that flooding is not a serious threat. Areas of localized flooding occur in segments 2 through 6 where the floodplain is more developed and where the channel has been encroached upon. A more significant concern is the lack of analysis relative to sizing culvert crossings. Crossings are purported to be sized for the 100-year event; however, it is not clear that this is the case. Pipe size(s), shape, number and type will be site specific, driven by design flows, slope, and physical site conditions. All of these elements should be considered and analyzed for new and/or replacement crossings.

Objective B1.4 in the Town of Danby's 2003 Comprehensive Plan is to "protect water resources from sedimentation, run-off from erosion, drainage, contamination and flooding." The flooding problems in Buttermilk Creek are a concern in residential areas and at crossings.

The Town of Danby's Article VII Environmental Conservation for Standard Subdivisions regulations under Section 701 state that areas of 100-year flooding as defined by the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps cannot be built on or disturbed during site construction. There has not been a FEMA Flood Insurance Study (FIS) completed for Buttermilk Creek. Because of this, it is possible that houses are currently within an area that would are located in the Special Flood Hazard Area (SFHA) if the base flood (100-year flood) were evaluated for the watershed.

3. *Protection of Water Quality and Ecological Habitat*

Objective B1.4 in the Town of Danby's 2003 Comprehensive Plan is to "protect water resources from sedimentation, run-off from erosion, drainage, contamination and flooding." Land use practices, particularly agricultural practices, roadway drainage practices, and minimization of impervious cover can have an impact on sediment runoff in the watershed.

Due to the amount of agricultural land and open fields in the watershed land use practices should be monitored for the effects of turbid runoff. It is likely that turbid flows from field runoff, field ditches, and road during rain events in the Buttermilk Creek watershed has added to the sediment in the creek and deposited in impounded areas. It is recommended that small check dams be implemented in runoff ditches where flow is significant to improve sediment trapping capabilities and that the trapped sediment is periodically removed.

Land use conversion on regularly inundated areas as well as direct drainage of turbid runoff from agricultural fields is a threat to water quality in the Buttermilk Creek and Cayuga Lake. Additionally, adjusting cropping plans based on field inundation (i.e., changing the wettest areas from corn to hay), cover cropping, conservation tillage, injection spreading, row cropping, and other practices should be discussed with farmers to reduce nutrient-rich runoff.

Good water quality supports habitat for fish species, macroinvertebrates, as well as other aquatic organisms. In addition to maintenance of good water quality, physical conditions are also an important consideration for habitat quality. Where possible, bottomless culverts or box culverts with buried bottoms are preferred, as they provide better ecological habitat and aquatic species passage.

4. *Establishment of Riparian Buffers*

A common goal of establishing riparian buffers along the creek has been identified by numerous watershed stakeholders. Healthy riparian buffers can contribute to protection of private property and infrastructure and protection of water quality by increasing bank stabilization and decreasing bank scour and erosion. A watershed-scale approach is can improve land management practices to decrease sediment loading and restore riparian buffer. This can be best accomplished with an integrated and coordinated planning effort involving all stakeholders with vested interest in Buttermilk Creek watershed health.

Riparian buffers are essential for the health of streams and habitat that reside in the surrounding area. Buffers are important for good water quality by preventing sediment, nitrogen, phosphorus, pesticides, and other pollutants from entering a stream, for valuable habitat for wildlife, and for maintaining stable streambanks. Article VII in the Subdivision and Land Division Regulations states that building is not permitted within 50 feet from a stream.

The Town of Danby strives to protect water resources from sedimentation, runoff from erosion, drainage, contamination, and flooding. To accomplish this they discourage development on erosion-prone steep slopes. Section 703 in the Zoning Ordinance states that if quarry is abandoned all steep sides shall be sloped to a slope of not greater than one vertical foot of slope in each three lineal feet, and the entire area is to be adequately seeded or otherwise landscaped to prevent erosion. These efforts will help establish riparian buffers and prevent erosion.

Voluntary riparian buffer plantings and protections should also continue to be encouraged including through the Tompkins County Stream Corridor and Flood Hazard Mitigation Program.

3.3 Recommendations

The following recommendations are offered:

1. Judiciously apply engineered bank treatments in priority areas to protect existing structures, private property, and infrastructure, and where sediment contributions to Buttermilk Creek are the greatest. Table 2-2 presents a summary of bank failure locations. Within this list, priority should be given to sites with the greatest potential for sediment release as well as those that are located in close proximity to or have the potential to compromise existing development, including structures and infrastructure (utilities, roadways, etc.). Alternate water quality renovation approaches should be explored for the purpose of protecting downstream recreational uses and ecological habitat. The long-term economy of stabilizing individual sites (often on the order of

$0.5 M or more) should be evaluated in contrast to downstream sediment management approaches.

2. Conduct hydraulic analysis of Buttermilk Creek using current modeling software such as HEC-RAS to evaluate the adequacy of existing and planned structures at roadway crossings and to assess flooding potential for a variety of storm events.

3. Design future creek crossings to accommodate a desired design flow (to be determined) and require design review by the town and/or county engineer before construction takes place. . Such crossings are generally designed to convey at least the 10- to 25-year storm event, and up to the 100-year storm event when the crossing is located at a point of critical ingress and egress. The appropriate design storm should be guided by the surrounding grades as well as the extent of predicted flooding. Two bridge crossings – one at Bald Hill Road and one downstream at West Miller Road – are planned to be replaced in 2013. These upgrades should undergo hydrologic and hydraulic analysis within the context of the upstream and downstream reaches and they should be sized to accommodate the desired design storm event

4. White Hawk Lane passes through a low lying wetland and has no adequate way of passing high flows through the existing culverts. An analysis of the existing culverts is recommended (consistent with item 3 above) to assess the existing capacity at this crossing and to evaluate the requirements and cost of a crossing with capacity to support larger storm events.

5. Undertake routine inspection and maintenance of all stream crossings in an effort to reduce sediment buildup, which limits passable flow and increases flooding potential.

6. Require engineering analysis and review of stormwater drainage systems consistent with current regulations and consider bolstering requirements relative to specific design storms.

7. Consider amending local regulations to establish riparian buffers along Buttermilk Creek for the protection of habitat, maintenance of a healthy functional floodplain, and placement of sensitive land uses and infrastructure out of flood prone areas.

8. Consider establishing a watershed education and outreach program to convey the importance of and nexus between land use practices and stream water quality. Principal recipients should include the agricultural community and residential population.

PHOTO LOG

PROJECT PHOTOS

PHOTO NO.: 1 DESCRIPTION: Jenning's Pond dam spillway crest. **SEGMENT: #1** **STATION: 61+70**	
PHOTO NO.: 2 DESCRIPTION: Low flow outfall in Jenning's Pond dam. **SEGMENT: #1** **STATION: 61+70**	

PROJECT PHOTOS

PHOTO NO.: **3** DESCRIPTION: Looking downstream of Jenning's Pond dam from the pedestrian bridge. **SEGMENT: #1** **STATION: 61+70**	
PHOTO NO.: **4** DESCRIPTION: Looking across Jenning's Pond from park parking lot on Jenning's Pond Road. **SEGMENT: #1** **STATION: 61+70**	

PROJECT PHOTOS

PHOTO NO.: **5** DESCRIPTION: Looking upstream to the backside of Jenning's Pond Dam and spillway. **SEGMENT: #1** **STATION: 61+70**	
PHOTO NO.: **6** DESCRIPTION: Jenning's Pond Road culvert immediately downstream of Jenning's Pond Dam. **SEGMENT: #1** **STATION: 63+50**	

PROJECT PHOTOS

PHOTO NO.: 7 DESCRIPTION: Buttermilk Creek looking downstream from Bald Hill Road bridge. **SEGMENT: #2** **STATION: 84+50**	
PHOTO NO.: 8 DESCRIPTION: Buttermilk Creek looking upstream from Bald Hill Road bridge. **SEGMENT: #2** **STATION: 84+50**	

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PROJECT PHOTOS

PHOTO NO.:

9

DESCRIPTION:
Double culverts at new private driveway on Danby Road across from Hornbrook Road, looking upstream..

SEGMENT: #3

STATION: 99+50

PHOTO NO.:

10

DESCRIPTION:
Buttermilk Creek looking downstream from the Gunderman Road bridge.

SEGMENT: #4

STATION: 107+80

PROJECT PHOTOS

PHOTO NO.: **11** DESCRIPTION: Upstream right bank wingwall of Gunderman Road abutment. **SEGMENT: #4** **STATION: 107+80**	
PHOTO NO.: **12** DESCRIPTION: Buttermilk Creek looking upstream from the Gunderman Road bridge. **SEGMENT: #4** **STATION: 107+80**	

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PROJECT PHOTOS

PHOTO NO.: **13** DESCRIPTION: Upstream end of culvert crossing of Buttermilk Creek at White Hawk Lane. **SEGMENT: #5** **STATION: 122+50**	
PHOTO NO.: **14** DESCRIPTION: Buttermilk Creek looking upstream at wetland south of White Hawk Lane. **SEGMENT: #5** **STATION: 122+50**	

PROJECT PHOTOS

PHOTO NO.:

15

DESCRIPTION:
Buttermilk Creek looking upstream from West Miller Road bridge.

SEGMENT: #6

STATION: 149+40

PHOTO NO.:

16

DESCRIPTION:
Downstream of West Miller Road Bridge looking downstream along Buttermilk Creek.

SEGMENT: #7

STATION: 151+80

PROJECT PHOTOS

PHOTO NO.: **17** **DESCRIPTION:** Major slope erosion/failure along left bank, large woody debris in channel, site upstream of gas line crossing. **SEGMENT: #8** **STATION: 230+00** Bank Failure Site #1 See Table 2-2	
PHOTO NO.: **18** **DESCRIPTION:** Buttermilk Creek looking upstream at underground gas line crossing. **SEGMENT: #8** **STATION: 232+50**	

PROJECT PHOTOS

PHOTO NO.: **19** DESCRIPTION: Debris jam upstream of the private pond off of Olde Towne Road. **SEGMENT: #8** **STATION: 239+50**	
PHOTO NO.: **20** DESCRIPTION: Buttermilk Creek looking upstream at a private pedestrian bridge off of Olde Towne Road. **SEGMENT: #8** **STATION: 241+50**	

PROJECT PHOTOS

PHOTO NO.: **21** DESCRIPTION: Private pond in floodplain off of Olde Towne Road. **SEGMENT: #8** **STATION: 242+50**	
PHOTO NO.: **22** DESCRIPTION: Private crossing of Buttermilk Creek. **SEGMENT: #8** **STATION: 243+50**	

PROJECT PHOTOS

PHOTO NO.: **23** DESCRIPTION: Major slope erosion/failure along left bank, large woody debris along slope and toe of site. **SEGMENT: #8** **STATION: 245+00** Bank Failure Site #2 See Table 2-2	
PHOTO NO.: **24** DESCRIPTION: Major slope erosion/failure along left bank, large woody debris along slope and toe of site. **SEGMENT: #8** **STATION: 249+00** Bank Failure Site #2 See Table 2-2	

PROJECT PHOTOS

<table>
<tr><td>
PHOTO NO.:

25

DESCRIPTION:
Major slope erosion/failure along right bank, large woody debris along toe of site.

SEGMENT: #8

STATION: 254+00

Bank Failure Site #3
See Table 2-2
</td><td></td></tr>
<tr><td>
PHOTO NO.:

26

DESCRIPTION:
Minor headcut/step in Buttermilk Creek downstream of previous slope failure sites.

SEGMENT: #8

STATION: 272+50
</td><td></td></tr>
</table>

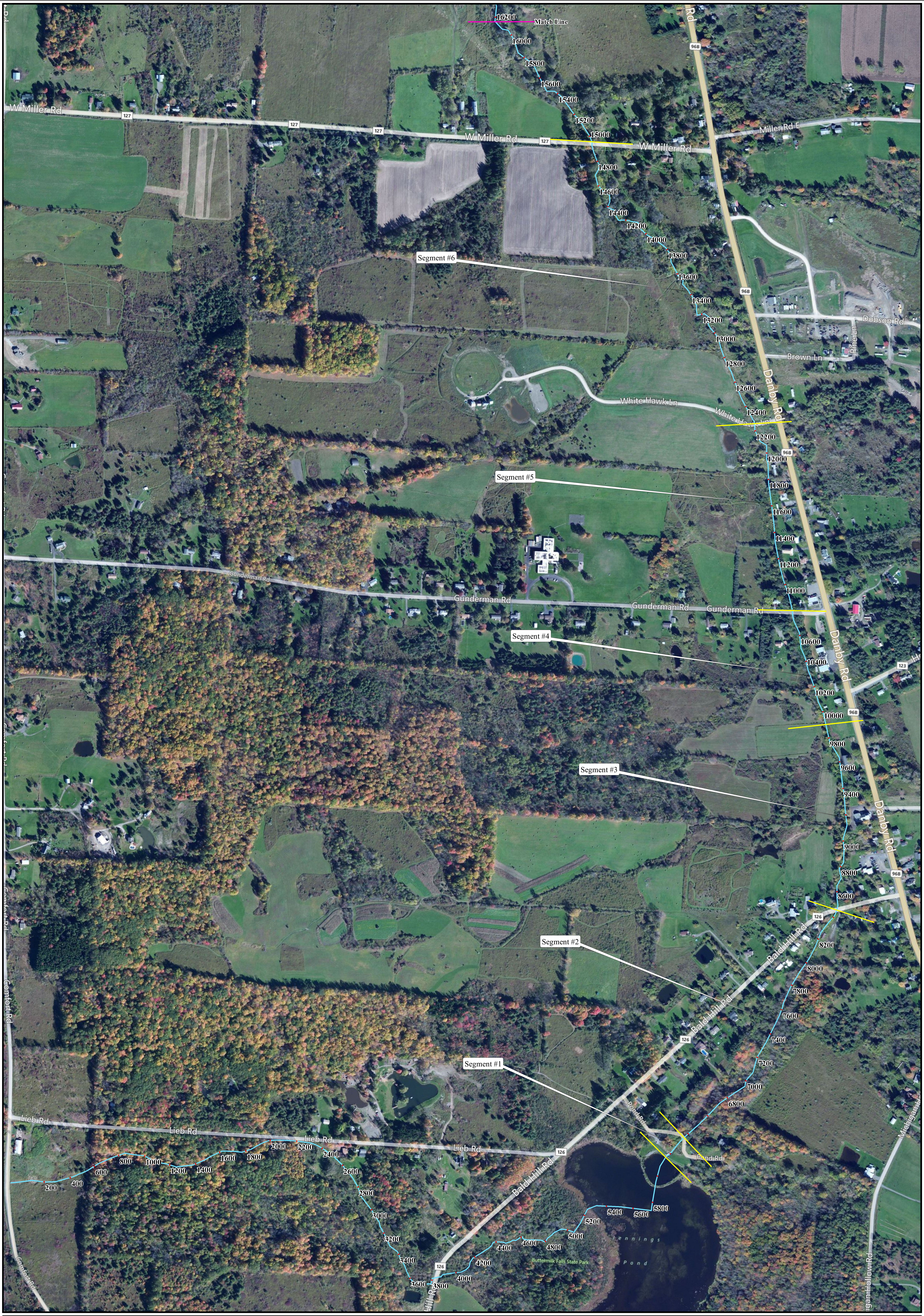
PROJECT PHOTOS

PHOTO NO.: **27** DESCRIPTION: Major slope erosion/failure along left bank, large woody debris in channel. **SEGMENT: #8** **STATION: 274+50** Bank Failure Site #7 See Table 2-2	
PHOTO NO.: **28** DESCRIPTION: Stabilized/vegetated bank failure along right bank. **SEGMENT: #8** **STATION: 277+00** Bank Failure Site #8 See Table 2-2	

PROJECT PHOTOS

PHOTO NO.: 29 DESCRIPTION: Overhead power lines crossing at Buttermilk Creek. **SEGMENT: #8** **STATION: 280+00**	

APPENDED FIGURES



PLAN VIEW OF BUTTERMILK CREEK

BUTTERMILK CREEK WATERSHED NEEDS ASSESSMENT

DANBY, NEW YORK

SHEET NO.	APPENDED FIGURE I
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PROJECT NO:	4395-03
1st VERSION:	12/26/2012
1st VERSION:	12/26/2012
SCALE:	
DESIGNED	-
DRAWN	JEP
CHECKED	-

REVISIONS

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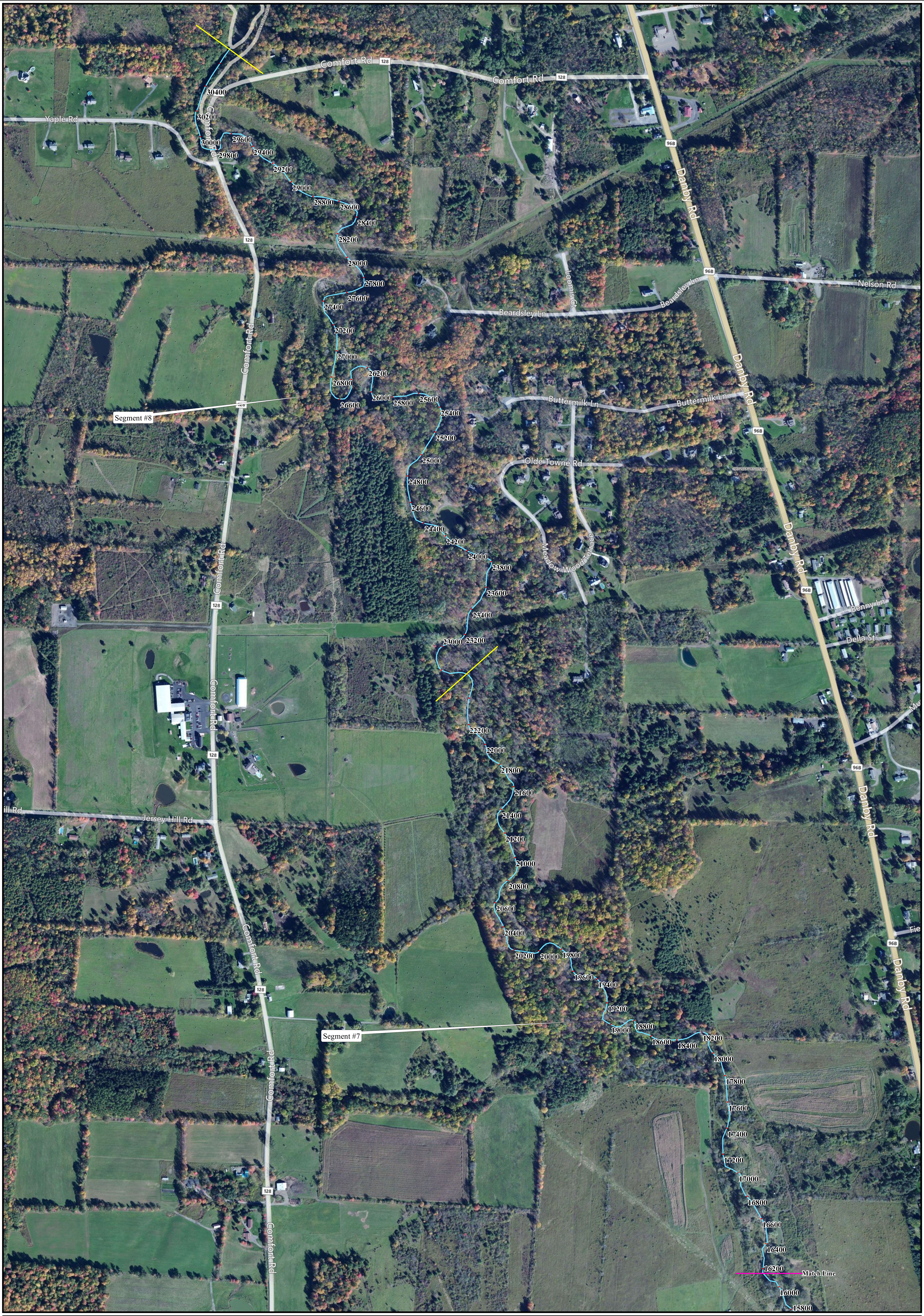
SOURCE(S):
Bing Maps Hybrid



PLAN VIEW OF BUTTERMILK CREEK

BUTTERMILK CREEK WATERSHED NEEDS ASSESSMENT

DANBY, NEW YORK

DESIGNED	-
DRAWN	JEP
CHECKED	-
SCALE:	1 inch = 300 feet
1st VERSION:	12/26/2012
1st VERSION:	12/26/2012
PROJECT NO:	4395-03
MXD NAME:	H:\4395-03\GIS\Maps\AppendedFigureII.mxd
SHEET NO.	APPENDED FIGURE II

REVISIONS

Engineering, Landscape Architecture and Environmental Science

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