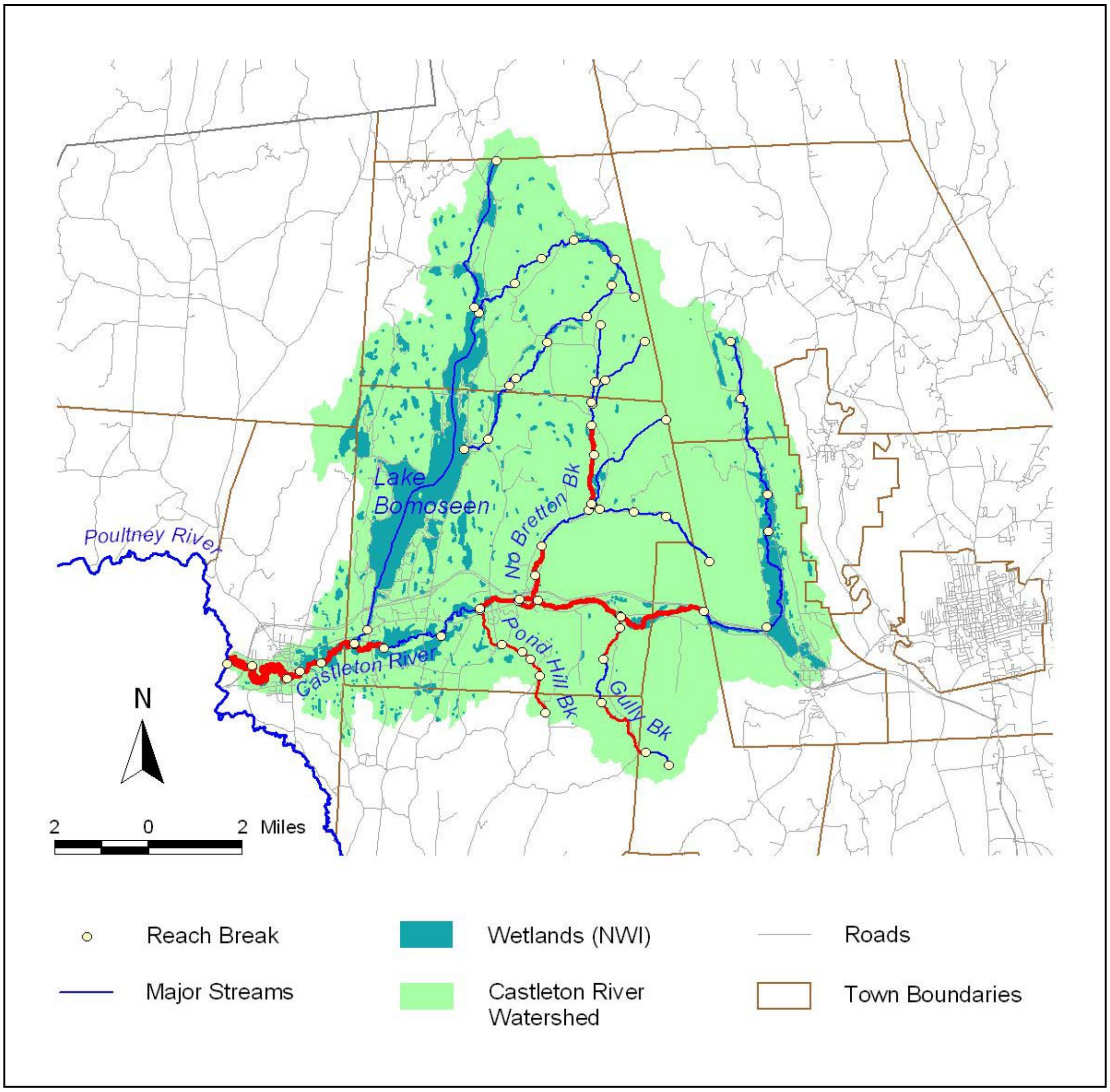
Phase 2 Stream Geomorphic Assessment
Castleton River Watershed – Town of Castleton
Rutland County, Vermont

March 2007 (Revised April 2008)



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ACKNOWLEDGEMENTS

This study was made possible through River Corridor Grant funding from the Vermont Department of Environmental Conservation, Water Quality Division (Governor Douglas's Clean & Clear program).

Field work was conducted with the cooperation of many riparian landowners in Castleton, Fair Haven, Poultney, and Ira, who granted permission to cross their property to access the river. Historical accounts of past flood events and channel management activities were also generously offered by many local representatives.

EXECUTIVE SUMMARY

Phase 2 stream geomorphic assessments were completed in 2005 and 2006 on 22 reaches (21.9 river miles) of the Castleton River main stem and North Bretton Brook, Pond Hill and Gully Brook tributaries following protocols published by the Vermont Agency of Natural Resources (VTANR, 2005, 2006).

Geomorphic data will be used by watershed stakeholders (including landowners, community members, watershed organizations, and state and federal resource agencies) to identify potential site-level, town-level, and watershed-level strategies for reducing streambank erosion and sediment and nutrient loading in the Castleton River watershed, by managing toward the equilibrium channel. The geomorphic condition of a given river reach or segment will help to define the short-term compatibility and long-term sustainability of various restoration or conservation projects and inform future land use or channel management choices.

Field investigations and limited historical data reviews have identified various watershed and channel disturbances that have impacted the Castleton River main stem and tributaries. Significant disturbances to the assessed river reaches have included:

- Channelization / straightening / dredging of tributary and main stem reaches;
- Berming along the banks of select tributary reaches;
- Channel armoring (rip-rap);
- Floodplain encroachment by roads, a former electric trolley grade, railroads, and residential and commercial development;
- Undersized culverts and bridges, which constrict channel flows;
- Direct pasturing of livestock in select main stem and tributary reaches;
- Introduction of increased flows and sediments through drainage ditches from adjacent agricultural fields;
- Stormwater runoff from roads, driveways and crossing structures;
- Active stream crossings (fords);
- Minimal or absent forested buffers along portions of the study reaches;
- Active logging and deforestation along Gully Brook reaches; and
- Flood events, including reasonably large events in December 2000, 1998, 1996, 1981, and the major floods of 1945 and 1927.

Also, several impoundments were noted on assessed reaches, including:

- four dams on the main stem (one intact low-head dam in Castleton and two intact dams and one breached dam in Fair Haven);
- one intact dam on the North Bretton Brook in Castleton;
- one breached dam on the Gully Brook in Poultney; and
- one breached and four intact dams on the Pond Hill Brook in Castleton.

The Castleton River and tributary channels are adjusting in response to these past watershed and channel disturbances. Adjustments have occurred to varying degrees, as dependent on many factors, including the magnitude and timing of past disturbances, the erosion resistance of sediment types in the channel bed and banks, the type and density of vegetative cover along stream banks, and presence of grade controls such as exposed bedrock. Broadly speaking, the assessed reaches can be grouped into three categories:

- Some of the assessed river reaches were in regime, showing an expected (natural) level of change or adjustment. Generally, these reaches were connected to their surrounding floodplain and appear to be maintaining average channel dimensions, planform, and profile, over time. These include bedrock-controlled reaches of the Gully Brook and Pond Hill Brook, as well as the bedrock falls through the village of Fair Haven. These segments are afforded greater stability by the underlying bedrock, and are less susceptible to lateral and vertical adjustments, even where significant channel disturbances have occurred. This category would also include several wetland-dominated reaches along the Castleton River main stem upstream of the Birdseye Road crossing in the towns of Castleton and Ira and downstream of the Castleton village to Fair Haven.

- In contrast, some of the assessed main stem and tributary reaches have become disconnected from their surrounding floodplain, following extensive historic channel manipulations to accommodate roads, railroads, trolley grades, or agricultural uses. In some cases, historic channel incision resulted from channel straightening and dredging. Often channel entrenchment was exacerbated by floodplain encroachments such as berms, railroad grades or road bed materials.

  Through historic channel manipulations, these channel segments have been converted from unconfined, meandering channels with opportunities for overbank and point bar sediment deposition to entrenched, linear more transport-dominated channels. The modified channel would be expected to have enhanced sediment transport capacity as a result of the increased slope and increased stream power. At present, enhanced erosive energies of these segments appear to be balanced by the resisting forces of the channel margins (e.g., forested buffers, armored beds, streambank revetments). Dominant adjustment processes observed in these reaches were planform adjustment, aggradation and widening; none of the segments exhibited signs of system-wide active incision. Nevertheless, these channel segments remain highly susceptible to catastrophic channel adjustments and associated fluvial erosion losses in future flood events, given their entrenched status. Also, they tend to translate erosive energies and sediment loads to downstream reaches. This category includes select reaches of the Gully Brook, North Bretton Brook, and Pond Hill Brook tributaries in proximity to commercial, municipal, agricultural and residential land uses.

- Between these extremes, a third broad category of the assessed reaches was apparent - reaches where historic incision has led to a minor to moderate degree of channel entrenchment, but the channel has some degree of floodplain connection, particularly in larger flood events. Dominant adjustment processes observed in these reaches were minor to moderate planform adjustment, aggradation and widening; none of the segments exhibited signs of system-wide active incision. Often, the coarseness and erosion resistance of materials in the stream bed and banks (including exposed or shallow bedrock) has moderated the potential for channel adjustments. Alternately, channel disturbances or encroachments may have been minimal. Some segments have experienced minimal adjustment despite evidence of significant channel manipulations – perhaps due to relatively intact forest and scrub/shrub buffers and cohesiveness of streambank soils. Many of the main stem and tributary reaches are in this category.

River management opportunities have been identified based on the Phase 2 geomorphic assessment results. A potential project listing forms the basis for follow-on project development activities which can be carried out by watershed stakeholders.

1.0 INTRODUCTION

Phase 2 geomorphic and habitat assessments were completed in 2005 and 2006 on 22 reaches (21.9 river miles) of the Castleton River main stem and North Bretton Brook, Pond Hill and Gully Brook tributaries following protocols published by the Vermont Agency of Natural Resources (VTANR, 2005, 2006). Objectives of the Phase 2 geomorphic assessments were to:

- determine the geomorphic condition of targeted reaches, and identify active vertical and lateral adjustment processes;
- identify current and historic channel and watershed stressors; and
- evaluate the sensitivity of reaches to future channel and watershed stressors given their current geomorphic condition and inherent vulnerability (e.g., valley setting, slope, streambed and streambank sediments, vegetative buffer conditions);

Assessment results will be used by watershed stakeholders (e.g., landowners; Castleton, Fair Haven, and Ira townships; Poultney Mettowee Watershed Partnership (PMWP), VT Department of Environmental Conservation Water Quality Division (VTDEC WQD), Rutland Regional Planning Commissions and Natural Resources Conservation Districts) to:

- provide a watershed and river-network context for site-specific restoration and conservation projects (i.e., understand if the river is actively degrading, aggrading, widening, or shifting its planform in the areas upstream and downstream of a proposed project site);
- support site-specific channel restoration design and planning;
- understand water quality and temperature monitoring trends in the river; and
- plan for future development which is compatible with adjusting river channels

Assessment data were entered into the online Data Management System (DMS), a custom database of Phase 1, 2, and 3 geomorphic data developed and maintained by the Vermont Water Quality Division. This summary report has been prepared by South Mountain Research & Consulting (SMRC) of Bristol, Vermont under contract to the Poultney-Mettowee Natural Resource Conservation District (PMNRCD).

2.0 BACKGROUND

Phase 2 assessments were undertaken in the Castleton River watershed to provide a geologic and geomorphic context for the streambank erosion and water quality issues documented in the river.

2.1 Geographic Setting

The Castleton River drains approximately 99.3 square miles of land area located in Rutland County, Vermont (Figure 1). The Castleton River joins the Poultney River at the Vermont / New York border. The Poultney River flows to the Champlain Canal to the north of Whitehall, New York; waters then drain to the north via the canal to the southern extent of Lake Champlain.

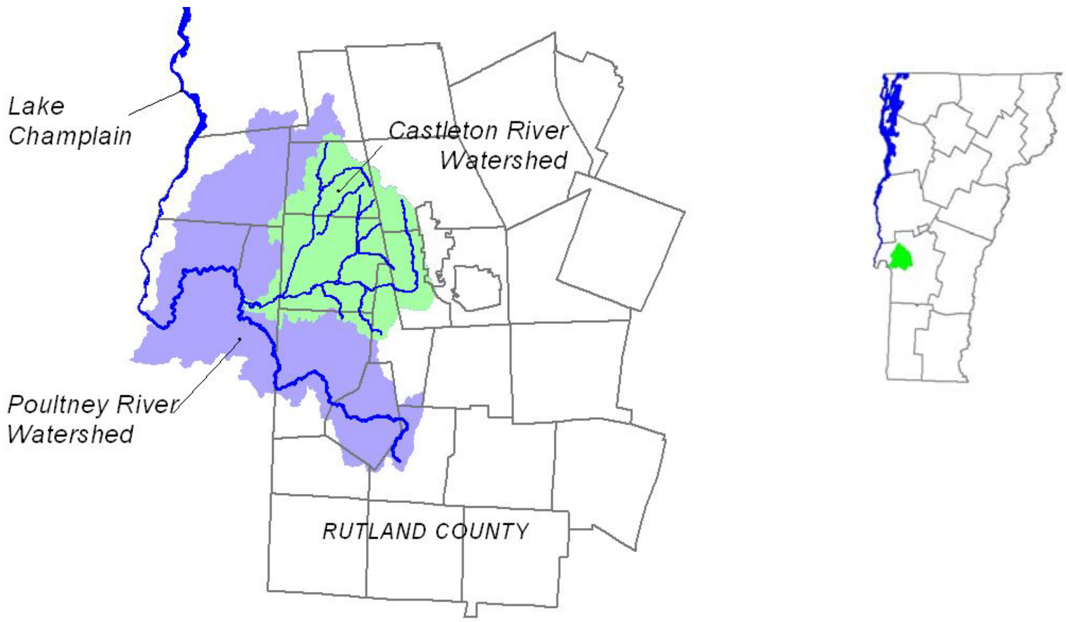


Figure 1. Location of Castleton River watershed, within Poultney River watershed and Rutland County, VT.

The Castleton River watershed drains portions of eight towns (see Figure 2). This Phase 2 Stream Geomorphic Assessment focused on 22 river reaches along 21.9 miles of the Castleton River main stem and three major tributaries in the towns of Castleton, Fair Haven, Ira, and Poultney.

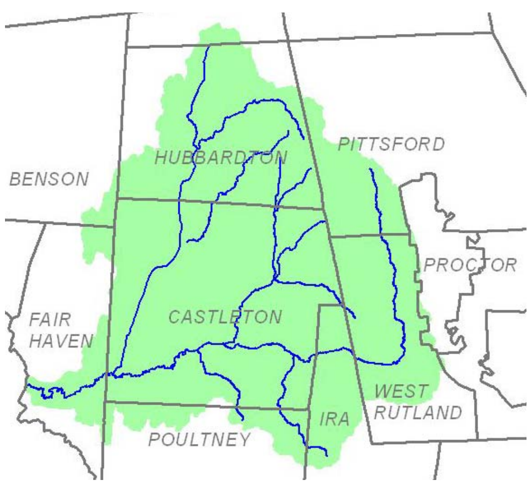


Figure 2. Location of Castleton River watershed within Rutland County towns

Town	Area (sq mi)	Percentage (%)
Benson	0.7	0.7%
Castleton	**41.9**	**42.2%**
Fair Haven	4.4	4.4%
Hubbardton	**21.7**	**21.9%**
Ira	6.2	6.2%
Pittsford	6.8	6.9%
Poultney	4.0	4.0%
Proctor	0.3	0.3%
Rutland Town	0.0	0.0%
Sudbury	0.5	0.5%
West Rutland	**12.6**	**12.7%**

2.2 Regional Geologic Setting

The Castleton River watershed is located largely within the Taconic Mountain physiographic province, a wide band of elevated terrain trending north-south from the Lake Bomoseen area to eastern New York and western Massachusetts. The Taconic province is positioned between the narrow Vermont Valley and the higher-elevation Green Mountains to the east and the broad Champlain Valley to the north and northwest. The upper headwaters of the Castleton River watershed through the West Rutland swamp are within the Vermont Valley province (Stewart, 1972).

Highest elevations within the Castleton River watershed include more than 1,780 feet on the western flanks of Herrick Mountain drained by Gully Brook in the southern extent of the watershed, and more than 1,800 feet along the western flanks of the Taconic Range drained by tributaries to the North Bretton Brook in the eastern portion of the watershed. The lowest elevation in the watershed is approximately 297 feet at the confluence of the Castleton River with the Poultney River.

In recent geologic time (prior to 14,000 years before present) this landscape was occupied by advancing and retreating glaciers, with ice up to a mile or more in thickness above the present land surface in the Champlain Valley to the north. Glacial tills now blanket much of the upper bedrock-controlled slopes and headwaters of the Castleton watershed. While earlier glacial advances covered all of Vermont, the final glacial advance (Burlington ice sheet) is believed to have extended only part way into the Castleton River watershed - along the lower-elevation main stem valley into West Rutland but not, for example, up into the higher-elevation tributary valley of Gully Brook. Terminal moraines were deposited near the village of Castleton, near Birdseye, West Rutland and Rutland. The largest of these is the Birdseye terminal moraine east of the Gully Brook confluence along the northern flanks of Bird Mountain (Stewart & MacClintock, 1969).

As the global climate warmed and the glaciers receded, a large fresh-water lake (Lake Vermont) inundated the Champlain Valley, and joined Lake Albany to the south in the Hudson River valley. At its highest stage, Lake Vermont's waters extended through the low-lying Castleton River valley to the north of West Rutland and also encompassed the broad valley now occupied by Lake Bomoseen. Silts and clays, originally deposited in Lake Vermont, are mapped near the present day land surface in the Castleton River valley from the vicinity of West Rutland downstream to the Gully Brook confluence. Ancient lake sand deposits are mapped from Castleton village downstream to the confluence with the Poultney River. At higher stages of Lake Vermont, it is likely that small deltas of sands and gravels formed at the margins of Lake Vermont where the tributaries joined the lake waters. Lacustrine sands are mapped where the Pond Hill Brook flows out into the broader Castleton River valley (MacClintock, no date). At lower stages of Lake Vermont, a delta of sands and fine gravels was formed in the vicinity of Fair Haven village, as sediments carried by the Castleton River were deposited out into the lake (Stewart and MacClintock, 1969).

Lake Vermont waters receded in stages. Initially, flow was directed to the south via Lake Albany and the Hudson River valley. Later flows reversed to the north as northward-retreating ice sheets opened up drainage to the Atlantic Ocean via the St. Lawrence Seaway. Subsequently, marine waters filled the Champlain Valley from the St. Lawrence Seaway as the rate of rise in ocean water levels far exceeded the rate of rise, or isostatic rebound, of the land surface now relieved of its glacial burden (Stewart and MacClintock, 1969; Cronin, 1977; Wagner, 1972; Connally and Calkin, 1972). The maximum elevation of these marine waters is not believed to have extended into the present-day Castleton River watershed (Wagner, 1972). Nevertheless, changing base levels in the Champlain Valley during this Champlain Sea event would have influenced erosional and depositional cycles in the Castleton River watershed.

Champlain Sea waters had receded from the greater Champlain Valley by approximately 10,000 years before present, as the rate of land rise began to outpace the rate of sea-level rise. River systems, including the Castleton River, then continued moving and redepositing sediments left in the wake of the glaciers, and further eroding the Taconic Mountains. As base levels dropped in the Champlain Valley (and the Poultney River), the Castleton River eroded downward through the Lake Vermont delta deposits and underlying lake silts and clays. Today, in the town of Fair Haven, the Castleton River is incised up to 80 feet into these deposits. Downward incision was apparently arrested at exposures of channel-spanning bedrock in the present-day village of Fair Haven. Currently, these bedrock exposures serve as a local base level for upstream reaches of the Castleton River.

2.2.1 Bedrock Geology

In general, the bedrock geology of the Castleton River watershed consists of folded and faulted slates and phyllites, with lesser amounts of quartzites, marbles and dolomite of Cambrian and Ordovician age (Stewart, 1972; Zen, 1964; Fowler, 1950). The slates and phyllites of the Taconic province originated as sedimentary mudstones deposited in an ancient sea (450 to 550 million years old). They were later compressed and altered under elevated temperature and pressure conditions during the Taconic mountain building event and subsequent regional deformations to form metamorphic slates and phyllites. In the process of Taconic mountain-building, older Cambrian and Ordovician rocks were folded and thrust over younger Ordovician limestones and marbles. Later, regional stresses caused further folding and faulting of the Taconic mass.

Generally, the Taconic Mountains are comprised of Cambrian and Ordovician slates and phyllites. The Vermont Valley province in the eastern part of the watershed is comprised of Lower to Middle Ordovician dolomites and limestones and phyllites. The underlying bedrock geology of the watershed influences the Castleton River in many ways. The topography of the watershed is a direct result of the characteristics of the underlying bedrock. Phyllite and slate members that are more resistant to weathering form the uplands of the watershed as in the area of Herrick Mountain, Pond Hill, and Bird Mountain. Upstream of West Rutland, the valley is underlain by less erosion-resistant phyllites, marbles and dolomites. The valley bottoms of the Castleton River main stem and its major tributaries have formed where the lithology and fractures of the bedrock cause it to be more erodible. The major tributaries to the Castleton are oriented north-south consistent with the bedrock layering and major faults. Tributaries draining from the north side of the watershed (i.e., North Bretton Brook and Lake Bomoseen) are much larger in area and have more gradual overall slopes than the tributaries draining from the southern portion of the watershed (i.e., Pond Hill Brook and Gully Brook).

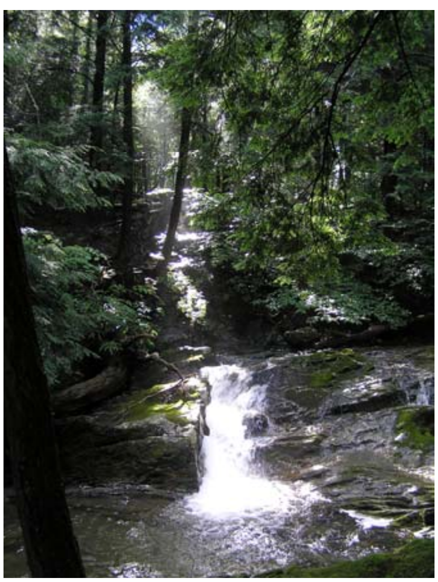


Figure 3. Bedrock gorge west of Birdseye Road on Gully Brook. (T02.11-s1.04)

The boundary between the Taconic Mountains to the west and the Vermont Valley sequence to the east is marked by a major north-south trending thrust fault – the Giddings Brook Fault, which continues to the south of West Rutland as the Pond Hill Thrust. Upstream of West Rutland, the western wall of the Castleton River valley is coincident with the Giddings Brook Fault, while the eastern valley wall is coincident with the Pine Hill Fault (Zen, 1964).

Frequent bedrock exposures influence the channel position and profile in the watershed. Bedrock exposures along the valley walls control the lateral position of the river channel. Locations of channel-spanning bedrock offer vertical grade control, preventing possible downward erosion of the channel in response to regional or local stressors (at least over the 10- to 100-year time spans on which this study is focused). Within the main stem and tributary reaches that were assessed in 2005 and 2006, prominent bedrock exposures were encountered in Gully Brook (Figure 3), Pond Hill Brook, the Castleton main stem downstream of the Fort Warren mobile home park, and the main stem through Fair Haven village at the sites of three low-head dams.

2.2.2 Surficial Geology

The nature of the surficial sediments and soils present in the Castleton River watershed today reflects the glacial and post-glacial lake history of the region. Upland slopes are dominated by shallow- to moderate-thickness glacial till deposits overlying bedrock. These till deposits are typically a dense mixture of sediment sizes from silts to cobbles and boulders; the till sediments are typically cohesive and of low permeability (Stewart, 1972; Stewart & MacClintock, 1966; MacClintock, no date).

As glaciers began to retreat to the north, ice stagnated in the low-land valleys of the Castleton main stem and its tributaries. Meltwater channels and tributaries deposited sands, gravels and cobbles along the margins of the ice at the valley walls. As the ice finally melted, these ice contact deposits were revealed in the form of kame terraces and kame moraines which are visible today along the edges of the Castleton River valley from the Castleton village (which is developed on a kame terrace) upstream and to the north of West Rutland. Kame terraces are also mapped along the lower reaches of the North Bretton Brook and Pond Hill Brook. These ice contact deposits are typically non-cohesive and have moderate to high erodibilities when exposed in stream banks and beds (Stewart & MacClintock, 1966; MacClintock, no date).

As the Lake Vermont waters inundated the Castleton River valley following deglaciation, fine silts and clays were deposited upstream of the Gully Brook confluence, and sands and fine gravels downstream of Castleton village. Coarser sands and fine gravels underlying the village of Fair Haven, comprise the delta deposit which extended out into Lake Vermont at the former confluence of Castleton River (Stewart & MacClintock, 1966; MacClintock, no date).

The Castleton River network today is eroding and re-depositing the mix of glacial and post-glacial sediments of the watershed. Upland tributaries are winnowing the finer-grained sediments from the mix of glacial till materials, leaving behind the larger cobbles and boulders that exceed the tributaries' transport capacity. Where major tributaries join the Castleton River (e.g., Pond Hill Brook, North Bretton Brook, Gully Brook) alluvial deposits are interlayered with alluvial fan deposits and overlie glacial kame terrace and moraine deposits (Stewart & MacClintock, 1969) as well as possible delta deposits. The ancient lake-bottom silts and sands exposed in the main Castleton River channel, are today overlain by more recent alluvial sands and gravels associated with overbank deposition and meander migration of the Castleton River (Stewart & MacClintock, 1969).

2.3 Geomorphic Setting

In the Phase 1 Stream Geomorphic Assessment (RRPC, 2005), the Castleton River watershed (Figure 4) was delineated into geomorphic reaches using remote sensing methods supported by windshield surveys. Geomorphic reaches were defined based on variation in valley confinement, slope, and sinuosity. The reader is referred to the Phase 1 summary report prepared by RRPC for details of the Phase 1 assessment.

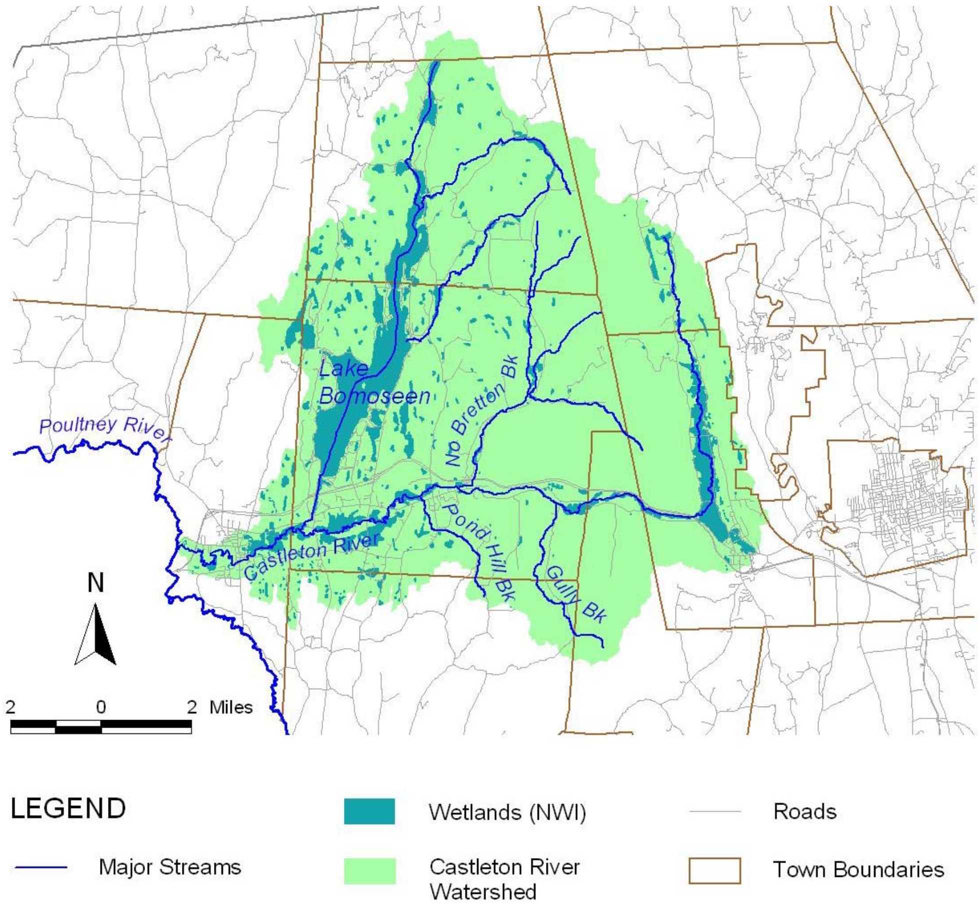


Figure 4. Identification of major tributaries in the Castleton River watershed.

The Castleton River watershed was delineated into a total of 56 reaches during the Phase 1 process (see Table 1). The Castleton River is the 2^{nd} major tributary (T02) to the Poultney River; thus, each of the Castleton main stem reaches is prefixed with a "T02". Major tributary reaches are denoted with a capital "S"; minor tributaries with a lower case "s". Reach lengths ranged from 0.2 mile to 7.8 miles, with an average length of 1.3 miles (RRPC, 2005).

Table 1. Phase 1 Reach Delineation in the Castleton River Watershed.

Tributary Identification	Name	Drainage Area (sq mi)	Channel Length (mi)	Number Reaches
T2	Castleton River	99.28396	25.4	17
T02.05-s1	Lake Bomoseen	37.5	11.9	14 (including tribs, Giddings & Sucker Brooks
T02.08-s1	Pond Hill Brook	2.5	3.1	5
T02.09-s1	North Bretton Brook	13.6	7.2	15 (including tribs)
T02.11-s1	Gully Brook	4.9	4.6	5

Figure 5 illustrates the Castleton River main stem and select tributaries in longitudinal profile. Generally, valley and river channel slopes become shallower as one progresses downstream toward the confluence with the Poultney River. Relief in the watershed varies from highest elevations of more than 1800 feet along the Taconic Range near the upper extent of the North Bretton Brook in the town of West Rutland, to a low elevation of approximately 297 feet at the confluence with the Poultney River in the town of Fair Haven.

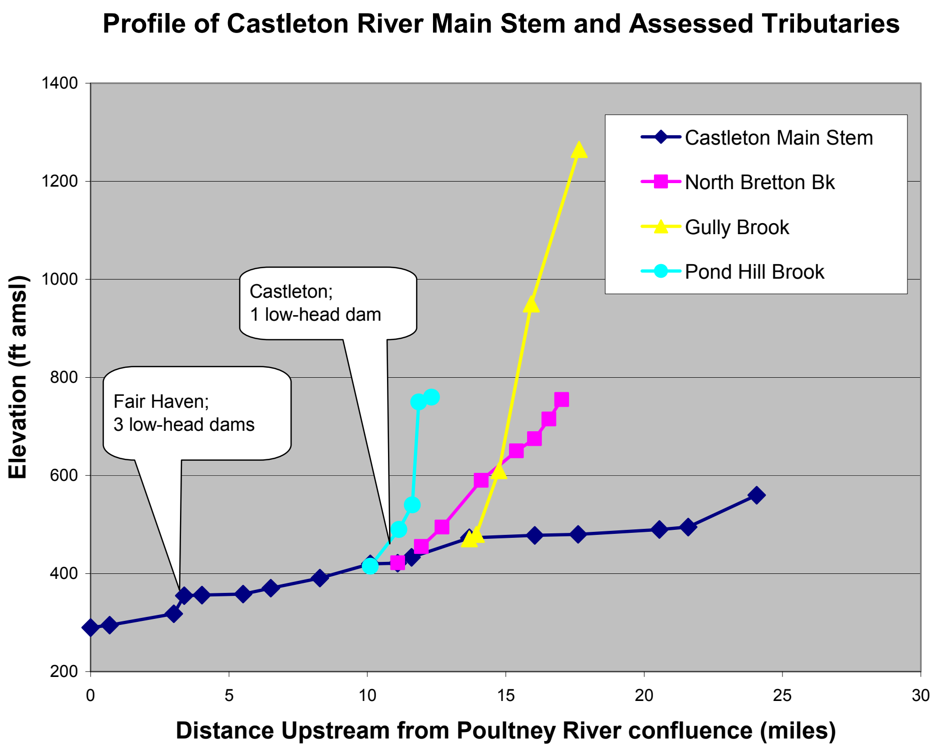


Figure 5. Longitudinal profile of Castleton River main stem and assessed tributary reaches.

Based on the channel and watershed stressors identified through remote sensing, windshield surveys and limited historical research during the Phase 1 Geomorphic Assessment, select reaches were targeted for field-based Phase 2 assessment. Targeted reaches were those expected to demonstrate higher degrees of channel adjustment and sensitivity based on their topographic setting and provisional identification of past and current watershed and channel disturbances.

Twenty-two reaches (21.9 river miles) were prioritized for Phase 2 Stream Geomorphic Assessment in 2005 and 2006: ten main stem reaches in the towns of Fair Haven and Castleton; five reaches along Pond Hill Brook in the towns of Poultney and Castleton; four reaches along the North Bretton Brook in Castleton; and three reaches along Gully Brook in the towns of Ira, Poultney, and Castleton (see Table 2 and Figure 6).

Table 2. Reaches in the Castleton River watershed selected for Phase 2 assessment in 2005 and 2006.

Tributary Identification	Reach Number	Channel Length (ft)	Year Assessed
Castleton River Main Stem	T02.01	3,626	2006
	T02.02	12,230	2006
	T02.03	1,996	2006
	T02.04	3,389	2005
	T02.05	7,849	2005
	T02.06	5,302	2005
	T02.09	5,234	2005
	T02.10	2,626	2005
	T02.11	11,021	2005
	T02.12	12,493	2005
Pond Hill Brook	T02.08-s1.01	5,451	2006
	T02.08-s1.02	2,537	2006
	T02.08-s1.03	1,256	2006
	T02.08-s1.04	2,425	2006
	T02.08-s1.05	4,802	2006
North Bretton Brook	T02.09-s1.01	4,507	2005
	T02.09-s1.02	3,964	2005
	T02.09-s1.04	6,709	2005
	T02.09-s1.05	3,458	2005
Gully Brook	T02.11-s1.01	1,346	2006
	T02.11-s1.02	4,275	2006
	T02.11-s1.04	9,130	2006

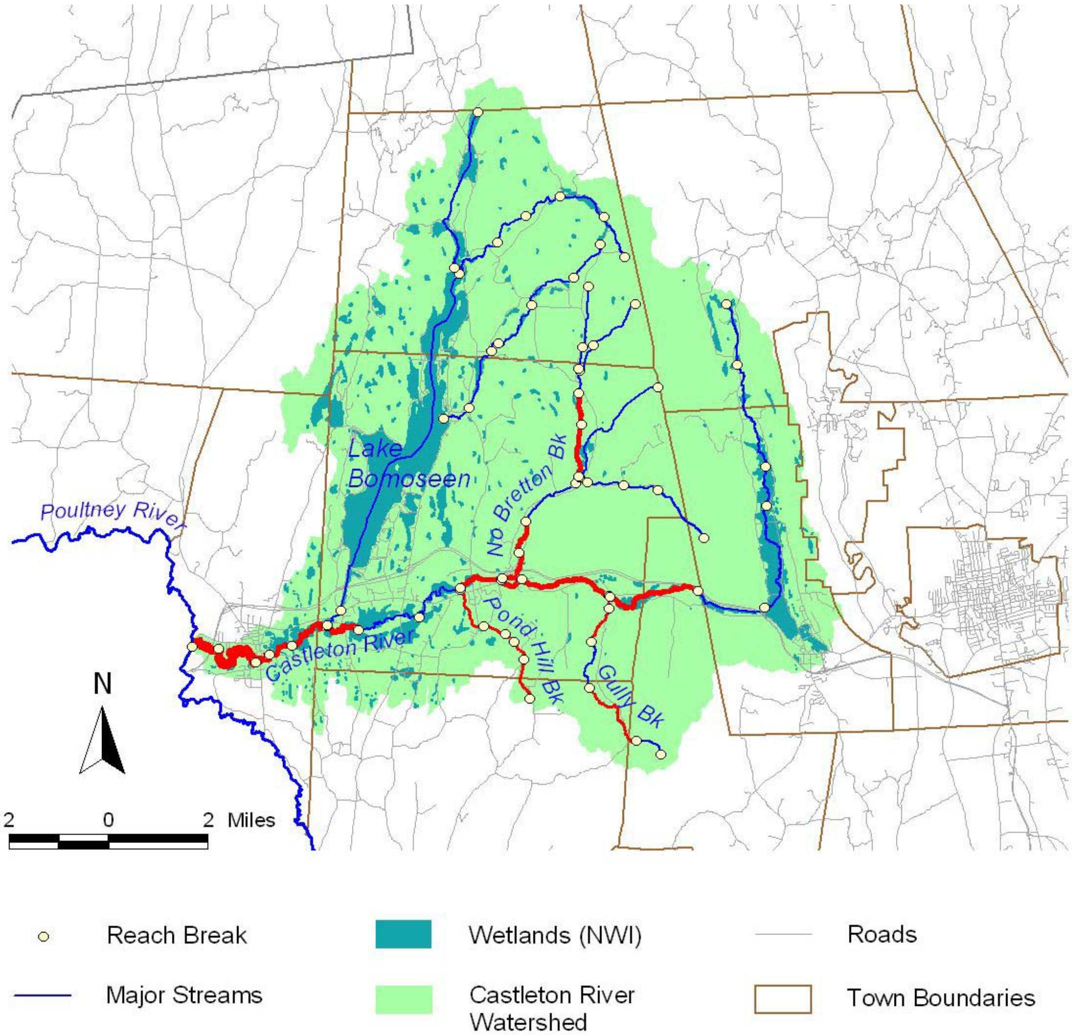


Figure 6. Reaches of the Castleton River watershed selected for Phase 2 Stream Geomorphic Assessments 9 (highlighted in red).

2.4 Hydrology

The United States Geological Survey (USGS) does not currently operate flow gages in the Castleton River watershed.

2.5 Flood History

Flood events can serve as a stressor to the Castleton River network, leading to localized or systemic channel adjustments. Readily available historic data were reviewed to identify flood events of significance in the previous several years in the Castleton River watershed (Table 3). A limited historical review included annual reports for the towns of Castleton and Fair Haven, history books, state-wide flood publications, and interviews with local citizens. The 1927 flood is the highest flood on record in the State of Vermont.

Table 3. Notable flood events in Castleton River watershed

Flood Date(s)	Description	Data Source
2000, Dec 17	Damages along Birdseye Road.	Swift, 2006
1998, June 25	Damages along Birdseye, Pond Hill and Moscow Roads. FEMA event 1228	Castleton Ann. Rpt, y/e June 1998
1996, January	FEMA event 1101	Castleton Ann. Rpt, y/e June 1998
1981, June 16	" 'Flash Flood' that wiped out roads, bridges and caused many families to evacuate their homes."	Castleton Ann. Rpt, 1981
1945, July	"Flash Flood"; expenses itemized for "reopening of Gulley Brook"; "all brooks [on Pond Hill Rd] cleaned with power shovel"; "Cemetery Road (washout at junction of U.S. No. 4)"; extensive damage [to] Birdseye road, Blissville North and South road."	Castleton Ann. Rpt, 1945
1927	Largest flood on record in Vermont.	USGS, 1990

2.6 Land Cover / Land Use

The following land cover / land use data set available from the Vermont Center for Geographic Information (www.vcgi.org) was utilized to summarize land cover / land use in the Castleton River watershed:

- Landcover / Landuse for Vermont and Lake Champlain Basin (LandLandcov_LCLU, edition 2003). Source dates of 1991 to 1993. Further details of this land cover / land use data set are available at: http://www.vcgi.org/metadata/LandLandcov_LCLU.htm.

Classification of land cover/ land use in the above data set follows methods of Anderson, *et al*, 1976. Land surface characteristics are classified into 17 different categories. These 17 categories were consolidated into 5 broader groups in Table 4: commercial / industrial, residential, agricultural, forest / shrub, and water/wetlands.

Table 4. Land cover/ land use in Castleton River watershed (RRPC, Phase 1 data, 2005).

Watershed	**Drainage Area (sq mi)**	Commercial / Industrial	Residential	Agricultural	Forest / Shrub	Water / Wetland
Castleton River	99.4	0.1%	6.5%	9.4%	74.5%	9.4%
Lake Bomoseen	37.5	0.0%	5.2%	5.9%	72.5%	16.3%
Pond Hill Brook	2.5	0.0%	8.1%	23.7%	60.7%	7.5%
North Bretton Brook	13.7	0.0%	3.1%	12.7%	79.4%	4.8%
Gully Brook	4.9	0.0%	2.4%	4.1%	87.7%	5.8%

While agricultural and developed uses comprise a relatively small percentage of the overall watershed area, these activities tend to be concentrated along the valleys of the Castleton and its tributaries.

Village areas within the towns of Castleton and Fair Haven operate municipal wastewater treatment facilities (WWTFs) which discharge treated wastewater to the Castleton River. At the points of their discharge to the Castleton River, flows from these WWTFs represent a very small percentage of the total flow in the river at bankfull (see Table 5).

Table 5. Discharges from Castleton and Fair Haven wastewater treatment facilities to the Castleton River.

		Castleton WWTF	Fair Haven WWTF
Geomorphic Reach Receiving WWTF Discharge		T02.07	T02.02
Upstream Drainage Area to the Reach	(square miles)	53.5	99.02
Approximate Bankfull Discharge at the Reach (VTDEC, 2001 Regional Hydraulic Geometry Curves)	(cubic feet per second)	1,250	2,416
	(millions of gallons per day)	807,840,000	1,561,393,152
WWTF Flow (2001) (from Lake Champlain Phosphorous TMDL)	(millions of gallons per day)	0.277	0.283
WWTF Flow as a percentage of the Total River Flow at Bankfull		0.00000003%	0.00000002%

3.0 ASSESSMENT METHODOLOGY

Stream geomorphic assessments conducted in the Castleton River watershed utilized protocols published by the Vermont Agency of Natural Resources and available at: http://www.vtwaterquality.org/rivers/htm/rv_geoassesspro.htm. Reaches assessed in 2005 utilized the 2005 version of the protocols, while reaches assessed in 2006 followed the 2006 version of the protocols. Reference is made to these protocols for a description of specific methods followed to complete Phase 2 Stream Geomorphic Assessments and Bridge and Culvert Assessments.

3.1 Phase 2 Stream Geomorphic Assessment

Phase 2 Stream Geomorphic Assessment protocols are field procedures for geomorphic and habitat assessment. Reach-specific and cross-section data gathered during Phase 2 identify the present geomorphic condition of the river reach and the dominant process(es) of adjustment (i.e., degradation, widening, aggradation and/or planform adjustment). Phase 2 results, along with Phase 1 assessment results, define the natural and human disturbances to the watershed and channel over time and the composite response or adjustment of the channel to these stressors.

Main stem reaches T02.12, T02.11 (select portions), T02.10, T02.09, T02.06, T02.05, T02.04, T02.02, and T02.01 were assessed by kayak. Other main stem reaches (T02.03 and portions of T02.11) and tributary reaches were accessed on foot. During Phase 2 assessments, specific features and present channel positions were located using a Garmin™ eTrex Vista global positioning system (GPS) unit. Pictures were recorded with a digital camera.

Assessments were completed during the following time frames:

- 2005 reaches – 28 June through 1 September
- 2006 reaches – 13 July through 23 August

In accordance with protocols, specific features were digitized in ArcView© 3.x. For the 2005 reaches, features were documented in shape files. For 2006 reaches, features were referenced to the Vermont Hydrography Dataset (VHD), using the Feature Indexing Tool, a component of the Stream Geomorphic Assessment Tool (SGAT v. 4.53). Later, features for the 2005 reaches were updated to FIT impact files by Leslie Fernandes of VTDEC River Management Section, and reviewed and updated by SMRC, so that the full Castleton River data set would be available as FIT files.

Phase 2 assessment data were entered into the online Data Management System (DMS) maintained by the VTDEC WQD at https://anrnode.anr.state.vt.us/ssl/sga/index.cfm . Phase 2 reach summary reports, standard output from the DMS, are compiled in Appendix B.

Assessments were performed under a programmatic Quality Assurance Project Plan (QAPP) generated by the Vermont Water Quality Division, River Management Section (VTDEC WQD, 2003). Quality assurance documentation is included in Appendix C (see also Section 3.2).

Bridge and culvert crossing structures were encountered during Phase 2 assessments. Structure spans, clearance and width measurements were conducted at each structure. The span of each minor and major crossing was compared to measured or predicted bankfull widths (VTDEC WQD, 2006b), to determine if the structure was a constrictor of flows at the bankfull stage or the flood prone width elevation (10-year to 50-year flood). Appendices D and E provide details of the bridge and culvert assessments.

3.2 Phase 1 Updates

For the Castleton River and tributary Phase 2 reaches assessed in 2005 and 2006, Phase 1 assessment data were reviewed and verified during field work as per VTANR protocols. Necessary corrections or updates were documented on Phase 1 summary sheets for each reach (see original field data sheets). As appropriate, GIS shape files were corrected or updated (using the Feature Indexing Tool), as well as the Phase 1 data in the DMS.

Phase 1 parameters updated, included:

- presence of alluvial fans (Phase 1 Step 3.1);
- presence and location of bedrock or other grade controls (Phase 1 Step 3.2)
- steepness of valley side slopes (Phase 1 Step 3.4);
- width of riparian buffers (Phase 1 Step 4.3);
- groundwater inputs (Phase 1 Step 4.4);
- revetment lengths and locations (Phase 1 Step 5.3);
- channel straightening (Phase 1 Step 5.4);
- location and lengths of berms and roads (Phase 1 Step 6.1);
- location and lengths of development (Phase 1 Step 6.2);
- occurrence of depositional bars and bedforms (Phase 1 Step 6.3);
- occurrence of channel avulsions, neck cut-offs, flood chutes (Phase 1 Step 6.4);
- erosion lengths and heights (Phase 1 Step 7.2);
- occurrence of, or potential for, ice/debris jams (Phase 1 Step 7.3)

The above features are more comprehensively inventoried for the study reaches during field assessments, than they are able to be during a Phase 1 which is accomplished through remote sensing and limited windshield surveys.

Occasionally, the reference stream type was updated as a result of field observation of valley confinement, or channel gradient and dimensions. Often, elevation data for the downstream and upstream reach breaks were updated as a result of field-based observations, or to correct for apparent interpolation or data entry errors in Phase 1 (see Appendix F). Accordingly, channel and valley gradient calculations were updated. As noted in Appendix F, these updates resulted in a change in stream type (slope) for select reaches.

As detailed in the protocols (VTANR, 2006), watershed and channel stressors defined in Steps 4 through 7 of Phase 1 are factored into impact ratings that are assigned to each reach. It was these impact ratings, in part, that helped the PMNRCD and VTDEC River Management Section to prioritize reaches for field-based assessments (RRPC, 2005). Many of these Step 4 through Step 7 parameters were updated as a result of field-based observations during Phase 2 assessments. Consequently, Phase 1 impact ratings changed.

3.3 Quality Assurance / Quality Control

Following completion of standard DMS Phase 2 quality control checks (X.1 through X.4), Phase 2 data were submitted to the River Management Section for a quality assurance review. QA/QC documents are contained in Appendix C.

The following considerations and limitations apply to the Phase 2 data for the Castleton River watershed:

- Where applicable, reaches were segmented using the Segmentation Tool contained in SGAT (v. 4.53). Segmentation was necessary to:

- Capture subreaches of a stream type (after Montgomery & Buffington, 1997; and Rosgen, 1994) that was different than the reference stream type of the overall reach;
- Identify sections of a reach that were of distinctly different geomorphic condition;
- Identify sections of a reach undergoing a different channel management or land use;
- Isolate in-stream wetlands; and
- Define bedrock channel sections, defined as "gorges" by protocols;

- The Segmentation Tool within SGAT automates the calculation of segment lengths. Elevation data for the downstream and upstream segment breaks were interpolated from USGS 7.5-Minute topographic maps. Segment lengths and elevations are presented in Appendix F, along with channel gradients calculated for each segment. Segment slopes were factored into the stream-type designation for each segment. The elevation data for the downstream and upstream ends of the overall reach were originally developed in the Phase 1 assessment of the Castleton River watershed (RRPC, 2005). During this Phase 2, reach break elevations were often updated as a result of field-based observations, or to correct for apparent interpolation or data entry errors in Phase 1. Accordingly, channel and valley gradient calculations were updated. In a few cases, these updates result in a change in stream type (slope) for the overall reach (see Appendix F). Phase 1 data in the DMS were updated accordingly.

- Select Phase 2 features (including, grade control locations, stormwater inputs, streambank erosion, revetment locations, and more) were geo-located using the Feature Indexing Tool (FIT) in SGAT. Using FIT, these features are indexed to the available Vermont Hydrography Dataset (VHD) for the Castleton River basin. In many cases, surface waters depicted on the VHD were significantly offset from their actual position on 1994 orthophotos available for the study area. Additionally, in some cases, the actual channel position has moved from its 1994 position as a result of channel management activities (e.g., straightening) or natural channel migrations. These cases were revealed by comparison of the 1994 orthophotos with the 2003 aerial imagery (NAIP, 2003), or by review of 2005 and 2006 channel positions recorded with a hand-held GPS. Thus, locations and lengths of features indexed to the VHD should be considered approximate. Waypoint logs and sketch maps contained on the Project CD provide more insight into the recorded locations of these features.

4.0 PHASE 2 ASSESSMENT RESULTS

Phase 2 geomorphic and habitat assessments were completed in 2005 and 2006 on 22 reaches (21.9 river miles) of the Castleton River main stem and North Bretton Brook, Pond Hill and Gully Brook tributaries. Phase 2 assessment results are summarized below for the Castleton River main stem (Section 4.1) and its tributaries (Sections 4.2, 4.3, and 4.4). Detailed Phase 2 assessment results are tabulated in Appendix B, the standard report output from the online DMS for Phase 1 & 2 Stream Geomorphic Assessment data.

A reference stream type (Phase 1) and an existing stream type (Phase 2) have been classified for each reach. Stream type designations are based on Rosgen (1996) and Montgomery & Buffington (1997). A sensitivity classification was also assigned to each reach based on the Phase 2 stream geomorphic assessment data. The sensitivity classification is intended to identify "the degree or likelihood that vertical and lateral adjustments (erosion) will occur, as driven by natural and/or human-induced fluvial processes" (VTANR guidance, 11 July 2007). Inherent in the stream sensitivity rating are:

- the natural sensitivity of the reach given the topographic setting (confinement, gradient) and geologic boundary conditions (sediment sizes) – as reflected in the reference stream type classification; and

- the enhanced sensitivity of the reach given by the degree of departure from reference (or dynamic equilibrium) condition – as reflected in the existing stream type classification and the condition (Reference, Good, Fair to Poor) rating of the Rapid Geomorphic Assessment).

Abbreviations used in the sections below include the following (see protocols for further description):

- LB, facing downstream (abbreviated, "LB")
- RB, facing downstream (RB).
- Incision Ratio (IR) = Low Bank Height / Bankfull Max Depth
  - IR_{RAF} = Recently Abandoned Floodplain Incision Ratio
  - IR_{HEF} = Human-Elevated Floodplain Incision Ratio
- Entrenchment Ratio (ER) = Flood Prone Width / Bankfull Width
- Flood Prone Width (FPW) – estimated as the 10- to 50-year flood event
- Large Woody Debris (LWD)
- Debris Jams (DJs)
- Rapid Geomorphic Assessment (RGA)
- Rapid Habitat Assessment (RHA)
- Vermont Hydrography Dataset (VHD)
- Global Positioning System (GPS)

4.1 Castleton River Main Stem (T02)

The Castleton River is a 99-square-mile subwatershed of the Poultney River. Approximately 74.5% of the watershed is in forest cover; only 9.4% is in agricultural use; 6.6% is developed; and the remainder is water or wetlands.

Phase 2 assessments were completed on 12.5 miles of the Castleton River main stem, including reaches T02.12, T02.11, T02.10, T02.09 and T02.06 in Castleton, and T02.05, T02.04, T02.03, T02.02, and T02.01 in Fair Haven. Results for the 10 reaches which comprise this section are summarized in Table 6 (and Appendix B). Findings are discussed by reach in the following text, proceeding from upstream to downstream.

T02.12

T02.12 is a 2.4-mile reach which extends from a point along the south side of the Route 4 highway in Ira and crosses under the Clarendon-Pittsford Railroad and Route 4A to end just downstream of the Birdseye Road crossing upstream of the Gully Brook confluence. This low-gradient reach meanders through a very broad valley dominated by wetlands. Over recent history, the natural floodplain for the river in this reach has been encroached upon by roads, a railroad and a trolley line:

- Route 4A and its predecessors beginning in the late 1770s, (Steele, 1877; Beers, 1869);
- The Clarendon-Pittsford Railroad (formerly Delaware & Hudson; a.k.a. Washington Railroad, Albany & Rutland Railroad) which was installed circa 1850 (Castleton Historical Society, 1998; Chace, 1854; Beers, 1869; Adams, 1870; USGS, 1897).
- Electrified trolley car line from West Rutland to Fair Haven installed by 1904, and operational until 1924 (RRPC, 2001; anon., 2005)
- Route 4 highway in the 1960s (post-1962 aerial photos).

While the river valley has become more confined as a result of the grades (berms) which support these rail lines and roads, valley widths still average over 10 times the channel width through the developed reach. Small feeder tributaries along the right-bank corridor in the mid-portion of the reach have been ditched and channelized, presumably to maximize the agricultural use of adjacent fields. This channelization has likely increased flows rates and peaks in the receiving portion of the Castleton River main stem during moderate to high rainfall events. Such increased flows would likely be attenuated in the wetlands dominating the downstream end of the reach.

The upper 1,700 feet (14%) of the reach appears to have been straightened in the 1960s, associated with construction of the Route 4 highway. In a mile-long stretch of reach T02.12 between the Clarendon-Pittsford railroad crossing and the Route 4A road crossing, the main stem appears to have been channelized in the late 1800s as the grade for the electric trolley car was installed along the left-bank corridor. The channel became pinned between the trolley grade along left corridor, and cultivated fields along right corridor. The river appears to have regained some sinuosity in this section of the reach since the trolley car was abandoned in the 1920s (RRPC, 2001). Straightening is also suggested by the linear planform immediately upstream and downstream of the Route 4A crossing, and adjacent to pasture lands at the downstream 950 feet of the reach. Periodic dredging and gravel extraction have occurred at the downstream end of the reach in the vicinity of the Gully Brook confluence (VTDEC WQD, 2006c; VTDEC WQD, 2004a; see Section 4.2 under reach T02.11-s1.01 for more details).

The river appears to have good access to its floodplain throughout the reach, with the possible exception of the upper 1700 feet, where the channel appeared slightly incised. Five (5) bridges (railroad, Route 4A, and private farm bridges), one culvert (former ski area access road), and one pair of old abutments (trolley grade crossing) were encountered along the reach. One private bridge and the culvert were noted to be bankfull-channel constrictors.

Table 6. Results of Phase 2 Geomorphic Assessments, Castleton River Main Stem

Castleton River Main Stem - Ira, Castleton, Fair Haven

Reach	Seg-ment	Channel Length (ft)	Channel Slope (%)	Drainage Area (sq mi)	Stream Type	Incision Ratio	RHA Condition	RGA Condition	Adjustment	Vertical Stream Type Departure?	Channel Evolution Stage	Sensitivity
T02.12	--	12,493	***0.1***	23.8	E4-R/D	Not Assessed - Wetland-Dominated						
T02.11	B	5,876	***0.3***		C4-R/P	1.3 (RAF)	0.55 Fair	0.39 Poor	Aggr, PF & Wid	No	IV [F]	Very High
	A	5,145	***0.3***	32.9	C4-PB	1.0 (RAF)	0.47 Fair	0.71 Good	Aggradation	No	V [F]	High
T02.10	--	2,626	***0.3***	33.3	C4-R/P	1.3 (RAF)	0.81 Good	0.65 Good	Wid (slight) & Aggr	No	IV [F]	High
T02.09	B	2,045	***0.6***		F4-PB	NM	0.58 Fair	0.49 Fair	Aggr, PF & Wid	C to F	II [F]	Extreme
	A	3,190	***0.3***	47.9	C4-R/P	1.0 (RAF)	0.66 Good	0.48 Fair	PF, Aggr, Wid	No	IV [F]	Very High
T02.08	--	9,625	***0.2***	52.8	Not Assessed - access denied							
T02.07	--	9,350	***0.2***	53.5	Not Assessed - access denied							
T02.06	--	5,302	***0.1***	57.5	C4-R/D	1.0 (RAF)	0.67 Good	0.78 Good	None	No	I [F]	High
T02.05	--	7,849	***0.1***	97.4	E5-R/D	NM	0.76 Good	0.78 Good	Planform (minor)	No	I [F]	High
T02.04	--	3,389	***0.1***	98.1	E5-R/D	NM	0.77 Good	0.83 Good	None	No	I [F]	High
T02.03		1,996	***2.4***	98.4	B3b-S/P	Not Assessed - Bedrock Channel / Impounded						Low
T02.02	B	6,938	***0.04***		B4c-R/P	1.0 (RAF)	0.71 Good	0.60 Fair	PF	No	I [D]	Very High
	A	5,292	***0.02***	99.0	C5-R/D	1.0 (RAF)	0.73 Good	0.63 Fair	PF	No	I [D]	Very High
T02.01	--	3,626	***0.1***	99.3	C4c-R/D	1.2 (RAF)	0.69 Good	0.78 Good	None	No	I [D]	High

Notes / Abbreviations:

Channel Slope: Values in italic bold have been updated since the Phase 1 SGA, due to field-truthing and/or segmentation.

Stream Type: S/P = Step/Pool; R/P = Riffle/Pool; R/D = Ripple/Dune; PB = Plane Bed; Casc = Cascade; Ref = Reference

Incision Ratio: RAF = Recently Abandoned Floodplain; HEF = Human-elevated Floodplain (following protocols, VTANR, 2007).

Condition: RHA = Rapid Habitat Assessment; RGA = Rapid Geomorphic Assessment (VTANR, 2006).

Adjustment: PF = Planform Adjustment; Aggr = Aggradation; Wid = Widening; Deg = Degradation; NM = Not Measured.

Channel Evolution Stage: F = F-stage model; D = D-stage model (see Appendix C of protocols, VTANR, 2006).

(a) (b)

Figure 7. View upstream (southeast) from Birdseye Road crossing at the downstream extent of reach T02.12. (a) 14 June 2005 at near bankfull condition; (b) 30 June 2005 at lower-flow conditions. Turbidity has also cleared as flows subside.

Reach T02.12 is dominated by wetland conditions, with diffuse flows through braided channels. Figure 8 shows several locations noted where flows were breaching the logging road (former ski access road) that crosses the wetlands complex downstream of the Route 4A crossing. The location of the culvert crossing is identified as a dam on the Vermont Dam Inventory (VCGI, 2003) – no construction information for this dam site was offered in the Inventory. The road which crosses the channel and wetlands at this location appears to have been constructed in the early 1960s to provide access to the Birdseye Mountain ski area that operated until the late 1960s or early 1970s (NELSAP, 2007).

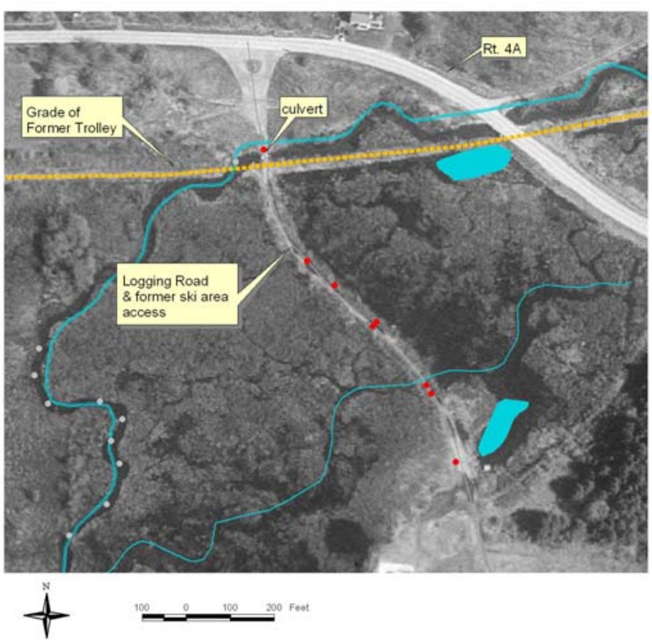


Figure 8. Red dots indicate locations where individual channel flows were crossing the logging road on 30 June 2005.

Channel adjustments along reach T02.12 were minimal. Occasional splitting flows associated locally with debris jams or beaver dams.

Habitat conditions were rated as "Good", on the threshold with "Reference". Numerous snags, submerged logs and trees, and the occasional boulder provided abundant epiphaunal substrate. Minimal floodplain encroachment has preserved ample buffers along this wetland-dominated reach.

T02.11

T02.11 extends from the Gully Brook confluence downstream to the Route 4A crossing by the Fort Warren mobile home park. Field conditions noted within the reach led to segmentation at the halfway point of this reach, resulting in two mile-long segments: Segment B: 5,876 feet; Segment A: 5,145 feet.

Segment B

The upstream half of the reach has experienced floodplain encroachment by the electric trolley grade, the Clarendon-Pittsford Railroad, agricultural land uses, and residential development. The trolley grade forms a berm along right bank for essentially the full length of the segment, reducing valley widths substantially in some locations. It is likely that the river was channelized historically (in the early 1900s) to accommodate the trolley grade. At a few discrete locations, the river channel is observed to have breached the grade, providing for localized floodplain access.

Periodic dredging and gravel extraction have occurred at the upstream end of the segment in the vicinity of the Gully Brook confluence – as recently as 2006 (VTDEC WQD, 2006c; VTDEC WQD, 2004a; see Section 4.2 under reach T02.11-s1.01 for more details).

Segment B is exhibiting signs of aggradation, and planform change. Based on field observations and geomorphic assessments conducted along the Gully Brook (see Section 4.2), the main source for sediments within Segment T02.11-B is the Gully Brook. Upstream main stem reach T02.12 is a wetland area providing flood and sediment attenuation for the watershed at that location. Sediment and debris-jam generated planform changes are evident throughout Segment B, and the channel appears to be regaining sinuosity.

Several flood chutes along left bank are active in Segment B, upstream of the Route 4A crossing (see Appendix B). Anecdotal accounts (Savage, 2006) and review of historic aerial photographs indicate that the Castleton River leaves its straightened planform and flows to the west across agricultural fields to reach the far left valley wall during larger-magnitude flood events. (A recent avulsion occurred in 2007).

Downstream of Route 4A, at the downstream extent of Segment B near the horse stables, a recent channel avulsion is apparent. The Castleton River has abandoned a meander approximately 600 feet in length to flow approximately 400 feet through active horse pasture (see Figures 9 and 10).

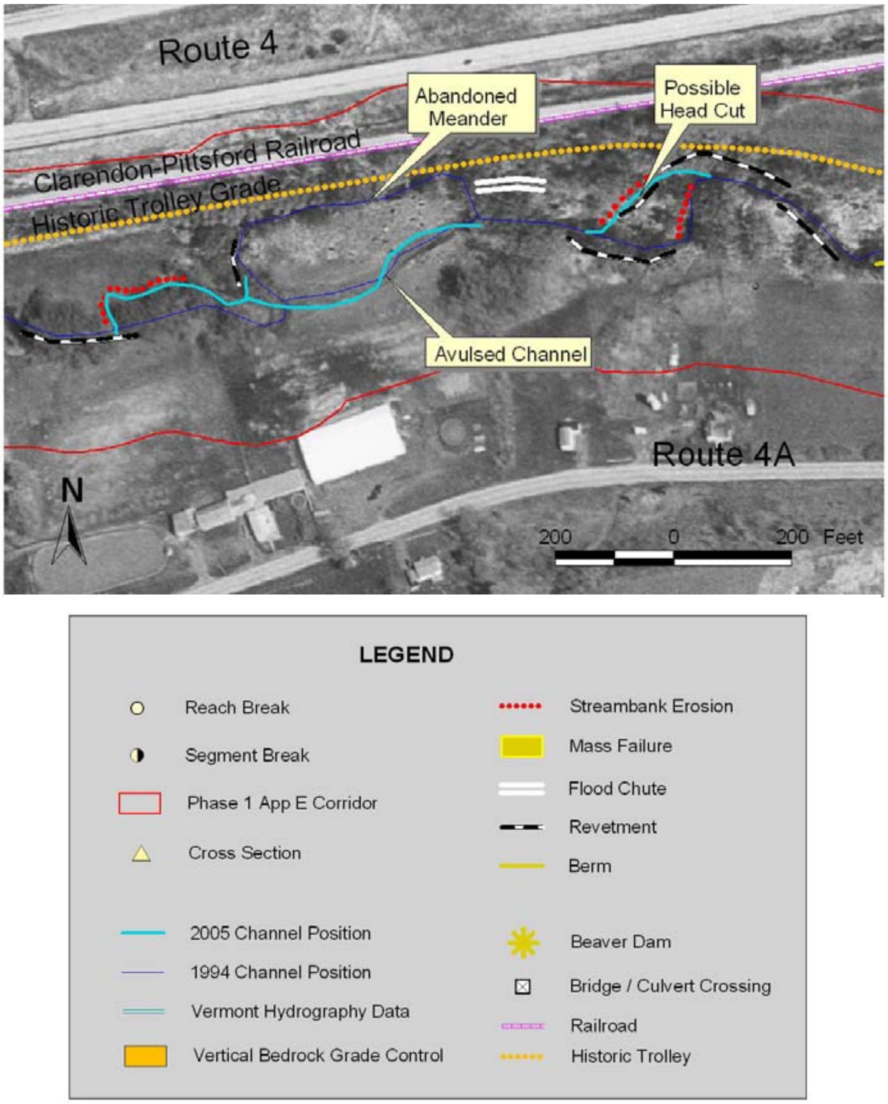


Figure 9. Channel avulsion occurring pre-1994 in which Castleton River abandoned a 600-foot meander to flow along a 400-foot length of channel through horse pasture. The channel was restored to its original planform by the landowner, but had re-avulsed prior to the 2005 assessment of this reach.

(a)

(b)

Figure 10. (a) View downstream (to the west) of avulsed channel through horse pasture. (b) View downstream (to the west) of abandoned channel. Castleton River main stem, 30 June 2005.

Approximately 250 feet upstream of the avulsion site, the channel is bifurcated in the vicinity of debris jam activity. The right-bank channel had then itself bifurcated to outflank a line of small rip-rap along its right bank. A steep nick point is present, where the river has eroded through a dense, cohesive surface layer of sediment to scour deeply into more erodible sediments beneath. A splitting of flows in this right-bank channel has resulted, as a portion of the flow was observed to be perched above the resistant layer, while the remainder of the flow was over the nick point into an immediately-adjacent scour pool which has eroded below the resistant layer (Figure 11). At first glance, it might appear that this nick point represents a head cut generated by incision from the avulsion site just downstream. However, the lack of an incised condition in the intermediate channel length (between the nick point and the avulsion site) suggests this nick point to be a localized phenomenon. The irregular channel form through this area may simply be the result of the layering of sediments of varying erosion resistance, exacerbated by the upstream sedimentation and downstream scour processes associated with debris jams which have since washed through. Vehicle tracks or other signs of heavy equipment use were not observed in the thickly-vegetated buffers along right and left banks.

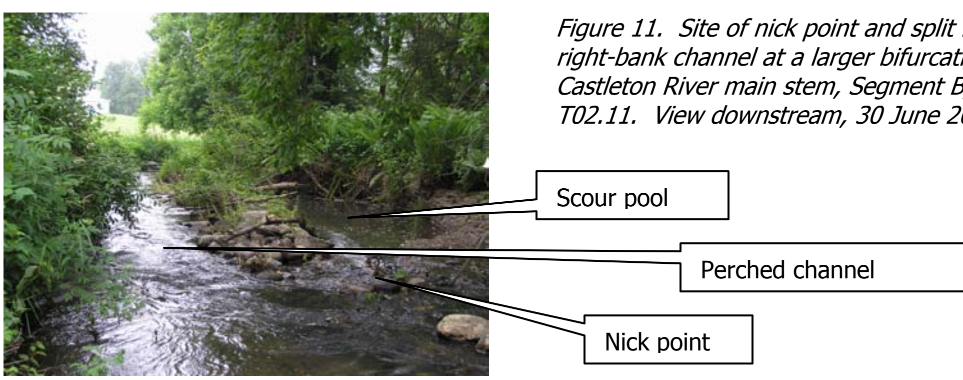


Figure 11. Site of nick point and split flows in a right-bank channel at a larger bifurcation of Castleton River main stem, Segment B, Reach T02.11. View downstream, 30 June 2005.

Habitat conditions for Segment B were rated as "Fair", compromised by an overall lack of wide tree buffers, high sediment deposition rates, and lack of bedform diversity due to historic channelization. On the positive side, the channel appears to be actively widening and adjusting its planform in response to aggradation. In the process, it is recruiting LWD which are contributing to pool formation and providing increasing morphological diversity.

Signs of significant water quality impacts were observed at the downstream end of the reach, below the horse farm. A noticeable increase in fine and suspended sediments was noted, with channel bed transitioning sharply from a firm gravel bed to a soft, mucky, bed. Turbidity increased noticeably. Hay and manure berms were observed along left bank.

Segment A

Segment A of reach T02.11 flows through the broad valley from the vicinity of the horse farm downstream nearly to the Route 4A road crossing near the Fort Warren Mobile Home Park. Historic channelization is suggested by: (1) the linear planform of the segment for distances much greater than 20 times the channel width, (2) abundant rip-rap armoring along both banks, (3) occasional berms, and (4) close encroachment of agricultural fields. The railroad and former trolley grade encroach along the right bank corridor at the upstream 800 feet and downstream 750 feet of the segment. The Route 4 highway (east-bound) is also location in the RB corridor beyond the railroad in the upstream 800 feet of Segment A. Vehicle access along the right (north) bank in the upstream 800 feet would enable gravel extraction or other channel modifications. Route 4A encroaches along the downstream 600 feet of the channel along the left corridor. A driveway encroaches along right bank in this section. Three farm bridges encountered along the segment (1 footbridge, and 2 equipment bridges) were each constrictors of the bankfull channel. Scour pools were evident downstream of two of the bridges.

Despite the apparent channel manipulations of the past, the channel has not incised to the degree expected. Most locations within the reach had reasonable floodplain access (IR_{RAF} = 1.0 to 1.2). The cross section site showed no incision. The upstream 800 feet along the railroad appeared somewhat incised. Overall, the channel was narrower and deeper than expected, indicating a width/depth ratio on the cusp between a C stream type and an E stream type.

Segment A appeared transport-dominated, with little sediment accumulation in the form of bars. A plane-bed bed form dominated, except in isolated locations where sedimented riffles and even short braided conditions existed. Buffers of shrubs and herbaceous plants were largely continuous along the length of the reach, but were minimal in width, averaging 5 to 25 feet.

It is possible that the combination of boundary conditions consisting of cohesive, erosion-resistant sediments in the channel bed and banks, along with reasonably contiguous buffers, and a relatively minor channel gradient (i.e., lower flow velocities) have served to moderate the potential channel incision and widening that might be expected in response to the substantial channelization of this segment.

Habitat conditions were rated as "Fair", compromised by a lack of morphological diversity and epiphaunal substrates resulting from historic channel management. Minimal buffer widths and lack of mature trees along a majority of the reach also limited the degree of shading and availability of detritus and LWD. Habitats were also compromised by the accumulation of fine sediments in the upstream end of the segment.

T02.10

T02.10 is a 0.5-mile reach which extends from the Route 4A crossing near the Fort Warren Trailer Park downstream to the next Route 4A crossing west of the intersection of East Hubbardton Road.

Several channel management choices in the valley appear to have influenced the current planform and condition of reach T02.10. At present, North Bretton Brook tributary joins the Castleton main stem just downstream of the reach break between T02.10 and T02.09. Based on review of topographic maps and historical resources (1897 USGS topographic map; Castleton Historical Society, 1998), it is apparent that this confluence was moved during the mid-1800s to accommodate the railroad (see discussion and maps under reach T02.09-s1.01, Section 4.3). Later in the 1960s, the Route 4 highway was constructed near the right valley wall of the main stem along reaches T02.10 and T02.09. Over time, residential and commercial developments were established in the floodplain near this confluence. Until the mid-1990s, a drive-in theater was present along the right bank corridor of reach T02.10. Since that time, a commercial building company has replaced the drive-in.

At either end of reach T02.10, the channel is locally confined between valley fill material that forms approach ramps for the Route 4A bridge crossings. These bridges are floodplain constrictions and the approach ramps likely serve to impound flood waters somewhat in high-magnitude flood events. In the mid-portion of the reach, the channel is somewhat incised, with reasonable floodplain access along the right bank. In discrete locations, the incision ratio appears to exceed the value of 1.3 measured at the reach cross section. Absence of headcuts or rejuvenating tributaries suggests that incision is historic in nature. The left bank is coincident with (or within one bankfull width of) the left valley wall, a very steep forested slope. Bedrock was exposed along approximately 10% of the left bank, and likely provides lateral grade control to a majority of the reach along this bank. At one mid-reach location bedrock was noted to be channel-spanning, offering vertical grade control.

Forested buffers are present along a majority of the reach, offering channel stability, shading, and recruitment of large woody debris and detritus. Other than the bridge crossings and commercial/ industrial development at either end of the reach, floodplain encroachment within the corridor is minimal.

Overall, the reach is exhibiting minor degrees of adjustment (aggradation and widening). Recent planform adjustments were negligible, based on a review of 1972 topographic maps, and 1960s, 1940s orthos. Lateral and vertical bedrock grade controls, a downstream low-head dam (see T02.09), and contiguous woody buffers along both banks, appear to be offering stability to a channel that otherwise might be expected to demonstrate a greater degree of adjustment in response to past channel management and a moderately incised condition.

Habitat conditions were rated as "Good", compromised somewhat by slight sedimentation and a limited degree of streambank erosion. Detritus and LWD were abundant in the reach offering good epifaunal substrate and morphological diversity.

T02.09

Reach T02.09 is nearly a mile in length and extends from a point between the Route 4A crossing and the Clarendon-Pittsford railroad crossing, upstream of the North Bretton Brook confluence, downstream to the north of Castleton village, under the North Road bridge crossing to end just upstream of the Cemetery Drive bridge crossing.

This reach passes through a broad to very broad valley setting, with a local valley pinch-point occurring near the downstream end of the reach. Surficial geologic mapping indicates a transition within the reach from glacial tills and coarser gravels and sands of kame terrace origins in the upstream half to sands of an ancient high-level lake setting in the downstream half (Stewart & MacClintock, 1969). A notable difference in channel management history led to a segmenting of the reach: Segment B, 2045 ft; Segment A, 3190 ft.

Segment B

There have been many encroachments along Segment B over time. The Clarendon-Pittsford railroad parallels the southern corridor. Historic mill buildings, residences and other development associated with the village also fill the southern (LB) corridor. Agricultural fields encroach along the northern (RB) corridor; and the Hillside Cemetery is present along the RB corridor at the downstream extent of the reach. The Castleton River is crossed by the railroad, Mill Street, and North Street within the reach. A low-head dam is located near the upstream end of the reach (Figure 12). This run-of-river dam serves as a vertical grade control, and appears to have a small impounding effect.

Figure 12. Low-head dam in reach T02.09, located just downstream of the confluence of North Bretton Brook, approximately 350 feet downstream of the Route 4A crossing, and 110 feet downstream of the railroad crossing. (View upstream on 11 August 2005).

A limited survey on foot along the left bank of the river at the dam, revealed what appeared to be a former sluiceway channel (now heavily overgrown) leading to the west toward the former mill buildings along the south bank of the Castleton River in the vicinity of the Mill Street bridge crossing. The sluiceway channel was marked by a terrace on its left bank, and an earthen berm on its right bank. The berm may be coincident with the grade for the former electric trolley that connected West Rutland to Hydeville and Fair Haven. Given the relative elevations of this sluiceway channel and the impoundment behind the dam, it is possible that this sluiceway functions as an overflow channel for the river (flood chute) during very high water events.

In the vicinity of the Mill Street crossing, Smith & Rann (1886) noted that a grist mill, carding and fulling mill, and cider mill were present. A turning lathe powered by water from the Castleton River was used to shape cider-mill screws, bedsteads and other articles. An oil-mill, marble mill and feed mill also operated at the site in later years. The 1869 Beers Atlas identifies "Union Mills" with H.H. Westover, proprietor, as well as a furnace near the Mill Street crossing. The Beers Atlas does not depict a dam at the current location of the low-head dam encountered during field work. Instead, a short flow diversion channel is shown leading to the furnace and Union Mills in the vicinity of the Mill Street crossing (Beers, 1869); this diversion channel is far shorter than the apparent sluiceway identified in the field reconnaissance.

The dam, intake structure, and raceway are, however, depicted on a survey plat of the "*Estate of Mortimer B. Brown – Mill Street – Castleton, Vermont*" dated 1977 (Castleton Land Records, Map files). Also, a dam and raceway, together with rights to divert water and access the dam in support of an oil mill operation, are referenced in a deed from 1807 (Castleton Land Records, Book 7, page 422).

The channel along reach T02.09 is exhibiting moderate signs of adjustment, and was rated in "Fair" condition following the VTANR protocols and Rapid Geomorphic Assessment. The linear planform of the channel through the former mill area suggests historic channelization, and the channel did have the appearance of a moderately incised condition immediately upstream and downstream of Mill Street for a length of approximately 800 feet (or 39% of the segment). Armoring (rip-rap) was present along both banks through this section, and select trees were leaning in from both banks. It is likely that potential channel incision through this portion of the reach would be arrested by the presence of channel-spanning bedrock just upstream, and also by the low-head dam further upstream.

In general, the segment appears to be exhibiting less channel adjustment than might be expected given the localized incision at the mill area, and the composite of encroaching land uses and disturbances to the channel over time. Channel adjustments may have been moderated by presence of highly-resistant channel boundary conditions, continuous (though narrow in width) woody buffers along both banks, some lateral bedrock controls, vertical grade controls of the bedrock ledge and the low-head dam near the upstream end of the reach, relatively cohesive soils, and occasional channel armoring. Reach T02.09 was segmented after the completion of field work, and while visual observations suggest an incised and entrenched channel, a full cross section site is not available to confirm these channel dimensions. Therefore, Segment B was assigned a stream type of F4-PB in the "Administrative Judgment" portion of the DMS. A F stream type would constitute a stream type departure from the expected reference stream type of C4-riffle/pool. An Extreme sensitivity assignment would apply to a segment undergoing a C to F stream type departure.

Habitat conditions in Segment B were rated as "Good", compromised somewhat by the history of channel alterations and narrowness of buffer widths (locally).

Segment A

In contrast to Segment B, Segment A of T02.09 is well connected to the adjacent floodplain, which extends 5 to 10 channel widths in the lower half of the segment. Extensive wetlands (NWI) are mapped at and below the North Street crossing. A mid-segment cross section site was chosen as being representative of the segment as a whole. Cross section measurements confirmed the reference C-stream-type. Some widening was indicated by the occasional erosion and leaning trees from both sides of the channel, and a slightly higher than reference width-depth ratio. A lateral and vertical scour pool was evident downstream of the North Street crossing. Moderate aggradation was suggested by frequent transverse bars, mid-channel and point bars, steep aggradational riffles, and some filling of pools. Active and substantial planform change through the wetlands downstream of North Street was indicated by numerous flood chutes, and a recent channel avulsion that has carved a new channel with a substantially different planform than the channel represented on the 1994 orthophotographs (see Appendix B). Segment A was rated in "Fair" condition by the RGA.

Habitat conditions were rated as "Good", compromised somewhat by the degree of bank instability, narrowness of buffer widths (locally), and moderate degree of sedimentation within the reach. Recruitment of LWD is frequent throughout the reach; six (6) channel-spanning debris jams were recorded in the segment.

T02.08

Reach T02.08 was not able to be accessed, as landowner permissions were not granted along a majority of the reach.

T02.07

Reach T02.07 was not able to be accessed, as landowner permissions were not granted along a majority of the reach.

T02.06

Reach T02.06 extends approximately 1 mile in length, from upstream of the Blissville Road crossing to the confluence of the Lake Bomoseen outlet channel (see reach map in Appendix B). The channel meanders through wetland complexes, where there are relatively few encroachments except for some agricultural lands along both left and right corridor, and limited development along Blissville Road which crosses mid-reach. The left and right valley walls converge on the corridor in the vicinity of this Blissville Road crossing. There is a possibility of channel straightening associated with the Blissville Road bridge.

Forested and shrub buffers are present along a majority of the reach, offering channel stability, shading, and recruitment of large woody debris and detritus. Erosion is common along most outside bends. Meander migration is minimal, based on comparison of 1994 orthophotos to 2003 NAIP imagery. One occurrence of a neck cutoff was noted by comparison of GPS readings (Sept 2005) to the 1994 and 2003 imagery upstream of the Blissville Road crossing. A substantially different planform is represented on the 1972 USGS topographic maps (which apparently formed the basis for the VHD utilized in the Phase 1 assessment for Castleton River). It is unknown if this planform difference is related to channel migration occurring between 1972 and 1994/ 2003, or whether it is related to the accuracy and/or resolution of the topographic coverage.

Overall, the reach is exhibiting minor degrees of adjustment, not substantial enough to constitute a stream type departure, and not substantially outside the realm of natural variability. Slight widening was indicated by a slightly wider than reference width-to-depth ratio. The possibility of historic planform adjustment is indicated by comparison of the current and 1994 channel positions to that depicted on the 1972 topographic map. Cross section measurements and observation of channel features indicate negligible incision or aggradation. The reach has excellent flood plain access.

Habitat conditions were rated as "Good" in the Rapid Habitat Assessment. Numerous snags and submerged logs and trees, provided abundant epiphaunal substrates. Active recruitment of LWD and detritus is providing habitat and organic matter. Seven (7) channel-spanning debris jams were recorded, along with 67 Large Woody Debris along the 1-mile reach. Habitat conditions are compromised somewhat by reduced buffers widths, particularly along right bank, due to agricultural encroachments and active scour along the outside bends of both banks.

T02.05

Reach T02.05 is a 1.5-mile reach extending downstream from the Lake Bomoseen outlet nearly to the crossing of the Clarendon-Pittsford railroad (see reach map in Appendix B). For a 2,300-foot section in the upstream half of the reach, the Clarendon-Pittsford Railroad encroaches within the right corridor. A linear planform of the channel along the railroad for a length of approximately 900 feet suggests historic straightening. The Clarendon-Pittsford Railroad (formerly Delaware & Hudson) was constructed and became operational circa 1850 (Castleton Historical Society, 1975; Beers, 1869; USGS, 1897; Adams, 1870).

Other than the railroad, there is negligible development along this reach of the Castleton River. One narrow, collapsed bridge was noted in the upstream half of the reach (possibly a footbridge or equipment bridge associated with the adjacent railroad). One pair of old abutments was noted in the downstream half of the reach associated with fallow pasture along right and left banks. Span measurements of both of these structures indicated them to be constrictors of the bankfull channel. However, because the channel gradient (and therefore flow velocities) are low, scour downstream of these structures was minimal.

This reach flows through wetlands (mapped by NWI) which extend to either side of the valley. Based on visual estimates, the channel appears to have ample floodplain access. Several oxbows and meander scars are visible along the reach on 1994 orthophotos and historic (1942, 1962, 1968) aerial photographs. Shrub and deciduous buffers are present along a majority of the reach, offering channel stability, shading, and recruitment of large woody debris and detritus. Erosion is common along most outside bends, though less in degree than was observed in upstream reach T02.06.

A cross section was not completed in the reach, as it does not exhibit standard fluvial characteristics. Channel slopes are very gradual through T02.05. It is possible that wetland hydrology through this reach is influenced by the impoundments in downstream reach T02.03. Three low-head dams are located in reach T02.03; each of them is constructed on a bedrock base.

Overall, reach T02.05 is exhibiting minor degrees of adjustment - limited planform adjustment in the form of one recent (post-1994, pre-2003) neck cutoff and one pending neck cutoff associated with debris jam sites. (As with reach T02.06, a substantially different planform is represented on the 1972 USGS topographic maps).

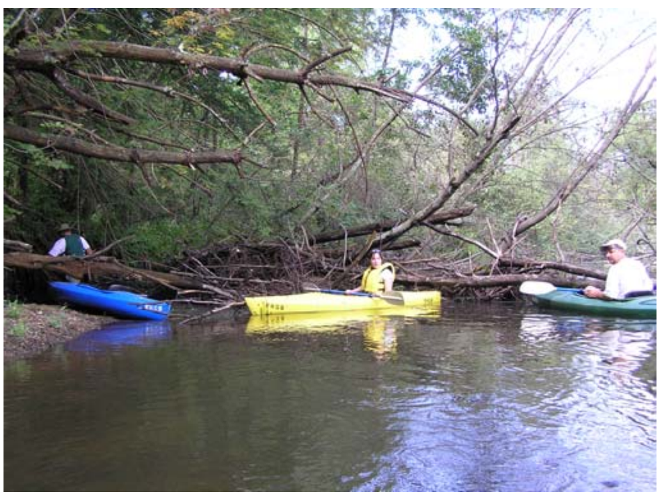


Figure 13. Fifteen (15) channel-spanning debris jams and 104 Large Woody Debris were recorded for the 1.5-mile length of reach T02.05.

Habitat conditions were rated as "Good" following the Rapid Habitat Assessment. Numerous submerged logs and trees, and multiple debris jams, provided abundant epiphaunal substrates. Active recruitment of woody material is providing pool habitats and organic matter. Fifteen (15) channel-spanning debris jams and 104 Large Woody Debris were recorded for the 1.5-mile reach. Habitat conditions are compromised somewhat by discrete sections of reduced buffers widths, particularly along right bank (due to former pasture encroachments), suspected historic channelization along 900 feet of the reach, and active low-bank scour along the outside bends of both banks.

T02.04

Reach T02.04 is a 0.6-mile reach extending from the vicinity of the Clarendon-Pittsford Railroad bridge crossing to a point just upstream of the River Street crossing in the village of Fair Haven (see reach map in Appendix B). The Clarendon-Pittsford Railroad encroaches along most of the reach – the right corridor for the upstream fifth of the reach, and the left corridor for the remainder of the reach downstream of the bridge crossing. River Street and associated residential and commercial development are positioned in the left corridor of the reach along the downstream 700 feet; and the town garage buildings with access via Maple Street Extension encroach along the right bank at the downstream 250 feet. Historic channel straightening is possible associated with the roads and railroad, given the observed linear planform. Except for the downstream end, which appears somewhat incised, the river has ample floodplain access through the reach.

As with upstream reaches T02.05 and T02.06, this reach flows through wetlands extending to the left and right valley walls. Additional wetland channels are visible on the 1994 orthophotos, particularly to the north of the main channel. Shrub and deciduous buffers are present along a majority of the reach, offering channel stability, shading, and recruitment of large woody debris and detritus. Low-bank erosion is apparent along some outside bends, though less in degree than was observed in upstream reach T02.05.

A cross section was not completed in the reach, as it does not exhibit standard fluvial characteristics. Channel slopes are very gradual through T02.04 (0.1%). Wetland hydrology through this reach is likely influenced by the impoundments in downstream reach T02.03. Three low-head dams are located in reach T02.03, each of them constructed on a bedrock base. The upstream-most dam is located at the River Street crossing approximately 450 feet downstream of the downstream end of T02.04.

Reach T02.04 was rated in "Good" condition following the Rapid Geomorphic Assessment protocols, on the cusp with "Reference". Overall, the reach is exhibiting very minor degrees of lateral or vertical adjustment. Similar to upstream reaches, the recent planform (as identified by GPS waypoints and 1994 and 2003 aerial photos) is more sinuous than the channel position represented on the 1972 USGS topographic maps and the VHD.

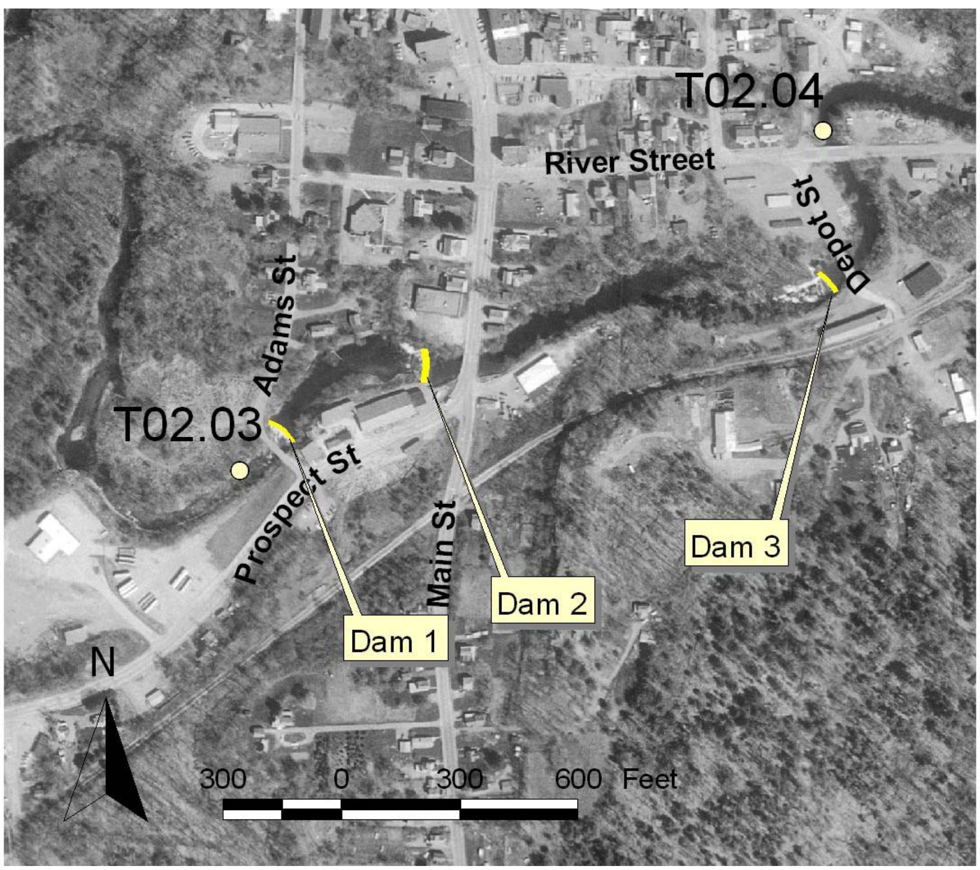
Figure 14. Length of armoring on left bank (view facing downstream) along the Clarendon-Pittsford railroad, reach T02.04.

Habitat conditions were rated as "Good" following the Rapid Habitat Assessment protocols. Active recruitment of woody material is providing epiphaunal substrates, pool habitats and organic matter. Two (2) channel-spanning debris jams and 20 Large Woody Debris were recorded for the 0.6-mile reach. Buffers are intact and of ample width, with the exception of the downstream developed end of the reach, and discrete sections where the channel is closely paralleled by the railroad. Habitat conditions may be compromised somewhat by streambank erosion (of limited extent) and lengths of channel armoring along left bank which have reduced canopy covers and limited near-bank vegetation.

T02.03

Reach T02.03 is a short section of narrowly-confined, bedrock-controlled channel through the village of Fair Haven. Three prominent bedrock falls are located at the upstream end, mid-point, and downstream end of the reach, respectively. Given the bedrock-controlled nature of reach T02.03 and the dams and impoundments, an RGA and RHA were not completed for this reach and a "Low" sensitivity was assigned, following protocols. The moderately steep gradient, predominance of bedrock in the channel bed and banks, and narrow confinement suggest that this reach would serve as a transport-dominated reach in a natural, unmodified state. However, construction of the dams has artificially created sediment and flow attenuation areas through impoundment effects.

The left-bank and right-bank corridors of reach T02.03 are encroached upon by roads, commercial and residential buildings, and a railroad (left bank) (Delaware & Hudson, formerly Whitehall & Castleton RR [Chace, 1854]). Historically, three dams were constructed between Depot Street and Adams Street to harness the water power of the natural bedrock falls (see Figure 15). These dams are associated with a more than 200-year history of industrial and manufacturing developments along the Castleton River. A brief summary of each dam site is provided below; additional details are provided in a separate report (SMRC, May 2006).



	Dam 1	Dam 2	Dam 3
Location in Reach T02.03	Downstream End	Mid-reach	Upstream End
Nearest Bridge Crossing	Adams Street	Main Street	Depot Street
Known As	Shirt Factory Dam	Structural Slate Dam	Water Street Dam

Figure 15. Dam locations on Castleton River, Reach T02.03, Fair Haven, VT (1994 orthophoto base; flow in river is from east (picture right) to west (picture left))

- Upstream Dam 3 (Water Street Dam) is located approximately 50 feet downstream of the Depot Street (formerly Water Street) bridge crossing (Figure 16). Dam 3 is a "… *run of the river dam, approximately 50 feet long and 7 feet wide at the crest. The height varies due to the bedrock in the streambed but it is estimated at 5 to 10 feet. There is a separate sluiceway portion separated from the main dam by a small island of bedrock. The sluiceway weir is approximately 20 feet long, with an upper plywood gate and an integral wooden gate in the weir*." (Bushman, 2004).

(a)

Figure 16. Dam 3 – Water Street Dam – Castleton River reach T02.03. (a) view upstream from bedrock falls; Depot Street crossing in the background; 23 August 2006. (b) view of the dam and right-bank sluiceway from top of left bank; 25 April 2005. Moderate to low flow conditions, each date.

(b)

A dam was originally constructed at this "Upper Falls" site in 1785 (Adams, 1870; Smith & Rann, 1886; Child, 1881-1882). In early years, water power afforded by the dam supported an iron works (c. 1785), the Rolling Mill Nail Factory (c. 1869), and the slate mills of AR & MH Vail and Vermont Union Slate Company in the late 1800s and early 1900s (Adams, 1870; Beers, 1869; Sanborn Maps dated 1885, 1897, 1904, and 1909). The Beers Atlas and early Sanborn maps illustrate a raceway or flume directed from the impoundment behind the dam toward the northwest to service these early manufacturing interests.

- Dam 2, known as the Structural Slate Dam, is located approximately 80 feet downstream of the Main Street bridge crossing (Figure 17).

Dam 2 is a "… *run of the river dam, approximately 75 feet long and 7 feet wide at the crest. The height varies due to the bedrock in the streambed but it is estimated at 7 to 10 feet."* Construction of the dam is *"slate core, with a concrete cap on the crest and upstream face*" (Bushman, 2004).

A

Figure 17a. Dam 2 – Structural Slate Dam, view to north from southern end of dam. Breach evident at north end. 18 May 2005, during moderate to low flows.

Figure 17b. Dam 2 – Structural Slate Dam, view upstream from vicinity of Adams Street. 5 April 2006 high water conditions.

breach of the Structural Slate Dam was reported to the VT Dam Safety Section by the Town of Fair Haven in February of 2004. The dam apparently breached at the location of a former sluice gate at the right abutment (facing downstream). During low water conditions, flow in the Castleton River is directed solely through the breached sluiceway (see Figure 17a). The left sluice gate was intact on the inspection date by the VTDEC Dam Safety Section (10 August 2004) but demonstrated signs of significant erosion and deterioration (Bushman, 2004).

Historically, Dam 2 was the center of more intensive manufacturing activities, as depicted in a 1915 photograph obtained from the Special Collections at the University of Vermont Bailey/Howe Library (Figure 18).

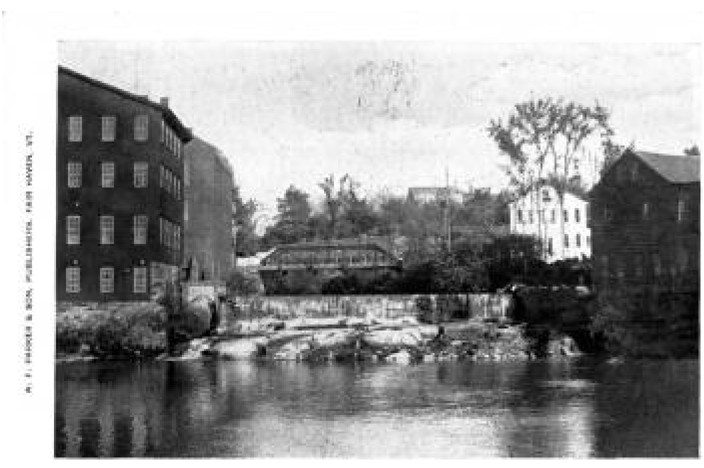


Figure 18.
Dam 2 in 1915, view upstream. Iron bridge crossing of Main Street in the background. Buildings of Fair Haven Grist Mill & A. B. Young Slate Works at picture left; buildings of Fair Haven Marble & Marbleized Slate Co. at picture right. (Sanborn 1909, 1922)

Source: Special Collections of Bailey/Howe library at UVM, via Perkins Landscape Change program (http://www.uvm.edu/perkins/landscape/)

The original date of construction of Dam 2 at the Lower Falls was not able to be determined from the references reviewed. The north side of the river near Dam 2, was the site of a saw-mill (1783), a grist mill and a "bark and hide-mill, and pump and rolling-mill" (c. 1850) which utilized "water from the flume" presumably directed from impoundments behind Dam 2 (Smith & Rann, 1886). In the mid to late 1800s and early 1900s, the mill sites were occupied by the Union Slate Company and later the Hazard Slate Company and Fair Haven Wire Works. Additional uses associated with the mills included a woolen factory and a manufacturer of oil safes (Smith & Rann, 1886; Adams, 1870; Beers, 1869; Sanborn, 1885, 1897). In the early 1900s, Sanborn maps indicate operations by the Fair Haven Grist Mill and A.B. Young slate works along the northern river bank (Sanborn maps 1904, 1909, 1922).

The south end of Dam 2 was historically occupied by the town's first grist mill (1783), and a paper mill (in the late 1700s / early 1800s). The Fair Haven Marble & Marbleized Slate Co. (and its successor Vermont Structural Slate Co., Inc.) has occupied the site since circa 1885 (Child, 1881-1882; Smith & Rann, 1886; Beers, 1869; Sanborn maps from 1885, 1897, 1904, 1909, 1922, 1929, and 1929/1960). *"As recently as 1991, The Vermont Structural Slate Co. was using the impounded water* [behind Dam 2] *as process water at* [their] *factory"* (Bushman, 2004). A penstock directed water from the impoundment into the building(s) along the south bank of the river. Vermont Structural Slate ceased using water in 1995 when operations moved to their Whitehall, New York site (Markcrow, 2006).

- Dam 1 (Shirt Factory Dam) is the most downstream of the three dams, located approximately 30 feet upstream of the Adams Street bridge crossing.

The Shirt Factory Dam is a "… *run of the river dam, approximately 75 feet long and 7 feet wide at the crest. The height varies due to the bedrock in the streambed but it is estimated at 7 to 10 feet*." (Bushman, 2004).

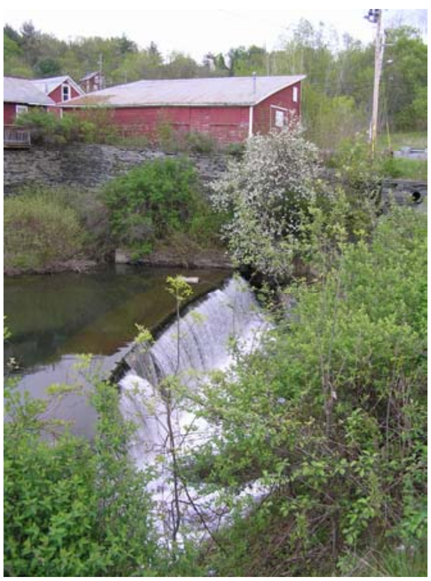


Figure 19. Dam 1 - Shirt Factory Dam
(a) view to southeast from Adams Street bridge crossing, 18 May 2005, low to moderate flows. (b) view upstream from right bank abutment under Adams Street bridge, 13 July 2006, moderate to high flows.

It appears that the earliest use of Dam 1 was associated with lands to the north and west of the dam on the inside of the river meander. Dam 1 was constructed about 1845 by Kittredge, Allen & Adams, an early marble sawing business (Adams, 1870). The Beers Atlas of 1869 depicts a sluiceway, and the associated business was then known as Adams & Allen Marble Sawing Mill. Construction of this sluiceway was described in *The History of Fair Haven, Vermont* , Adams (1870):

> "*Finding it possible to create a mill-power in the village by cutting through the peninsula, or intervale belonging to Alonzo Safford, below, and west of the paper-mill,* [Kittredge, Allen & Adams] *purchased of Mr. Safford, in March* [of 1845] *about six acres of land and proceeded immediately to erect a dam and mill. By turning the water into a simple*

> *trench in the soft, gravelly soil, a channel was speedily made of sufficient capacity for all the water required for a mill, and about 10 feet of fall was obtained. By the sinking of the river bed, below the mill, this fall has been increased. The first mill, … was started in October, 1845*."

The early Sanborn maps (1885, 1897, 1904) depict a "raceway", or straight flow diversion channel, trending to the northwest from the upstream, right-bank side of Dam 1 (facing downstream) across the intervale inside the river meander, connecting back to the river at the downstream end of the meander. The 1885 Sanborn map notes a wheelhouse and tailrace downstream of the mill buildings. In 1885 the mill buildings were occupied by Valido Marble, and in 1897 by the Hill Whitney Aluminum Co. and Busby Bell & Tool Co., manufacturer of clocks (Sanborn maps, 1885, 1897). By 1904 these lands on the intervale were "to be occupied" by The Vermont Unfading Green Slate Co (Sanborn map, 1904). The Vermont Unfading Green Slate Co. occupied Site A until at least 1922, based on the Sanborn mapping. From 1909 on, Sanborn coverage of this site depicts that the sluiceway from Dam 1 extended to the mill buildings but no longer connected entirely through the intervale to return to the Castleton River. It is possible that the sluiceway was filled in during the intervening years, or replaced by subsurface piping. 1929 Sanborn maps indicate that this site was occupied by the Fair Haven Marble & Marbleized Slate Company, and by 1960 the lot was vacant. Today, slate storage is evident on this lot and foundation remnants and abandoned tools are visible from Adams Street; however, the lot remains essentially vacant.

T02.02

Reach T02.02 extends from the Adams Street crossing about 2.3 miles downstream to the Route 4 highway crossing (see Figure 20). As further detailed in Section 2.2, the village of Fair Haven is built upon ancient delta deposits formed during the era of Lake Vermont. The main plateau supporting the village is at an elevation of approximately 360 to 380 feet. In the several thousand years of the recession of Lake Vermont and lowering of base levels in the Champlain Valley (to which waters of the Castleton River ultimately drain), the Castleton River has incised into the delta deposits and the underlying lacustrine silts and clays. The river now resides approximately 80 feet below this plateau at the upstream end of the reach. Unpaired, erosional terraces are present at heights varying from 12 to 80 feet above the current channel, suggesting that lateral channel adjustments were active during the post-glacial incision process.

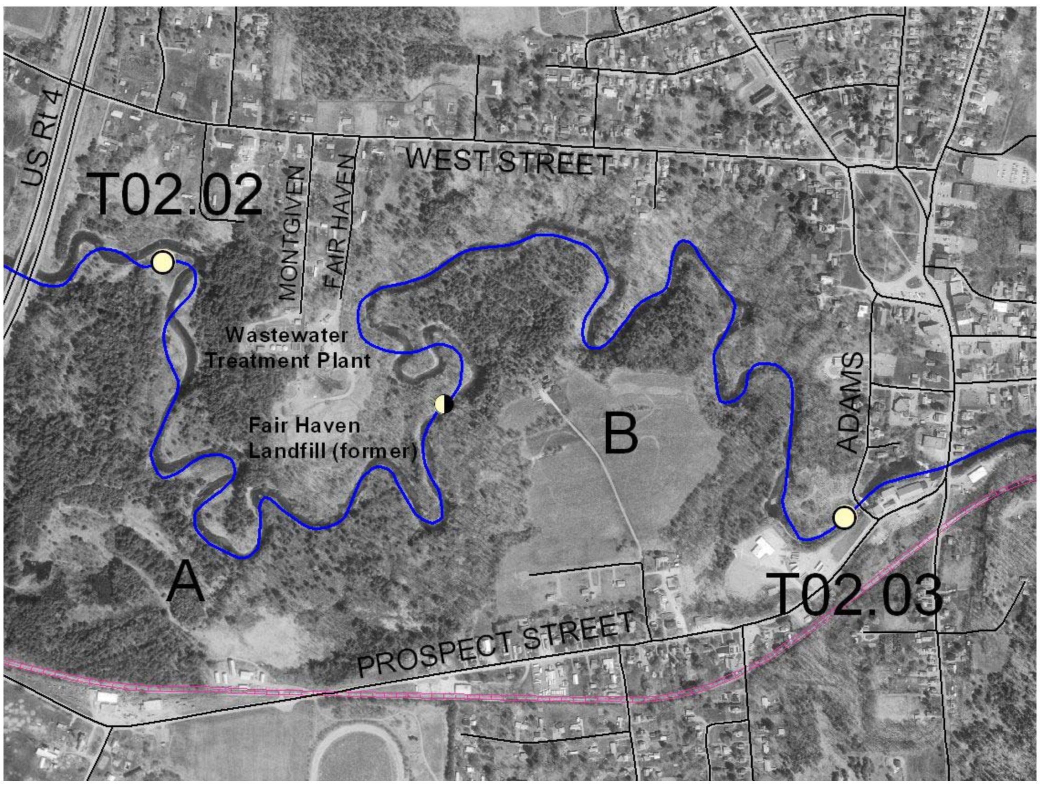


Figure 20. Segmentation of reach T02.02. Base map: 1994 orthophotograph. Flow is from east (picture right) to west (picture left).

It is inferred that this geologic incision was arrested in the upstream reach, T02.03, as erosion revealed channel-spanning bedrock. These bedrock exposures were later chosen as the site of the three low-head dams beginning in the 1700s and 1800s. It is possible that operation of these dams may have contributed locally to more recent incision in the upper portion of T02.02. As sediments from the upstream watershed are trapped behind the dams, this condition can increase the erosive power of waters flowing over the dams – creating a condition often termed "hungry water". It would be difficult to separate from the geologic (post-glacial) incision the amount of more recent incision that may have been induced by damming of the river in Fair Haven village. However, it is anticipated that post-glacial incision would be several orders of magnitude greater than any potential incision imparted by the dams over the last 225 years. Moreover, no recently abandoned floodplain was observed at low elevations within the geologically-entrenched valley of this reach.

At present, the valley setting for reach T02.02 in the upper 2/3 of the reach is narrowly confined between steep valley walls. Valley widths are between 1.5 and 2 times the bankfull width. Near the upstream end of the reach, valley confinement may have been increased marginally by the placement of slate and other fill materials along the tops of the valley walls. Height of the valley walls ranges from 20 to 80 feet above the channel. In the downstream 1/3 of reach T02.02, the valley opens up slightly to a width of 2 to 4 times the bankfull width. The height of the valley walls is somewhat reduced, typically ranging from 12 to 30 feet high. This change in valley setting compelled a segment break, due to the different reference stream types ("confined" versus "unconfined"). The segment position indicated in Figure 20 is approximate only; the transition from narrowly-confined to semi-confined occurs gradually.

The channel is highly sinuous (ratio of 1.9) in reach T02.02, exhibiting an irregular meander pattern which includes some tortuous meanders. Near the segment break and at the downstream end of the reach, the current planform, as depicted on 2003 and 1994 aerial photography, is substantially different than the planform indicated by the VHD (blue line in Figure 20), which itself appears coincident with the planform depicted on the 1972 USGS topographic map. These observations suggest historic planform adjustments occurring between 1972 and 1994. Anecdotal accounts of increased mass failure activity in the last two or three years suggest recent, active meander migration (Lobdell, 2006).

During Phase 2 assessments of reach T02.02, steep profiles of varved silts and clays overlain by laminated sands were revealed by high-bank erosion of the valley wall on the outside of several meander bends. The contact between the sands and varved clays was typically 30 to 50 feet above the channel, well above the bankfull elevation.

Figure 21. Downstream of Fair Haven village, the Castleton River has incised downward through deltaic sands and underlying lake silts/clays, over the past several thousand years. These sediments are revealed in 80-foot high streambank exposures, where the river impinges on the valley walls. Reach T02.02. Pictured: Scott Lobdell, kayaking through a large woody debris jam, 13 July 2006.

Erosion on the outside of meander bends is occurring principally where the channel impinges on the right and left valley walls. It is possible that groundwater seepage along the interface between the sands and clays may be contributing to slope failures. Local groundwater seepage rates can be increased if stormwater and other drainage associated with development are directed to the subsurface in greater amounts or with greater frequency. Increased magnitude and frequency of flows in the Castleton River could also contribute to high bank erosion, driven by increased erosion at the toe of the slopes. Further study would be required to characterize the mechanisms and driving forces of slope failure.

Segment B

Segment B of reach T02.02 extends from the Adams Street crossing downstream to a point mid-reach near the former Fair Haven Landfill (along right bank) (see Figure 20). The channel meanders through a narrow valley approximately 1 to 2 times the width of the bankfull channel – a reference stream type of Bc. A steep riffle was noted mid-reach; this appeared to be formed of varved clays. Observations were limited due to the high water conditions and fast current, as well as the turbidity of the river water, and it was not possible to rule out channel-spanning bedrock.

Encroachments along Segment B are limited to commercial development in the upper-most 500 feet. There is a history of industrial and commercial activity near the Shirt Factory Dam leading back to the middle 1800s (e.g., marble and slate mills, clock factory, shirt factory; Sanborn Fire Insurance Maps, various dates; Beers, 1869). It is possible that slate and other fill materials near the upstream end of the segment along both banks have locally reduced the natural valley width. Near the downstream end of the segment, cars and old machinery are exposed along the right bank in the vicinity of the former Fair Haven Landfill. Fair Haven reportedly discontinued use of this landfill in 1985. However, the site has not been formally closed in accordance with state laws – including capping and ongoing monitoring. More details of the history of this landfill are contained within the draft Poultney-Mettowee Watershed Basin Plan (VTWQD, 2004).

Segment B was rated in "Fair" condition following the RGA. No signs of active incision were observed. Aggradation and widening appeared minor in degree. A relatively high width/depth ratio was measured at the cross section site; however, this cross section was performed at the site of historic channel modifications in the vicinity of the former sluiceway return associated with the Shirt Factory Dam (described in above sections). Based on visual observations within the remainder of the segment, this is inferred to be a localized site of widening. A moderate to substantial degree of planform adjustment (meander migration) is indicated by high-bank erosion on the outside of nearly every meander bend. A few flood chutes were also observed.

Habitat conditions were rated as "Good" following the Rapid Habitat Assessment protocols. Active recruitment of woody material is providing epiphaunal substrates and organic matter. Four (4) channel-spanning debris jams were encountered (e.g., see Figure 21) and approximately 112 Large Woody Debris were recorded in the 6,938-foot segment. Given the moderate to high flow stage, it is possible that more debris jams and LWD would have been recorded at baseflow conditions. Tree buffers are largely intact and of ample width, with the exception of the upstream 500 feet of the reach, where commercial activities encroach on the corridor. However, these encroachments are elevated well above the current channel on the plateau at the top of right and left banks. Habitat conditions are compromised somewhat by active streambank erosion and landslides over approximately 46% of the segment (25% along LB and 21% along RB).

Segment A

Segment A of T02.02 consists of the lower 5,292 feet of reach T02.02 from the vicinity of the former Fair Haven Landfill downstream nearly to the US Route 4 crossing. The valley is somewhat wider in this portion of the reach (from 1.5 to 4 times channel width). Bank heights are less pronounced (4 to 8 feet above bankfull).

Encroachments along Segment A are minimal, with the following exceptions:

- The former Fair Haven Landfill is located along the north (right-bank) side of the river in the upstream half of the segment. High-bank erosion is exposing household rubbish.
- The current Fair Haven Wastewater Treatment Facility is also located in this same vicinity along the right bank of the river off Montgiven and Fair Haven Roads. An outfall of treated wastewater flows into the Castleton River approximately 1,900 feet upstream of the US Highway Route 4 crossing. Evidence of recent logging activity was observed in the wooded areas south and west of the WWTF in July of 2006.

- Encroachment of residential development along Wetherby Way is present at the top of the right-bank valley wall, downstream of the WWTF, near the downstream end of the reach. Two small tributaries along right bank were observed with associated "deltas" of fine sediment at their confluence with the Castleton River. It is possible that concentrated stormwater runoff is contributing to small sediment inputs from these tributaries.

A cross section was completed just downstream of the WWTF outfall. A sand-bed C stream type, with dune/ripple bed form was measured, consistent with reference stream type. The channel has good floodplain access. No signs of active incision were observed; evidence of widening and aggradation was minor to negligible. Active planform adjustment is indicated by the presence of flood chutes and by high bank erosion on the outside of nearly every meander bend. Overall, the segment was rated in "Fair" condition following the RGA.

Figure 22. High bank erosion along the right bank of the Castleton River is exposing household rubbish in the former Fair Haven landfill.

Habitat conditions were rated as "Good" following the RHA. Stream banks and corridors are largely undisturbed, and channel manipulations have been minor given the geologically entrenched setting. There is active recruitment of LWD and organic material from wide forested buffers along the channel margins. Submerged logs are offering epiphaunal substrates, and channel-spanning debris jams are contributing to pool formation.

However, the channel is closely coupled to the valley walls in this semi-confined setting, and frequent mass failures are contributing fine sediments to the channel. Streambank erosion was observed along 43% of the left bank and 35% of the right bank. Aggradation of these fine sediments within the channel may occlude streambed habitats of some species including freshwater mussels and fish.

T02.01

Reach T02.01 is a relatively short (3,626 feet), low-gradient section of the Castleton River extending from just upstream of the Route 4 highway crossing to the confluence with the Poultney River. Within reach T02.01, the Castleton River flows through a semi-confined valley setting, with occasional high-bank erosion (six to 16 feet) along the outside of meander bends revealing fine sands and silts. The river channel is geologically incised below a plateau (abandoned river terrace), perhaps 800 to 1,000 feet wide at an approximate elevation of 315 feet. This plateau is itself partially confined below steep terrace wall faces marking a second higher plateau at approximately 360 feet in elevation. The appearance of these multiple delta terraces, suggests that geologic incision of the Castleton River occurred in stages, probably in response to episodic lowering of base level elevations in the Poultney River and/or the Champlain Valley.

This section of the channel has a less sinuous planform than upstream reach T02.02. A valley width of approximate 2 to 3 times the channel width is typically available to the channel. The height of the valley walls (up to 16 feet) is less than in upstream reach T02.02 (where they range up to 80 feet above the channel). A brief section of channel-spanning bedrock was observed mid-reach; bedrock controls may be contributing to the somewhat linear planform. In the downstream half of the reach, a large oxbow is present along the north bank, at an elevation somewhat higher than the current channel. Based on review of historic maps, the neck cut-off of the pronounced meander bend that resulted in this oxbow occurred prior to 1950 (USGS, 1950). It is theorized that this neck cutoff represents a channel shift from several hundred to thousands of years before present related to post-glacial base level lowering.

Encroachments along the reach include agricultural fields to the north of the river, located at the top of the steep valley wall on the plateau feature at about 315 feet in elevation. Tree and scrub/shrub buffers are minimal along right bank at the edge of these fields. The left bank corridor is largely undisturbed; wide (>100 foot) deciduous buffers are present along this southern river bank.

The US Route 4 highway crosses the river in the upstream half of the reach. This highway was constructed sometime after 1950 and before 1972, based on review of historic maps (USGS, 1950; USGS, 1946 photorevised 1972). Channel straightening is inferred in direct vicinity of the crossing. The bridge crossings for the west-bound and east-bound lanes of the highway are each supported by a large concrete pier. A former road grade (slate bed) was observed parallel to and downstream of the highway leading from an abandoned exit ramp on the west side of the highway. This former road bed extended into and across the Castleton River. This ford is located approximately 100 feet downstream of the west-bound highway lane, and may have been utilized to access the channel during construction of the bridge piers. The slate cobbles and boulders comprising this ford form a local nick point in the stream bed otherwise dominated by fine gravels, sands and silts. A large lateral and vertical scour pool has developed immediately downstream of the ford.

A cross section completed at a meander cross-over point in the upstream half of the reach confirmed a fine-gravel C-dune-ripple stream type, consistent with the reference stream type. Channel width was narrower and maximum depth was deeper than predicted by VT Regional Hydraulic Geometry curves (VTDEC, 2006). The high percentage of silt in stream bed and bank materials may be contributing to these lower width/depth ratios in this lower portion of the Castleton River (Schumm, 1960).

The reach was rated in "Good" geomorphic condition following the RGA, with minor evidence of channel adjustments. A measured incision ratio of 1.2 suggests a minor degree of historic or recent incision. The cross section was completed near the Route 4 crossing and some degree of localized incision may be associated with straightening in vicinity of the crossing. It is also possible that bankfull elevation was underestimated. Negligible signs of active incision (e.g., headcuts, undercut banks) or active widening were noted.

Reduced buffer widths along the right bank, and minimal epiphaunal substrates contributed to less than optimal habitat scores following the RHA. The reach scored in "Good" condition, on the cusp with "Fair".

4.2 Gully Brook (T02.11-s1)

The Gully Brook is a small, but steep and flashy tributary in the southeastern portion of the Castleton watershed. This tributary drains a 4.9-square-mile watershed originating on the northern slopes of Herrick Mountain in Ira and flows to the northwest into Poultney, between Pond Hill to the west and the more prominent Bird Mountain to the east. Gully Brook then flows north into Castleton to join the Castleton River main stem at the upstream end of reach T02.11 near the intersection of Birdseye Road and Route 4A.

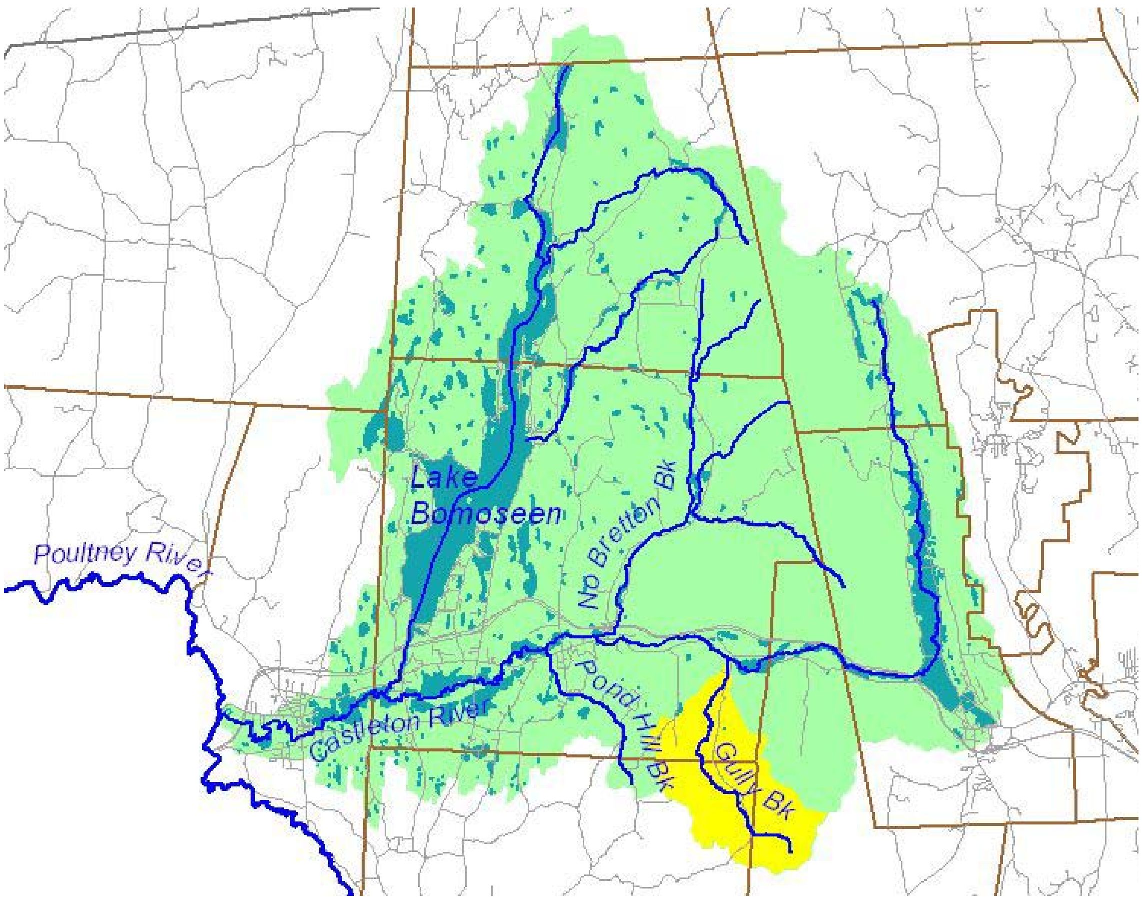


Figure 23. Gully Brook subwatershed of the Castleton River watershed.

This tributary watershed is a small portion (approximately 5%) of the 99-square-mile Castleton River watershed. Approximately 87.7% of the tributary watershed is in forest cover; only 4.1% is in agricultural use; 2.4% is developed; and the remainder is water or wetlands.

Three reaches of the Gully Brook were selected for Phase 2 field-based assessment; results are summarized in Table 7.

Table 7. Results of Phase 2 Geomorphic Assessments, Gully Brook Tributary

Gully Brook - Ira, Poultney, Castleton

Reach	Seg-ment	Channel Length (ft)	Channel Slope (%)	Drainage Area (sq mi)	Stream Type	Incision Ratio	RHA Condition	RGA Condition	Adjustment	Vertical Stream Type Departure?	Channel Evolution Stage	Sensitivity
T02.11-s1.04	D	995	***5.5***		B3a-S/P	1.0 (RAF)	0.77 Good	0.74 Good	Wid, PF (min)	No	I [D]	Moderate
	C	1,297	***3.5***		Cb3-S/P	1.1 (RAF)	0.78 Good	0.83 Good	None	No	I [D]	Moderate
	B	1,442	***3.8***		F3b-S/P	2.3 (RAF)	0.66 Good	0.49 Fair	Aggr / PF/ Hist Deg	Cb to F	IV [F]	Extreme
	A	5,395	***4.6***	3.03	B1-S/P	1.0 (RAF)	0.88 Ref	0.75 Good	Aggr (min)	No	I [D]	Very Low
T02.11-s1.03	--	6,201	***3.9***	3.73	A - S/P	Not Selected for Assessment - Steep Gorge						
T02.11-s1.02	B	3,746	***3.2***		B4b-S/P	1.0 (RAF)	0.72 Good	0.68 Good	Aggr (mod)	No	I [D]	Moderate
	A	529	***1.5***	4.83	F4c-PB	2.77 (RAF)	0.50 Fair	0.46 Fair	PF / Aggr / Hist Deg	D to F	III [F]	Extreme
T02.11-s1.01	--	1,346	***1.4***	4.94	C4c-PB	1.0 (RAF)	0.45 Fair	0.60 Fair	PF (min)	No	IV [F]	Very High

Notes / Abbreviations:

Channel Slope: Values in italic bold have been updated since the Phase 1 SGA, due to field-truthing and/or segmentation.

Stream Type: S/P = Step/Pool; R/P = Riffle/Pool; R/D = Ripple/Dune; PB = Plane Bed; Casc = Cascade; Ref = Reference

Incision Ratio: RAF = Recently Abandoned Floodplain; HEF = Human-elevated Floodplain (following protocols, VTANR, 2007).

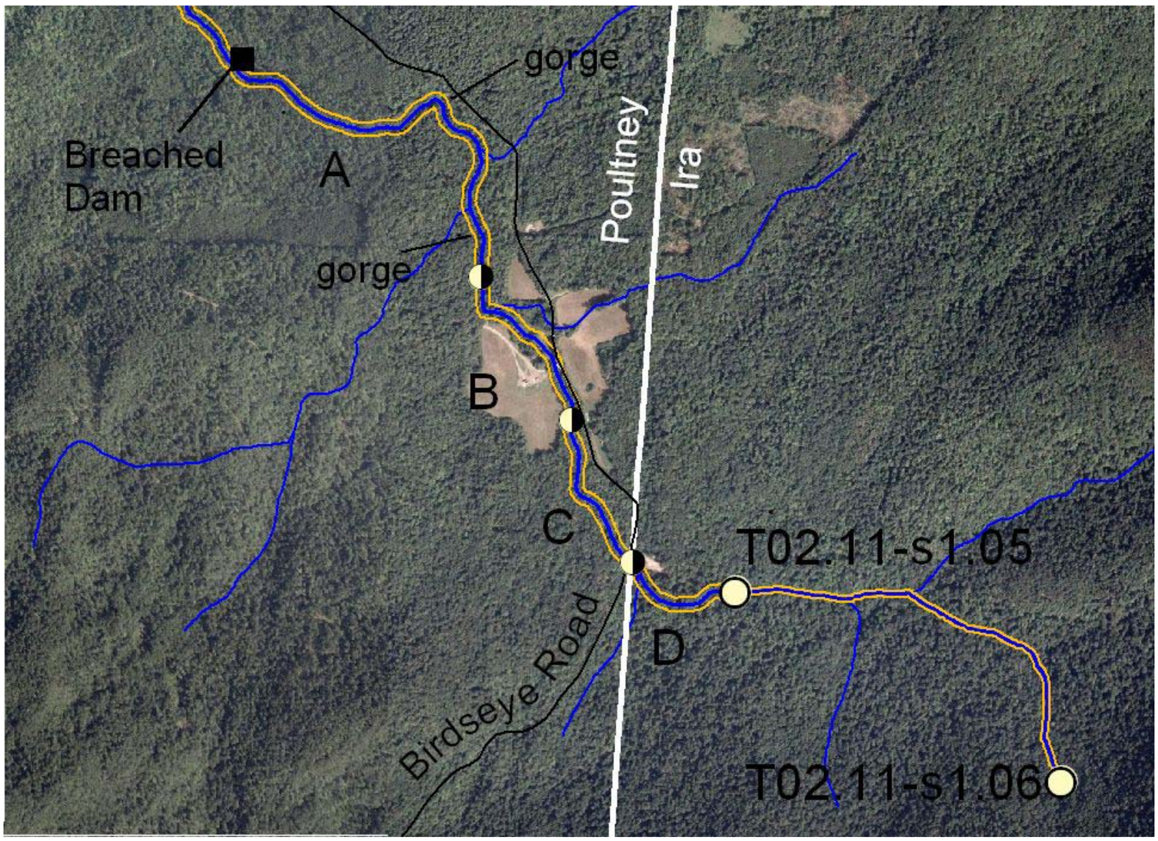
Condition: RHA = Rapid Habitat Assessment; RGA = Rapid Geomorphic Assessment (VTANR, 2006).

Adjustment: PF = Planform Adjustment; Aggr = Aggradation; Wid = Widening; Deg = Degradation; NM = Not Measured.

Channel Evolution Stage: F = F-stage model; D = D-stage model (see Appendix C of protocols, VTANR, 2006).

T02.11-s1.04

While the overall channel slope and valley confinement of reach T02.11-s1.04 suggest a B-step/pool reference stream type, there is considerable variation of valley confinement, slope, channel bedform and geomorphic condition along the length, compelling the following segmentation (see Figure 24):



Segment (u/s to d/s)	Approximate Length (ft)	Phase 2 Updated Slope (%)
D	995	5.5
C	1,297	3.5
B	1,442	3.8
A	5,395	4.6

Figure 24. Segmentation of reach T02.11-s1.04, Gully Brook, Castleton River Watershed.

Segment D

Segment T02.11-s1.04-D extends from the upstream reach break nearly to the crossing of Birdseye Road. This short segment of Gully Brook is at the transition between steeper (>4%) slopes (A1-cascade and A2-step/pool) further upstream in reach T02.11-s1.05 and a broader valley of lesser gradient (2 to 4%) through the meadows at the middle of reach T02.11-s1.04 (Segment B).

Segment D is narrowly-confined between steep bedrock-controlled valley walls, and has a steep gradient. The channel is dominated by a cobble-boulder step/pool form, with frequent exposures of channel-spanning bedrock of modest control heights. Ample forested buffers and well-established near-bank shrubs, saplings, and deciduous trees offer additional roughness and stability in the channel margins. Encroachments within the segment are minor, limited to an active equipment ford and bankfull-constricting timber bridge crossing near the downstream end. A localized degree of aggradation was observed immediately upstream of the ford and upstream of the bridge crossing. A small cleared area (possible former logging landing) was located to the north of the channel near the downstream segment break.

A cross section completed mid-way along Segment D confirmed a B3 stream type; a subclass slope of "a" was assigned following estimation of the 5.5% segment gradient (see Appendix F). The RGA indicated a geomorphic condition of "Good" with minor, localized indications of widening (mid-channel bars; W/D = 23) and planform change (flood chutes, meander extension). Segment D is transport-dominated.

RHA conditions were rated at the high end of "Good", compromised only somewhat by minimal availability of pools, and a slight increase in fine gravels, estimated to be the result of in-channel and upstream bank erosion.

Segment C

Proceeding downstream from the Birdseye Road crossing, the Gully Brook enters a locally wider valley (unconfined) with slightly shallower channel gradient. Encroachments within the segment are minor, limited to a bankfull-constricting timber bridge crossing (Birdseye Road) at the upstream end. A localized degree of aggradation was observed immediately upstream of the bridge crossing. Bedrock outcrops along the left valley wall contribute to the low degree of sinuosity within the segment.

Two brief sections of channel-spanning bedrock (ledge) were exposed mid-segment, ranging in length from 10 to 15 feet. One longer section of bedrock 210 feet in length was noted near the downstream end of the segment. Outside of these bedrock-controlled sections, the channel exhibited a cobble and gravel step-pool form with occasional riffle-pool features. A cross section completed mid-segment indicated a good degree of floodplain connection (IR = 1.1; ER = 2.76), and a stream type of Cb3-S/P. Ample forested buffers and well-established near-bank shrubs, saplings, and deciduous trees offer additional roughness and stability along the channel margins. The RGA indicated a geomorphic condition of "Good" with minor degrees of widening, aggradation, and planform change.

RHA conditions were rated at the high end of "Good", given the absence of significant encroachments and ample forested buffers which offer shading and detritus, organic matter, and LWD. A reasonable diversity of epiphaunal substrates was observed in the form of un-embedded boulders and cobbles and submerged bedrock ledges. Active recruitment of LWD is also evident (LWD = 9; DJs = 6).

Segment B

Segment B flows alongside Birdseye Road through a locally wider valley setting on an alluvial fan setting (a Cb reference stream type). This area known as Traverse Park has been historically cleared and some recreational buildings are present, though none within the Phase 2 belt-width derived corridor surrounding Gully Brook. One active equipment ford, and one possible historic ford (now mostly overgrown), appear to provide access to the cleared area west of Gully Brook from Birdseye Road. Birdseye Road is slightly elevated above the floodplain and reduces the reference valley width somewhat along the right bank. However, the reduction in reference valley width is minor in significance, as the channel still has available floodplain along the left bank and an unconfined valley setting.

The linear planform of Gully Brook alongside Birdseye Road suggests historic channelization and dredging. A cross section performed mid-segment indicated an incision ratio of 2.3 and an entrenchment ratio of 1.2, suggesting a stream type departure from Cb to F. Near bank areas are occasionally steep and undercut. A few trees were observed leaning toward the channel from both banks. However, no active head cuts or nick points were observed. Bed materials were dominated by cobbles and occasional boulders, inferred not to be mobile except at high flood flow stages. The coarseness of sediments in channel bed and banks, the well-developed (though narrow) woody buffers along the channel margins, and presence of channel-spanning bedrock at the head of the segment and in upstream segment C are all factors which appear to be moderating incision and widening in this segment. The measured width/depth ratio (19.6) indicates negligible widening.

Several visual observations within Segment B suggested a losing condition – that is, a downward-directed flow component such that a significant portion of flow in the channel (especially during baseflow conditions) is lost to the groundwater aquifer underlying the channel. With distance downstream in the segment, flow velocities appeared to decline; the width of the water in the channel became reduced, exposing a greater proportion of channel substrates; and aggradation increased consistent with a localized reduction in sediment transport capacity. A losing condition is not uncommon at the transition from shallow soils over bedrock to more permeable deposits of coarse gravels and cobbles, such as occurs within this segment according to NRCS soil mapping and surficial geologic mapping. A reduction of surface flow velocities could contribute to aggradation and planform shifts, as the stream power of the channel would be reduced. The locally shallower gradient and apparent reduction in discharge may also be contributing to prevalence of detritus and debris jams through the segment (DJ = 6; LWD = 15).

Segment B of T02.11-s1.04 was ranked in "Fair" geomorphic condition following the RGA. Historic channel degradation inferred as a result of channelization and floodplain encroachments along the Birdseye Road. Aggradation and planform adjustments are active in response to historic channel disturbances and entrenchment. Active incision and widening appear to be moderated by the coarseness of the bed, roughness of channel margins (cobble/boulders, well-established woody buffers), and possible decrease in stream power offered by the reduction in gradient and losing conditions. While the segment is in Fair condition, a sensitivity of "Extreme" was assigned due to the Stream Type Departure.

Habitat conditions were ranked in "Good" condition (on the cusp with "Fair" following the RHA, due to apparent historic straightening, and the significant aggradation and planform shifts. On a positive note, LWD recruitment is active (LWD = 15; DJs = 6), and good canopy cover is offered by reasonably wide forested buffers.

Historically, channelization of this segment would be expected to modify a natural attenuation area with laterally shifting channel to a single-thread, transport-dominated channel. The channel now appears to be regaining some measure of sinuosity, particularly in downstream half. In absence of future channel manipulations, some sediment attenuation function could be restored to this segment.

Segment A

From the Traverse Park downstream to the end of the reach (approximately 5,400 feet) the Gully Brook flows over bedrock ledge and waterfalls through a valley that is narrowly-confined on left and right banks by bedrock-controlled valley walls. Overall, the segment was typed as a B1-step/pool. However, there was considerable variability in channel gradient and valley confinement along the length. Four isolated sections of the channel in the vicinity of waterfalls would be typed as A1-cascade – two prominent sections at the upstream end of the segment and two short sections near the downstream end. These are each identified as a "gorge" on Figures 24 and 25. Between these bedrock exposures, approximately 600 feet of the Gully Brook flows through a broader valley setting of 2% gradient near the mid-point of the segment. NRCS indicates soils of a glacial-fluvial origin in this location, in contrast to the till covered bedrock slopes surrounding upstream and downstream channel sections (USDA, 1998).

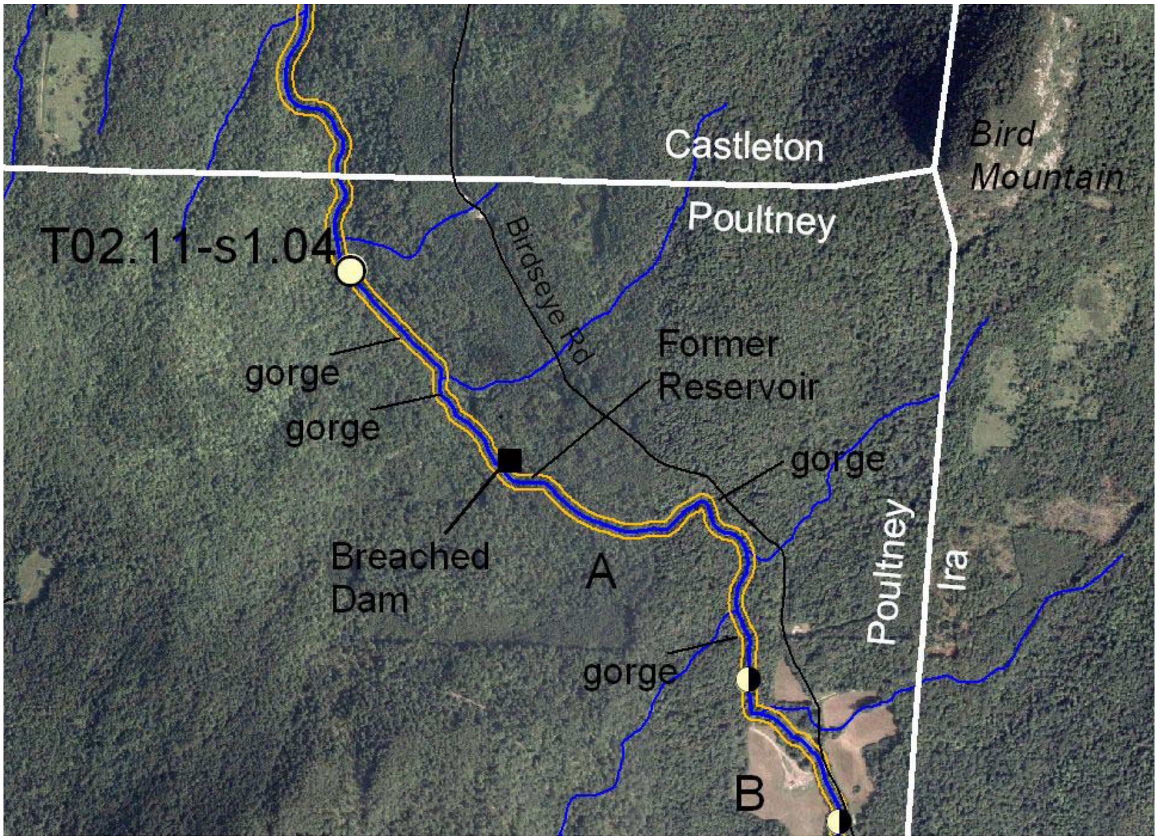


Figure 25. Downstream end of Reach T02.11-s1.04, Gully Brook, Castleton River Watershed.

At present, encroachments along the reach are minimal. At its closest point, the Birdseye Road passes within 120 feet northeast of the gorges near the upstream end of the segment. Logging or recreational gravel roads cross the segment in two locations – one site facilitated by a bridge and nearby ford, the other site accessed by a ford. Selective logging is occurring within a few hundred feet of the Gully Brook through this segment, with active crossings of many of the tributary channels.

Historically, a large dam and reservoir were operational mid-segment in the locally-wider valley setting. A vertical concrete wall (dam), keyed into a bedrock knoll and reinforced by earthen fill material, extends more than 100 feet in length perpendicular to the Gully Brook. Remnants of the dam extend perhaps 30 from the right bank of the channel at a height of 3 to 4 feet above the current channel, and 70 feet or more from the left bank, at an elevation of perhaps 10 to 12 feet above the current channel. The presence of collapsed concrete slabs along the channel margins, in line with (and just downstream of) the left bank and right bank concrete walls, suggests that a dam previously extended across the Gully Brook, impounding it perhaps to a height of 10 feet or more. However, the channel now is free from obstructions, flowing on bedrock. Channel-spanning bedrock is exposed in the Gully Brook beginning at the dam location and extending at least 130 feet downstream. To the southwest of the current channel upstream of the dam is a former reservoir, portions of which are still impounded at an elevation slightly above the current channel.

Within 50 feet downstream of the dam, a major tributary channel flows along the southwestern extent of the dam, over channel-spanning bedrock falls, to join the present Gully Brook channel from left bank. Neither the USGS topographic map nor surface water coverage indicates the presence of a tributary channel at this location. Scope limitations prevented a thorough reconnaissance of the dam and reservoir area to determine the origin of this tributary channel with greater certainty. However, it is possible that this channel represented the former position of the Gully Brook and/or a former raceway for dam operations that previously contained most of the run-of-river flows exiting the reservoir. The current position of the Gully Brook upstream and east of the reservoir may have resulted from an avulsion following a dam breach at the present gap in the concrete wall.

Figure 26. T02.11-s1.04-A. Remnants of vertical concrete wall / dam at former reservoir site located mid-segment. View (to the southwest) from right bank corridor toward the channel and mill pond.

Building foundations and other concrete infrastructure elements were observed in close proximity to the wall. The dam site is now considerably overgrown; based on the size of the trees, the site may have been active until 25 to 75 years ago.

Historic records were reviewed in the Poultney town clerk's office. Historic deeds and a 1960 Young & Hemenway plan of "*Snow & Hart Farms, Towns of Ira, Castleton, and Poultney*", indicate that lands surrounding this former reservoir and dam are owned by the Town of Castleton (Town of Poultney land records). Historic records available in the Castleton town clerk's office include design plans and bidders documents for construction of a "storage reservoir and dam on Gully Brook … as a source of water supply for the Village of Castleton, Vermont". These plans include water pipes extending down the Gully Brook valley and northwest to the village of Castleton. Proposed construction documents were dated from 1926 through 1928. Thus, it appears that the reservoir was constructed sometime after 1928. This time frame post-dates the largest flood on record for the State of Vermont which occurred in 1927. At least two major flood events have occurred since that time, either of which may have caused the dam to breach – the 1938 flood and the 1945 flood (see Section 2.6).

Overall, Segment A of T02.11-s1.04 is in fairly stable condition. Much of the segment is flowing directly on channel-spanning bedrock. Channel planform is controlled largely by structural features of the bedrock. Two brief sections of channel showed signs of moderate incision and loss of connection to the adjacent flood plain: a 50-foot length downstream of the breached dam on approach to the bridge crossing, and a 500-foot length upstream of the dam. Possible tributary rejuvenation was evident in a left bank tributary and a right bank tributary immediately upstream of the bridge. The very limited degree of streambank erosion within the segment (up to 7 and 8 feet in height) was localized to 600 feet of channel upstream of the former dam and reservoir site. Along a majority of the segment, however, the main Gully Brook channel did not show evidence of active or historic incision.

A moderate amount of aggradation was apparent, particularly downstream of the breached dam site, as evidenced by a few unvegetated mid-channel bars, point bars and side bars of gravel- to cobble-sized sediments. Minor to moderate planform adjustments are indicated by presence of a few active flood chutes on the inside of meander bends. As discussed above, a channel avulsion may have occurred historically associated with the dam breach. Thus, with the exception of minor to moderate channel adjustments occurring in response to historic impoundment and subsequent breaching of the dam, Segment A is generally in very stable condition. Extensive lateral and vertical controls offered by the bedrock exposures, and maintenance of well-forested wide buffers along the channel margins have contributed to the overall stability of Segment A. A "Very Low" sensitivity was assigned to the segment.

Habitat conditions were rated in Reference condition following RHA protocols. Ample forested buffers, stable streambanks, and frequent and diverse epiphaunal substrates including bedrock ledges, cobbles and boulders of limited embeddedness, frequent LWD and detritus.

Given the overall steepness of gradient, Segment A operates as a transport reach – a very efficient delivery system for sediments conveyed via several smaller tributaries.

T02.11-s1.03

While a Phase 2 assessment was not completed on this reach, certain aspects of historic land uses and conditions within the catchment area for this section of the Gully Brook have relevance to observed conditions of upstream and downstream reaches.

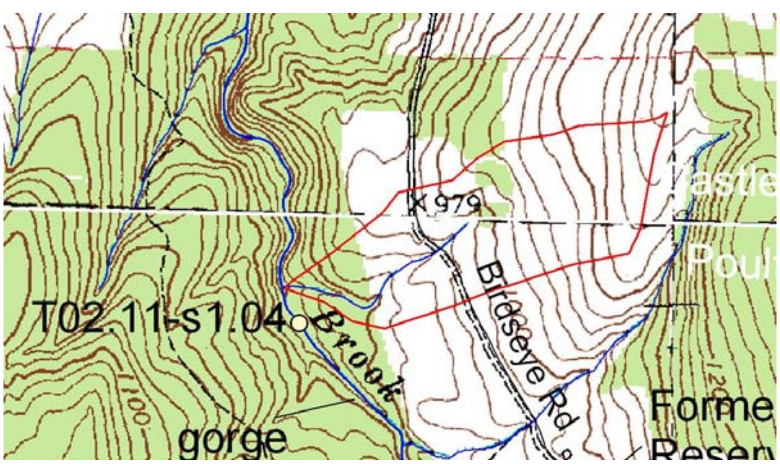
Remote-sensing data reviewed in Phase 1 (RRPC, 2005), suggest a reference A-step/pool stream type. A channel gradient of 5.48% is estimated for this 6,201-foot channel. Given the close spacing of topographic contours and steep gradient visible on the topographic map, this reach would be expected to have channel dimensions and a valley setting similar to that observed in upstream segment T02.11-s1.04-A or downstream segment T02.11-s1.02-B.

Several of the tributary reaches to T02.11-s1.03 were observed to be incised and overwidened. One tributary was viewed while walking out to Birdseye Road from the downstream end of T02.11-s1.04 (see Figure 27). Based on the drainage area for this tributary (approximately 0.07 square mile), a bankfull width of 4 feet and a maximum depth of 0.5 foot would be expected (VT Regional Hydraulic Geometry Curves; VTDEC WQD, 2006). The present channel is 8 to 12 feet wide and 1 to 2 feet deep.

(a)

Figure 27. Right bank tributary to Gully Brook exhibiting signs of active incision and widening. (a) View upstream from confluence with Gully Brook reach T02.11-s1.03.

*(b) Based on the drainage area for this tributary (in red below: approximately 0.07 square mile),
a bankfull width of 4 feet and a maximum depth of 0.5 foot would be expected. The present channel is 8 to 12 feet wide and 1 to 2 feet deep.*



(b)

Active incision and widening were also observed in several smaller tributaries to Gully Brook reach s1.03 in the vicinity of Birdseye Road crossings – both upstream and downstream of the culverts. Birdseye Road has required substantial maintenance and culvert crossings have been replaced several times over the past decades in response to flooding events, including the 1945, the 1998, and the 2000 floods (Castleton Annual Reports). Most recently, following the December 17, 2000 flood, road / culvert maintenance in the Summer of 2001 included installation of rock-lined ditches on the uphill side of the road.

The cause(s) of incision and widening in these tributary channels can not be decisively determined based on currently available data. However, several factors have been identified that may contribute to the current conditions. First, if recent channel incision has occurred within the Gully Brook channel itself over recent decades, this condition could lead to a phenomenon termed "tributary rejuvenation", where base-level lowering in the main channel increases the gradient of the tributary channel locally, and head cuts migrate upstream in the channels, leading to incision and widening. While the Gully Brook main stem appears stable at present, flowing on bedrock over much of its length, it is possible that channel incision has occurred in the main channel as a result of (a) historic impoundment at the water supply reservoir and dam in upstream reach T02.11-s1.04; (b) sudden hydrologic impacts if this reservoir released catastrophically; and/or (c) base-level lowering downstream near the Castleton River confluence associated with mid-1900s channelization, dredging and windrowing (see next sections).

Secondly, drainage improvements along the Birdseye Road in response to past flood events may have increased the frequencies, magnitudes and peaks of flows in these tributaries to such a degree that thresholds for erosion were exceeded. Birdseye Road cuts across the slope of Bird Mountain east of and uphill of Gully Brook. Flows that naturally would have slowly percolated through and sheeted over the rough, forested land surface to small sinuous cobble and gravel feeder channels have now been captured along the upslope side of Birdseye Road, diverted into straight, relatively steep roadside ditches, through culverts and into a few select tributaries on the downslope side of Birdseye Road. In some cases, the natural drainage area for a given tributary may have been effectively increased by the diversion of flows – perhaps to a degree to exceed erosion thresholds. Depending upon how rock lined ditches and armoring in the vicinity of these road culvert crossings were "keyed" into the adjacent soils and stream channels, localized nick points may have been created that led to headward migration of incision.

Flood events, such as the 17 December 2000 flood and the 1945 flood, may also have involved flows substantial enough to exceed erosion thresholds, contributing to channel incision and widening.

Also, an ongoing history of logging in the watershed may have contributed to channel incision and widening in tributaries to T02.11-s1.03. The USGS topographic map (dated 1964, photorevised 1972) indicates most of the eastern catchment to be cleared (Figure 28a). Removal of trees along the channel margins would be expected to lead to channel instability. Moreover, precipitation and snowmelt would run off more quickly and in higher volumes in a nonforested catchment. Higher peaks and magnitudes of flow could lead to channel incision and widening.
A 1994 orthophoto indicates very young forest growth in these previously cleared areas; by 2003 the forest is revegetating (see Figure 28b).

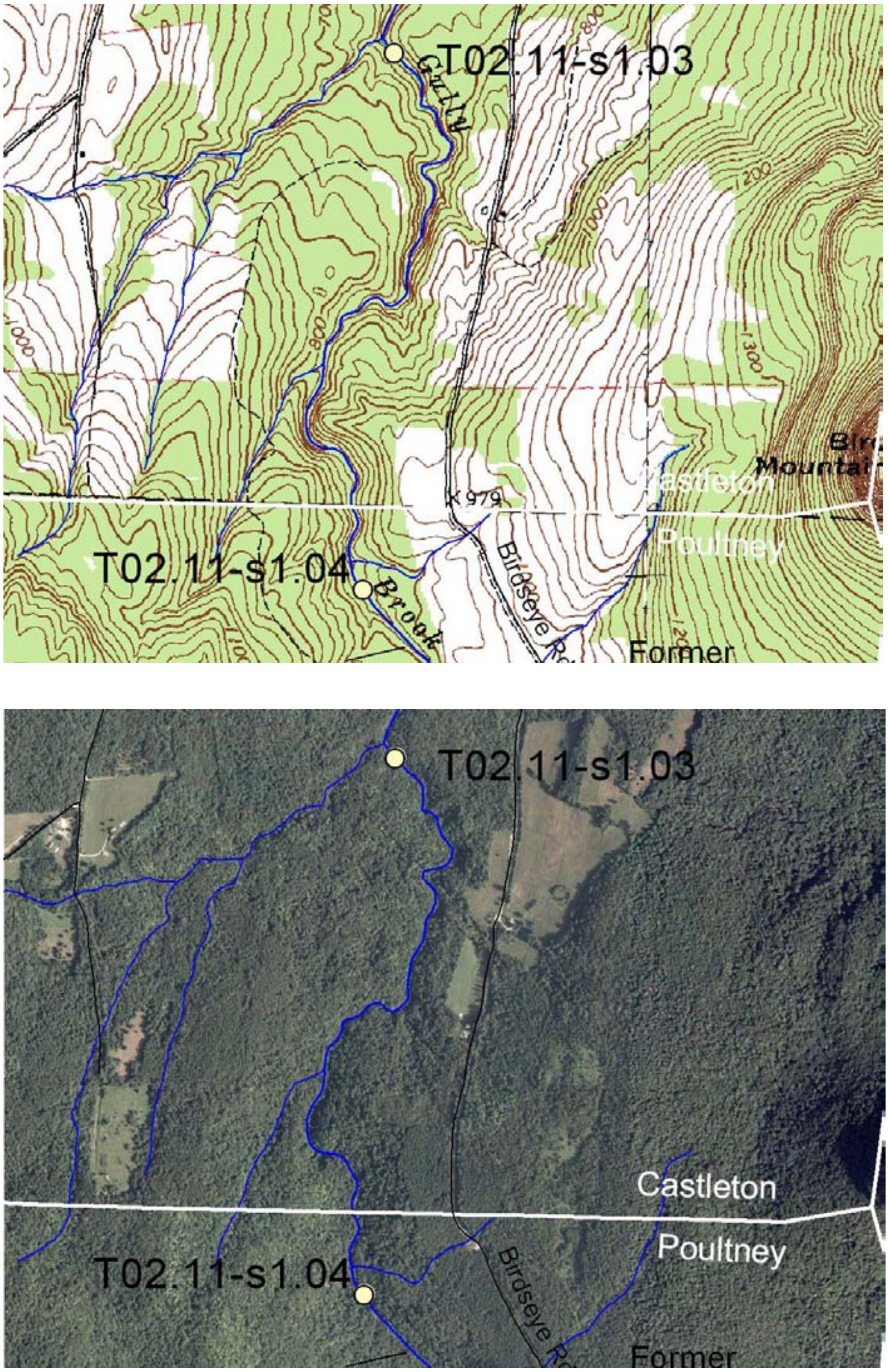
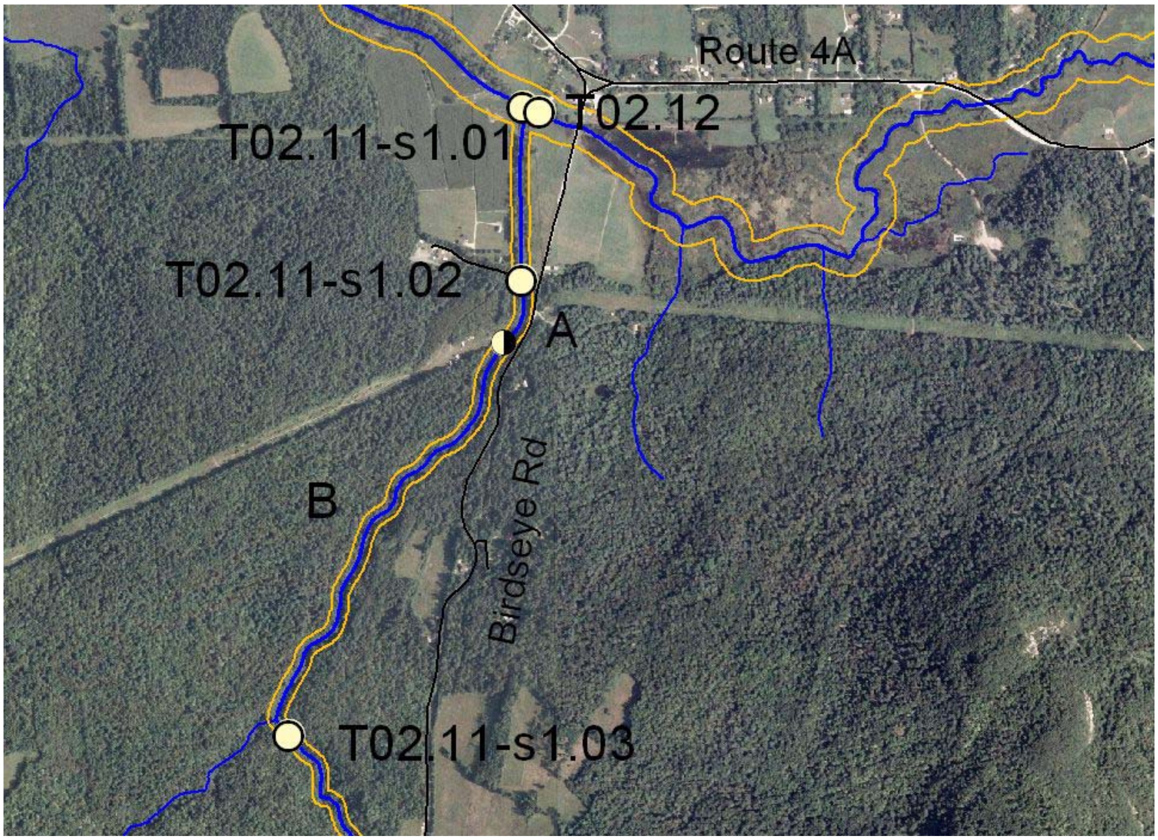


Figure 28. Revegetation of forest land cover in eastern catchment of Gully Brook reach T02.11-s1.03 along Birdseye Road in Castleton, VT. (a) 1964 USGS topographic map (photorevised 1972); (b) 2003 aerial photograph

T02.11-s1.02

The majority of this reach flows through a steep, narrowly-confined, bedrock-controlled valley. A small section of the reach at the base of Bird Mountain was segmented where the Gully Brook transitions out into the broad valley of the Castleton River main stem, due to the change in slope and reference stream type (see Figure 29).



Segment (u/s to d/s)	Approximate Length (ft)	Phase 2 Updated Slope (%)
B	3,746	3.2
A	529	1.5

Figure 29. Downstream reaches of Gully Brook (T02.11-s1.02, T02.11-s1.01), town of Castleton, Castleton River watershed. Orange line depicts Phase 2 belt-width-derived corridor.

Segment B

Segment B is approximately 3,746 feet in length and flows through a narrowly-confined forested bedrock valley (see Figure 30). This valley setting, and an estimated slope of 3.2% suggest a B-step/pool reference stream type. Current encroachments within the segment are essentially non-existent. The Birdseye Road parallels the channel for a length of approximately 170 feet within the Phase 2 belt-width-derived corridor near the downstream end of the segment. However, the road is elevated well above the floodprone width elevation of the channel.

Figure 30. Segment T02.11-s1.02-B is a gravel and cobble step/pool channel flowing through a forested, narrowly-confined, bedrock-controlled valley of moderate to steep gradient.

A cross section performed near the upstream end of the segment confirmed a B4b-step/pool stream type. Within locally shallower-gradient sections of the reach, channel form was dominated by gravel riffle/pool substrates. Two prominent exposures of channel-spanning bedrock (characterized as "ledge" by protocols) were observed in the downstream half of the segment. Given the prevalence of bedrock along channel banks, a relatively thin deposit of gravel and cobbles over bedrock is inferred elsewhere along the channel. Channel planform is controlled largely by structural features of the bedrock – leading to a relatively low sinuosity.

Overall, Segment B of T02.11-s1.02 has good access to a narrow floodplain. Signs of active incision (e.g., undercut banks, recently abandoned floodplain, high incision ratio) were absent. Possible tributary rejuvenation was evident in a right bank tributary leading from a Birdseye Road crossing near the downstream extent of the segment. Tributary rejuvenation might suggest active incision of the main channel. This location is close to historic dredging, berming and channelization activities of the Gully Brook in downstream Segment A and reach T02.11-s1.01 (see next sections). However, this right bank tributary location is spanned by the above-noted exposures of bedrock in the main channel of the Gully Brook upstream and downstream of the tributary.

Signs of active channel widening were also sparse. Streambank erosion was minimal; most near-bank areas are bedrock. A moderate degree of aggradation within Segment B was indicated by the presence of several long and wide unvegetated, cobble and gravel side bars, point bars, an island and a mid-channel bar. A second cross section completed near the mid-channel bar indicated a higher-than-average width/depth ratio (44). The source of sediments is likely from streambank and stream bed erosion occurring in upstream reaches and from in-reach and upstream tributaries. Three "deltas" (as defined by protocols) were recorded within the reach: one at a large (topographic "blue line") tributary to left bank near the upstream end of the segment; one at a small left-bank tributary at the upstream segment break, and one at a small right-bank tributary near the downstream segment break (the same tributary exhibiting possible rejuvenation as discussed above). Minor to moderate planform adjustments were indicated by presence of a few active flood chutes on the inside of meander bends, not uncharacteristic of a confined, steeper gradient channel.

Overall, Segment B of T02.11-s1.02 was rated in "Good" condition following the RGA, and a "Moderate" sensitivity was assigned. Extensive lateral and vertical controls offered by the bedrock exposures, and maintenance of well-forested wide buffers along the channel margins have contributed to the overall stability of Segment B. Overall, Segment B is operating as a transport reach, although there are localized pockets of aggradation. Large boulders are probably mobilized only in the highest magnitude flood events.

Habitat within Segment T02.11-s1.02-B was rated in "Good" condition following the RHA. Ample forested buffers provide shading and permit recruitment of large woody debris and detritus (LWD = 35; DJ's = 8). Reasonably un-embedded cobbles and boulders, as well as submerged logs and debris jams are providing epiphaunal substrates. Aggradation has led to decreased pool depths along much of the segment, and stream bed substrates are exposed during moderate to low flows. Nevertheless, several 6 to 10-inch trout were observed in shaded pools near the downstream half of the segment.

Segment A

Segment A is comprised of the downstream 529 feet of reach T02.11-s1.02 where the Gully Brook begins its transition from the narrowly-confined, bedrock-controlled steep valley setting to the broader Castleton River floodplain at the Gully Brook confluence. The channel gradient decreases substantially (from 3.2% in T02.11-s1.02-B to 1.5% in Segment A and ultimately to 1.3% in T02.11-s1.01). The sediment transport capacity of the Gully Brook drops significantly and an alluvial fan has developed over the last several thousand years. Segment T02.11-s1.02-A is located at the upstream end of this alluvial fan feature. The valley widens from approximately 30 feet in Segment B to approximately 180 feet in Segment A.

The sediment transport capacity of the Gully Brook becomes reduced here, as the valley widens and the channel slope decreases. The larger cobbles and gravels drop out in the channel, the channel aggrades and flow is diverted around these sediment deposits resulting in an actively shifting planform and braded flows. A reference D-braided stream type is consistent with this alluvial fan setting.

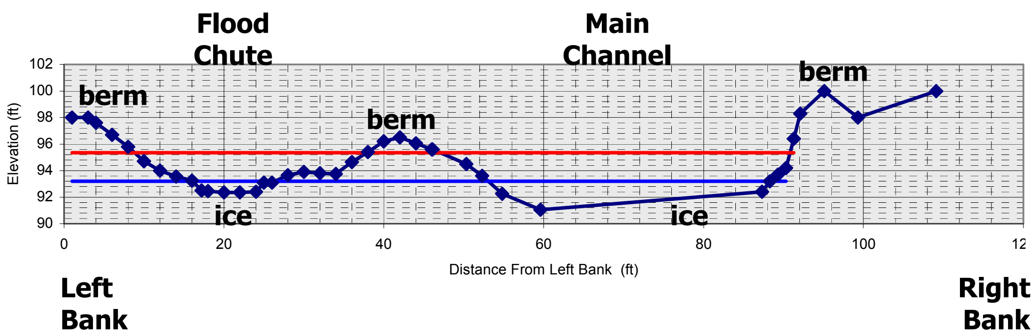
Field observations as well as historical research indicate that this section of the Gully Brook (and downstream sections) have been periodically dredged, windrowed, channelized and bermed (particularly following major flood events) to restore and protect the Birdseye Road, as well as the bridge crossing of Woodbury Road at the downstream extent of Segment A (see also discussion under "T02.11-s1.01"; Castleton annual reports 1945, 1946; VTDEC WQD, 2006c; VTDEC WQD, 2004a). Additional encroachments along the segment include a clearing for electric transmission lines, and evidence of active fording by recreational vehicles associated with this cleared area.

The cross section completed in this segment indicates an F4c-plane bed stream type (IR >2; ER of 1.26). The current channel has a linear planform and appears to be developing a slight secondary sinuosity and riffle-pool form. The channel is incised below the adjacent left bank floodplain; entrenchment is also exacerbated by the presence of berms along both left and right banks. A two to five-foot high gravel and cobble berm is present along the right top of bank from a point where the channel leaves the right valley wall downstream to the Woodbury Bridge crossing. On the left bank, there are two parallel gravel and cobble berms, one along the left top of bank, and a second berm within one bankfull width of the channel. The closer berm terminates at the channel half-way to the Woodbury Road crossing. The second berm is present along the full length of the segment. An active flood chute separates from the channel at the upstream end of these berms and flows between the berms to rejoin the channel (see Figure 31). Mature trees rooted in each of these berms suggest their age to be between 20 and 50 years.

Signs of active incision were not observed within the segment. Channel-spanning bedrock is exposed just upstream of the upstream end of the segment, which would serve as a grade control for potential headward migration of headcuts. The present degree of incision appears to be historic in nature, related to channelization and dredging, and exacerbated by the placement of high berms along both left and right bank (see Figure 31).

Figure 31. Gravel and cobble berm along left bank of Gully Brook upstream of Woodbury Road bridge crossing. Berm height ranges from 4 to 9 feet above channel thalweg.

(below) Cross section completed 24 January 2007. View downstream. Red line indicates Flood Prone Width elevation (10- to 50-year storm). Blue solid line indicates Bankfull elevation (annual high flow).



The current channel is only slightly wider than regime. Active lateral migration of the channel is suggested by an undercut left bank, exposed tree roots and active slumping of the left bank berm materials observed within 100 feet upstream of the Woodbury Road bridge crossing. These observations, along with the active left-bank flood chute indicate a moderate degree of planform adjustment. A braided channel would be expected in this setting rather than the linear, single-thread channel which has been constructed and maintained over the last several years. A minor degree of aggradation is suggested, by two side bars and a mid-channel bar.

The span of the Woodbury Road bridge crossing was measured as 37 feet, slightly wider than the measured cross section width of 35.8 feet and the predicted (regime) bankfull width of 26.2 feet. This bridge, as presently constructed, would be expected to be a constrictor of the flood prone width, but not necessarily bankfull flows. However, fill material for the road approaches partially fill the Gully Brook floodplain along left bank – an area that in a more natural condition would be occupied by multiple-thread, braided elements of the channel. Debris jams have occurred historically at this crossing, and former bridges have been replaced several times (Poultney-Mettowee Watershed Partnership, 2006).

Overall, Segment A was rated in "Fair" condition by the RGA. Due to the stream type departure from D-braided to F4c-plane bed, a sensitivity of "Extreme" was assigned. While historic channelization, dredging and berming may have temporarily protected the Birdseye Road and Woodbury Road crossing, they have resulted in the entrenchment of the Gully Brook, which is disconnected from its floodplain. Annual event and flood event flows are now trapped within the channel and the high energies of these flood flows are no long able to be dissipated out in the surrounding floodplain or through a braided, multi-thread channel that would be expected in a natural, unmanaged setting.

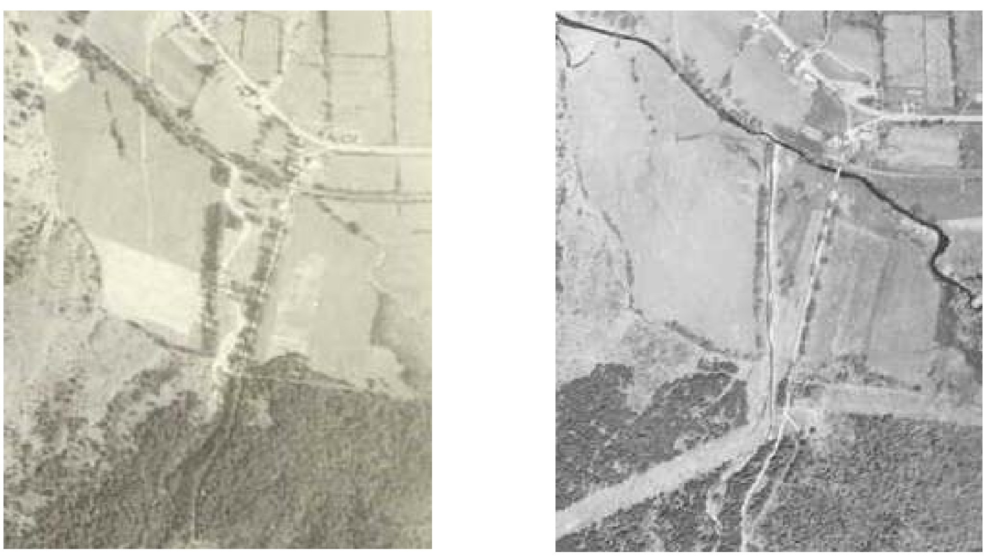
Habitat was rated in "Fair" condition following the RHA. Historic channel manipulations have reduced the diversity of channel morphology. Bed depths are relatively uniform, and pools are absent. Moderate aggradation has reduced the availability of epiphaunal substrates and much of the channel bed is exposed at moderate to low flow stages. Despite some degree of floodplain encroachment by the Woodbury Road crossing, the transmission line crossing and Birdseye Road, reasonable widths of forested or scrub/shrub buffers are present along both banks (averaging 50 to 100 feet), offering canopy cover and trees and saplings along the channel margins.

T02.11-s1.01

The downstream-most reach of Gully Brook extends 1,600 feet from the vicinity of the Woodbury Road crossing off Birdseye Road downstream to the confluence with Castleton River. Here the Gully Brook is emerging from the narrowly-confined, bedrock-controlled valley alongside Bird Mountain and flowing out onto the much broader Castleton River floodplain comprised of silt/clay deposits of glacial Lake Vermont overlain by more recent alluvial deposits. The channel gradient decreases substantially (from 3.2% in T02.11-s1.02-B to 1.3% in T02.11-s1.01). The sediment transport capacity of the Gully Brook drops significantly. Topographic contours at this slope transition suggest an alluvial fan feature. This alluvial fan probably formed under earlier post-glacial environments (thousands of years before present) when sediment deposition was more active. These alluvial fan deposits probably overlie glacial terminal moraine deposits near the southern valley wall of the Castleton River. Farther to the north near the center of the Castleton River valley alluvial fan deposits are probably interlayered with recent Castleton River alluvial sediments to cover post-glacial silt and clay deposits (Stewart & MacClintock, 1966).

A braided channel (D stream type) might be expected as the reference stream type in this valley setting under more intense hydrologic and sediment regimes. A meandering and laterally adjusting reference stream type of C may be more appropriate under present sediment and hydrologic regimes.

The Gully Brook is prone to very dynamic lateral and vertical adjustments within this reach due to the natural reduction in sediment transport capacity. Over recent decades, the sensitivity of this reach has apparently been enhanced by increases in sediment delivery to this point from upstream reaches and tributaries, by the partial removal of forested buffers, and by the gradual encroachment of road networks, residential and agricultural land uses. In an attempt to protect the investments of the Woodbury Road bridge crossing, Birdseye Road, residential development, and agricultural lands along this highly dynamic section of the river, there has been a history of channelization, windrowing, and berming of the Gully Brook as well as repeated gravel extraction from the Gully Brook and from the Castleton River in the vicinity of the confluence. The previously sinuous channel now has a very linear planform (Figure 32).



(a) (b)

Figure 32. T02.11-s1.01. Gully Brook upstream from the confluence with Castleton River main stem. The brook was channelized between 1942 and 1962. (a) 1942 aerial photograph; (b) 1962 aerial photograph.

Channel Management History

The flood of 1945 resulted in damages to the Birdseye Road along Gully Brook. A WPA project, "sponsored by the State Highway Department as part of the State Flood Reconstruction Program" involved replacement of several culverts along the Birdseye Road and the "reopening of Gulley Brook" (annual town report, year ending 1945, page 26). The following year's annual report for Castleton (year ending 1946) states that additional work was performed in response to "damage caused by the Flash Flood of 1945. The channel of Gully Brook was dredged and widened." (Town Manager's message, page 28.).

According to VTDEC documents, the Gully Brook was straightened in 1959 by the Army Corps of Engineers (VTDEC WQD, 2006c; VTDEC WQD, 2004a).

These actions of channelization, dredging and berming had the effect of disconnecting the Gully Brook from its floodplain. They also stripped the channel of its meanders and the function of associated point bar areas for sediment deposition. Consequently, the straightened and bermed channel now was an efficient conveyor of sediments directly to the area of its confluence with the Castleton River. Following Gully Brook channelization, sediments were reported to accumulate at the confluence and downstream of the confluence within the Castleton River. This caused backwater effects in the Castleton River, leading to occasional flooding of upstream pasture and barnyard areas near the Birdseye Road crossing of the Castleton River (VTDEC WQD, 2006c). Repeated gravel extraction in the area of the confluence was required to mitigate upstream flooding; dredging spoils were placed along the stream banks of the Gully Brook, further entrenching the channel.

Thus, the overall effect of these intensive channel manipulations on the Gully Brook was to shift flooding and sediment accumulation issues to downstream neighbors. Moreover, the modified channel form was not sustainable and required recurring maintenance efforts that were both time-intensive and costly.

In 2002 and 2003, a collaboration was formed between landowners and various state, federal and regional resource agencies to evaluate potential solutions for the area of the Gully Brook confluence. In 2004, a restoration project was implemented by the VTDEC Water Quality Division (WQD) in partnership with the US Department of Agriculture – Natural Resources Conservation Service, US Fish and Wildlife, the Poultney-Mettowee Natural Resources Conservation District, the Poultney-Mettowee Watershed Partnership (PMWP), and landowners (VTDEC WQD, 2004a).

The restoration project involved both passive and active geomorphic elements to re-connect the Gully Brook channel with its floodplain. Active measures involved excavations to remove the right-bank berm and lower the floodplain elevation along the right-bank corridor. Approximately 7,000 cubic yards of sediments were excavated (and trucked to a permitted off-site location). The left-bank berm remains in place, since residential homes occupy the left-bank corridor, and floodplain lowering in this area was deemed incompatible with these current investments (Swift, 2006; PMWP, 2006).

Ongoing passive geomorphic elements of the project include allowing the Gully Brook to re-establish meanders on a natural timeline. During field assessments of the Castleton River watershed in 2005 and 2006, multiple active flood chutes (incipient meanders) were observed along the right bank extending out onto the constructed floodplain. Sediments are actively being deposited in the floodplain (see Figure 33). Passive geomorphic elements have also included wildlife habitat enhancements, including tree plantings in the new floodplain (PMWP, 2006).

Figure 33. Deposition of gravels, sands, and silts is active on the newly-constructed floodplain of Gully Brook reach T02.11-s1.01. View downstream from Woodbury Road bridge crossing, 8 August 2006.

VTDEC WQD and PMWP will continue to monitor the restoration site over the next few years. It will take some time for the channel to create the more sinuous planform and fully utilize the new floodplain with roughness offered by deposited sediments and maturing vegetation. In the next few years, the channel and floodplain may not function as effectively as expected over the long term, and sediments accumulating at the confluence may need to be removed on occasion. One such "maintenance" event occurred on 25 August 2006 under direction of the VTDEC WQD. It is expected that such maintenance events will not be required in future.

Geomorphic Assessment

A reference valley width of up to 2,000 feet was historically reduced by the placement of Birdseye Road, to an approximate width of 1,200 feet. This reduction, however, was not significant enough to cause a change in valley confinement, as both values would generate a confinement ratio of more the 10 (i.e., "Very Broad").

A cross section performed by VTDEC WQD at the mid-point of reach T02.11-s1.01 indicates a gravel-dominated, plane-bed C stream type. The channel has ample floodplain access along the right corridor at this time (following 2004 berm removal and floodplain restoration). A wider-than-regime bankfull width (43.4 feet) and a very large width/ depth ratio (53) are evident. Prior to berm removal and floodplain restoration in 2004, the channel would have had an F4c-plane bed stream type, due to entrenchment caused by berm placement and a reported degree of historic incision (VTDEC WQD, 2004a).

Overall, geomorphic conditions in the reach were rated at the high end of "Fair" following the RGA. Signs of active incision were not observed within the reach (e.g., head cuts, undercut banks). While the high width/depth ratio might suggest active widening within the reach, other signs of active widening, such as collapsing banks, trees leaning in from both banks, fracture lines at the top of banks) were absent, suggesting that the shallow and wide channel dimension may instead be the result of past dredging activities combined with the effect of aggradation in this alluvial fan setting. The channel bed indicated a plane bed form, with occasional side bars, but lacking mid-channel bars or point bars, suggesting minor aggradation at this time. A subtle secondary sinuosity at low flow was observed within the overall linear bankfull channel. The active flood chutes along right bank and evidence of floodplain deposition, indicate a moderate degree of current planform adjustment. It is anticipated that as flood chutes become more pronounced, and the channel re-establishes more of a sinuous planform, depositional bars are expected to become more prevalent.

Habitat was rated as "Fair" following the RHA. Historic channelization and dredging, as well as aggradation, have resulted in a lack of morphological diversity and minimal epiphaunal substrates. Habitat is further compromised by the "losing" condition which leads periodically to the channel drying up and exposing channel substrates. On a positive note, maintenance of a forested buffer along both banks has offered shading and detritus. While this woody buffer is of minimum width at present, especially along right bank, it has contributed to stability of the streambanks. Future management plans for right bank corridor include re-establishment of a wide, forested buffer.

Historically, Segment A was a response reach. Channel management in the mid to late 1900s converted this reach to a transport reach. A goal of passive and active geomorphic measures implemented in 2004, is to restore this reach to a depositional, response zone, to reduce sedimentation and flooding issues in the downstream Castleton River.

4.3 North Bretton Brook (T02.09-s1)

The North Bretton Brook (a.k.a., North Brittain Brook on USGS Topographic Map) drains a 13.7 square mile watershed in a bedrock-controlled valley in the mid portion of the Castleton watershed (Figure 34). The North Bretton Brook valley trends north-south along the western slopes of the Taconic Range. This tributary joins the Castleton River main stem at the upstream end of reach T02.09 near the Exit 5 interchange of East Hubbardton Road with Vermont State Highway Route 4 in Castleton.

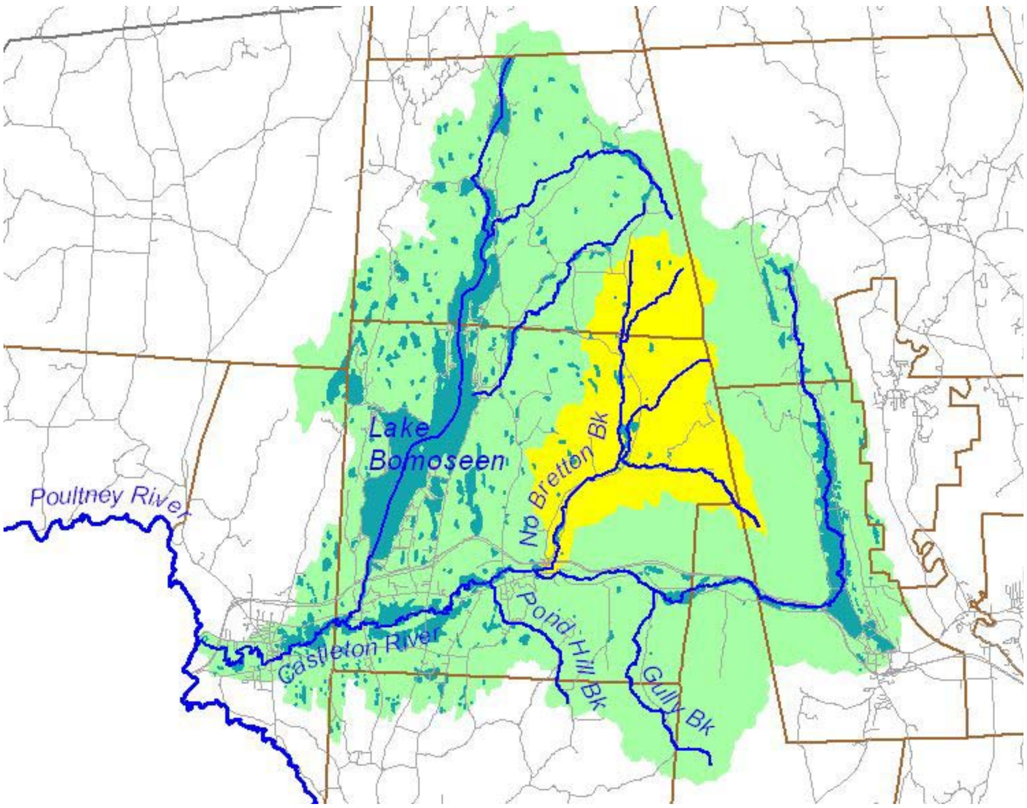


Figure 34. North Bretton Brook subwatershed of the Castleton River watershed.

At 13.7 square miles in area, this tributary watershed accounts for nearly 14% of the 99-square-mile Castleton River watershed. Approximately 79.4% of the tributary watershed is in forest cover; 12.7% is in agricultural use; 3.1% is developed; and the remainder is water or wetlands.

Four reaches of the North Bretton Brook were selected for Phase 2 field-based assessment; results are summarized in Table 8.

Table 8. Results of Phase 2 Geomorphic Assessments, North Bretton Brook Tributary

North Bretton Brook - Castleton

Reach	Seg-ment	Channel Length (ft)	Channel Slope (%)	Drainage Area (sq mi)	Stream Type	Incision Ratio	RHA Condition	RGA Condition	Adjustment	Vertical Stream Type Departure?	Channel Evolution Stage	Sensitivity
T02.09-s1.05	--	3,458	***0.9***	4.39	Not Assessed - Wetland-Dominated, Beaver-Impounded							
T02.09-s1.04	E	1,014	***1.0***		F4c-PB	2.2 (RAF)	0.45 Fair	0.30 Poor	Wid, PF, Aggr	C to F	III [F]	Extreme
	D	1,566	***0.6***		C4-PB	1.5 (HEF)	0.43 Fair	0.54 Fair	Aggr, PF (min)	No	II [F]	Very High
	C	2,960	***0.8***		C4-R/P	1.0 (RAF)	0.77 Good	0.65 Good	Aggr	No	IV [F]	High
	B	342	***2.9***		B1-Casc	Not Assessed - Bedrock Gorge						Low
	A	827	***1.2***	10.34	C4-R/P	1.0 (RAF)	0.71 Good	0.75 Good	Aggr, (min)	No	I [F}	High
T02.09-s1.02	B	3,530	***0.5***		C4-R/P	1.12	0.71 Good	0.56 Fair	PF, Aggr	No	IV [F]	Very High
	A	434	***0.5***	13.39	Not Assessed - Wetland, Impoundment - Pelletier Dam							
T02.09-s1.01	B	1,762	***1.1***		F3c-PB	2.6 (HEF)	0.60 Fair	0.53 Fair	Min Wid, PF, Aggr	C to F	III [F]	Extreme
	A *	2,745	***0.7***	13.65	C4-PB	NM	0.47 Fair	0.66 Good	Min Wid, PF, Aggr	No	V [F]	High

Notes / Abbreviations:

Channel Slope: Values in italic bold have been updated since the Phase 1 SGA, due to field-truthing and/or segmentation.

Stream Type: S/P = Step/Pool; R/P = Riffle/Pool; R/D = Ripple/Dune; PB = Plane Bed; Casc = Cascade; Ref = Reference

Incision Ratio: RAF = Recently Abandoned Floodplain; HEF = Human-elevated Floodplain (following protocols, VTANR, 2007).

Condition: RHA = Rapid Habitat Assessment; RGA = Rapid Geomorphic Assessment (VTANR, 2006).

Adjustment: PF = Planform Adjustment; Aggr = Aggradation; Wid = Widening; Deg = Degradation; NM = Not Measured.

Channel Evolution Stage: F = F-stage model; D = D-stage model (see Appendix C of protocols, VTANR, 2006).

* Subreach, with Modified Reference Stream Type

T02.09-s1.05

Upon closer field inspection, it was determined that reach T02.09-s1.05 of North Bretton Brook is dominated by wetlands and beaver-impounded sections. Completion of a Rapid Geomorphic Assessment and Rapid Habitat Assessment was therefore impractical, as the reach does not exhibit fluvial characteristics. Field notes of pertinent features were completed for accessible portions of the reach on the upstream and downstream ends.

This ¾-mile reach traverses a very broad valley section, with a slope of 0.9% overall. A reference E stream type is suggested by the valley setting and predominance of wetlands. Field observations indicated ample floodplain access.

The upstream extent of the reach exhibits a linear planform for a distance greater than 20 times the channel width; this planform, coincident with closely-encroaching agricultural fields on both banks, suggests historic channelization. A plane-bed channel form is present (see Figure 35).

Figure 35. Plane-bed channel form at upstream extent of T02.09-s1.05.

The channel begins to meander more freely and split into multiple channels on approach to the wetlands. Field staff walked nearby fields and East Hubbardton Road to bypass the wetlands and access the downstream 700 feet of the reach. The downstream extent has a C-riffle pool bedform. A wooden bridge crossing for an apparent recreational trail (possibly VAST) was noted approximately 425 feet upstream of the downstream reach break (length measured following the 1994 channel, rather than the VHD which appears to be based on the 1972 USGS topographic map). Channel-spanning bedrock was observed just upstream of this bridge crossing. Approximately 50 feet upstream of the bedrock control, a beaver dam was noted, which impounded approximately 200 feet of the channel upstream of this point.

With the exception of hay fields and the trail crossing, there is relatively minor floodplain encroachment in the reach. Buffers are reasonably contiguous, offering shade, organic material, and LWD recruitment to the channel. Morphological diversity and epiphaunal substrates were lacking in the upper 500 feet of the reach (where historic straightening is inferred).

T02.09-s1.04

This reach continues southward along the broad agricultural and residential valley west of East Hubbardton Road to a valley pinch point where North Bretton Brook is joined by Belgo Brook tributary. Field observations and measurements collected in the reach identified a subreach of alternate stream type, and sections of variable stream condition and management history, compelling the following segmentation (reach maps in Appendix B show segment locations): Segment E – 1014 ft, Segment D – 1566 ft, Segment C – 2960 ft, Segment B – 342 ft, Segment A – 827 ft.

Segment E

Upstream Segment E shows signs of recent incision and active widening, including a recently abandoned floodplain along the left bank, as well as scour, undercut roots, and actively leaning trees along both banks simultaneously. The channel is incised (IR= 2.2) between the bedrock-controlled right valley wall and corn fields along left bank (Figure 36). Incision appears historic, given a lack of observed head cuts. A plane-bed channel form dominates. Substantial lateral erosion on outside bends, active flood chutes inside meander bends, frequent debris jams, and unvegetated sediment bars indicate active planform adjustment and aggradation. Active recruitment of LWD and debris jams are beginning to restore riffle / pool diversity, and the channel is regaining some degree of sinuosity (contrary to the indicated linear planform of the VHD).

Historic straightening is suspected in Segment E given the proximity of left-bank crop fields, as well as channel management in the next downstream segment. It is inferred that channelization in this segment (as well as the downstream segment) initiated incision, which could have migrated headward at least to the location of channel-spanning bedrock exposures in upstream reach, T02.09-s1.05.

Figure 36. In Segment T02.09-s1.04-E, North Bretton Brook is incised (IR= 2.2) between the bedrock-controlled right valley wall and corn fields along left bank. View downstream, 2 August 2005

Historic incision has resulted in a stream type departure from a reference C channel to an F channel. The channel has lost connection with its floodplain. Over-steepened stream banks and active aggradation from in-segment bank failures are contributing to channel widening. An incipient floodplain, 1.5 to 2 times channel width, appears to be developing in this upstream extent of the reach (Stage III of F-stage CEM). Overall, the segment was rated in "Poor" condition following the RGA. Given the stream type departure, a sensitivity rating of "Extreme" was assigned by protocols. In the absence of future channel manipulations, this segment could have a high potential for recovery, especially given the preservation of forested buffers.

Sediment deposition and streambank instabilities are contributing to less than adequate habitat conditions. On the other hand, ongoing planform adjustments are leading to recruitment of LWD and creation of local scour pools, which are favorable from an aquatic habitat standpoint. Forested buffers along the right bank are very wide (>100 feet) and extend beyond corridor boundaries. Left-bank forested buffers along crop fields are minimal in width (20 to 60 feet). Segment E was rated in "Fair" condition following the RHA.

Segment D

Segment D is located between crop fields on right and left corridors. This segment has undergone substantial and recent channel management. The highly linear planform over a distance greater than 20 channel widths, and the close proximity of agricultural fields suggest straightening. Trees in the 25 to 70 foot wide buffer along both banks appear at least 15 to 20 years old based on their size. This evidence suggests that straightening has been historic in nature. Low berms are present along both banks through the middle 600 feet of the segment. Limited, annual, herbaceous vegetation on the sand and gravel sediments along the inside edge of the berms suggests recent windrowing. The channel bed is uniform (plane-bed), and vehicle tracks were noted along the exposed channel.

For a 700-foot length, approximately coincident with this channelized and bermed section, there was no sustained flow in the channel on the date of assessment (2 August 2005). Isolated very shallow "pools" were separated by long expanses of dry bed. This observation (in absence of a flow diversion) suggests that this segment of the North Bretton Brook is a "losing reach". Surficial geologic mapping (MacClintock, no date; see Section 2.2), indicates presence of kame terrace deposits in this location along North Bretton Brook. The permeable nature of these glacial deposits could result in losing conditions.

Measurements at the mid-point of the segment indicated that the berms are spaced approximately 27 feet apart. This distance is slightly less than the reference channel width for this reach of 32.7 feet. However, the berms do not appear to exceed the flood-prone elevation of the channel, and the berm material (sands and fine gravels) would likely be easily mobilized in a flood event. Beyond the berms (IR_{HEF} = 1.5), the channel has reasonable access to a wide, floodplain.

Despite the substantial channelization and berming, no indications of active incision, widening, or planform adjustments were noted along the channelized and bermed central portion of the segment. It is possible that reductions in flow imparted by the losing condition of this segment, reduce the stream power through this section, to a degree that moderates the potential for incision. It is also possible that this segment has more recently experienced aggradation (to superimpose on potential incised conditions), as a result of sediments mobilized during headward migration of incision into the upstream segment. Reasonably mature deciduous forest along both near bank areas has likely moderated the potential for widening. Planform adjustment and minor aggradation were indicated at the downstream and upstream ends of the segment, where the channel, unconstrained by a straightened and bermed form, was observed to be actively eroding outside bends and regaining some measure of sinuosity (more than what is indicated by the VHD). Overall, Segment D was rated in "Fair" geomorphic condition following the RGA.

The extensive channel management has contributed to a relative lack of epiphaunal substrates and morphological diversity in Segment D. These conditions are further compromised by the natural conditions of minimal flow status (at least in mid-Summer to mid-Fall months) and low diversity of velocity/depth patterns. On the positive side, well-developed forested buffers of reasonable width are providing separation from intensive nearby cropping uses and providing shading, detritus and LWD to the channel.

Figure 37. Approximately 700 feet of dry streambed in channelized, bermed section of T02.09-s1.04, Segment D. View downstream.

Segment C

Downstream of this channelized segment of T02.09-s1.04, the North Bretton Brook flows through a very broad valley setting with hydric soils and occasional pockets of channel-contiguous wetlands. The corridor along Segment C appears more consistently forested and less influenced by floodplain developments and agricultural land uses than upstream segments. An active sand and gravel quarry is present to the east of the stream, outside the stream corridor. Buffers are dominantly greater than 100 ft on both banks and are longitudinally contiguous along the channel. Frequent bedrock exposures, particularly in the downstream portion of the segment, offer lateral and vertical grade controls to the channel.

A cross section was completed mid-segment, which indicated good floodplain connection, and a gravel-bed C-riffle/pool stream type consistent with reference valley setting. No signs of active incision were observed in the segment. A minor degree of planform adjustment in the form of meander extensions was suggested by limited erosional scour on outside bends. Sinuosity in the segment is significantly greater than what is indicated by the VHD. Moderate aggradation within the reach is suggested by presence of unvegetated mid-, point-, side and diagonal bars (less than half bankfull height). A relatively high width/depth ratio was measured at the cross section site, however, this was a localized phenomenon, uncharacteristic of the segment as a whole, which shows minor signs of widening. Segment T02.09-s1.04-C was rated in "Good" condition by the RGA, on the cusp with "Fair".

Habitat conditions were good in the segment. Riffle-pool bedform and debris-jam induced meander bends offer good morphological diversity. Frequent snags and submerged logs provide epiphaunal substrates. Consistent forested riparian buffers offer canopy for shading, and recruitment of LWD and detritus.

Segment B

Segment B of reach T02.09-s1.04 was delineated to identify a short section (approximately 300 feet) of steep-gradient, bedrock-controlled channel with narrowly-confining valley walls. According to protocols, an RHA and RGA were not completed for this "gorge" segment. A "Low" sensitivity was assigned.

Segment A

Segment A represents the small remaining section of reach T02.09-s1.04 downstream of the bedrock channel in Segment B. Within Segment T02.09-s1.04-A, the North Bretton Brook is joined by tributary Belgo Brook. A minor tributary to Belgo Brook also has its confluence in this general vicinity. A semi-confined valley ranging from 1.5 to just over 4 channel widths is present along this segment.

Encroachments are very minimal within the segment, limited to residential lawn along the left bank within 90 to 150 feet of the channel. Bedrock is exposed along alternating left and right banks of Segment A imparting lateral controls on the stream channel. Sinuosity is therefore quite low.

Habitat conditions, as evaluated by the RHA, were compromised somewhat by the degree of sedimentation, which has reduced flow diversity and pool presence in this short segment just over 20 channel widths in length. However, wide coniferous forest buffers are present along both banks, contributing to streambank stability, and providing shading and detritus / organic material to the channel. Overall, habitat conditions were rated as "Good".

Cross section data from Segment C were applied to this segment, given the similarity of channel dimensions and gradient indicated by visual observation. The channel has good access to a narrow, bedrock-controlled floodplain through the segment. No evidence of active incision, widening, or planform adjustments were noted. A large transverse bar (less than one-half bankfull height) and a slightly overwidened profile suggest minor aggradation. Several unvegetated bars of gravel and cobble sediments were noted in the Belgo Brook and its tributary upstream of the confluence with North Bretton Brook. Overall, Segment A was rated in "Good" geomorphic condition following the RGA.

Segment A is a local sediment attenuation area, and would be sensitive to future lateral adjustments if sediment loading from tributaries increases.

T02.09-s1.02

Reach T02.09-s1.02 flows through a broad to very broad valley setting west of East Hubbardton Road and ends in a wetlands complex and impoundment (former mill pond) upstream of the Pelletier Dam owned by the Vermont Fish & Wildlife Department (VCGI, 2005, Vermont Dam Inventory).
Reach T02.09-s1.02 was segmented to delineate the impoundment and dam separately from the remainder of the reach: upstream Segment B: 3530 feet; downstream Segment A containing the dam, 434 feet.

Segment B

Segment B flows through a broad valley setting of moderate slope (0.5%), transitioning from an upstream reach of steeper gradient and narrow confinement. Floodplain encroachments along the segment include minor residential properties and a length of the East Hubbardton Road within the left-bank corridor, and crop fields along the right bank in the upper half of the segment. The channel has a somewhat linear planform, although sinuosity is more pronounced than depicted on the VHD. Channel-spanning bedrock was observed near the upstream end of the segment, and bedrock walls along the right bank offer lateral grade controls in the downstream half of the segment. Historic channelization may be possible in the upper half between East Hubbardton Road (LB) and crop fields (RB). A substantial length of the channel was recorded (with GPS) to be in a different position than that represented on the 1972 USGS topographic map (and VHD coverage). The 1994 channel position was digitized from orthophotographs, and a 2005 channel position was digitized from GPS waypoints for this section; GIS shape files are included on the project CD.

A cross section completed mid-segment indicated a C4-riffle/pool stream type, consistent with reference stream type. The channel has good floodplain access (IR = 1.1). If historic incision occurred in response to possible channelization, it is expected that incision would be moderated by the presence of channel-spanning bedrock. Also, active aggradation within the segment (evidenced by multiple unvegetated bars, unconsolidated sediments in the bed, and a moderately high width/depth ratio may have offset potential degradation in response to channelization. Frequent flood chutes and bifurcated channels around mid-channel bars are evidence of active planform adjustment. A debris-jam generated channel avulsion was noted mid-segment.

Segment B was rated in "Fair" geomorphic condition following the RGA, with a "Very High" assigned sensitivity. This deposition-dominated reach is exhibiting signs of active planform adjustment and aggradation. The segment is serving as a sediment attenuation area upstream of the Pelletier Dam grade control.

Overall habitat conditions within the reach were rated as Good. There is fairly substantial diversity of bedforms, velocity/depth patterns and epiphaunal substrates are available. Active recruitment of LWD was observed (LWD = 60; DJs = 10). Continuous deciduous and coniferous buffers are present along both banks, except through the wetlands portion of the reach. The main detriment to habitat appears to be sedimentation presumably from upstream sources as well as in-segment erosion.

Segment A

Segment A consists of the Pelletier Dam and the upstream impoundment. According to available records, a dam (either this structure or its predecessor) has been located in this place since at least 1792. A grist mill and sawmill were present on Foot's mill lot in the late 1700s; the site was noted as "Miner's mills" circa 1825. The Sherman marble cutting mill utilized water power from the dam site in the early 1800s and as late as 1869 (Castleton Historical Society, 1998; Beers, 1869).

The present dam is approximately 15 feet in elevation above the downstream channel bed. A low-elevation outlet is present at approximately 10 feet above the channel (visual estimate only; not surveyed). On the field assessment date (20 July 2005), a beaver dam was observed immediately upstream of the dam. Bedrock is exposed in the channel and along the right bank immediately downstream of the dam.

No geomorphic assessment (or RGA, RHA) of this segment was completed due to the impounded nature of the channel and wetlands (as per protocols).

Figure 38. Pelletier dam is coincident with the downstream reach break for T02.09-s1.02. A wetland (former mill pond) is present upstream of the dam for a distance of approximately 400 feet. View upstream from East Hubbardton Rd bridge crossing.

T02.09-s1.01

Reach T02.09-s1.01 extends from just below the Pelletier Dam downstream to the confluence with the Castleton River main stem. This reach grades southward from a somewhat narrow North Bretton Brook valley out into the broader Castleton River valley. The lower half of the reach is positioned on an alluvial fan feature. In hindsight, a Phase 1 reach break should have been placed near the current location of the Route 4 highway westbound exit ramp crossing of North Bretton Brook, due to the change in valley setting and this alluvial fan feature. While the change in channel gradient is subtle (from 1.1% to 0.7%), the change in valley width and reference channel type is significant. A pre-colonial reference channel type for the downstream half of the reach would likely have been a D-type, braided channel. A braided channel undergoing active lateral adjustments is a natural channel form for an alluvial fan setting.

Given these findings, a segment break was placed at the upstream side of the Route 4 Exit 5 off-ramp. This segment break separates upstream and downstream channel segments of different reference stream type: downstream Segment (Subreach) A: 2,745 feet; and upstream Segment B: 1,762 feet.

A Modified Reference Stream Type was assigned to the alluvial fan Segment A, as further explained in the following sections. The Modified Reference Stream Type was designated in keeping with guidance provided in the VTANR protocols (Step 7, page 71, 2006 edition). During the last 150 to 200 years, this alluvial fan segment has been subjected to significant channel modifications and floodplain encroachments of a semi-permanent nature (i.e., highway, railroad). As such, it would be impractical to consider restoration of this segment to pre-colonized reference conditions.

Segment B

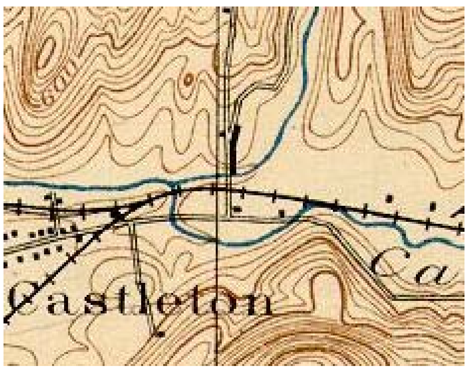
An historic road is visible on the 1972 topographic map along the left valley wall at the upstream extent of Segment B. This road appears to have been truncated at the Route 4 corridor, during the development of the highway. While the road grade is overgrown and appears to be abandoned, it nevertheless encroaches on the channel and serves as a berm. The left bank floodplain is reduced by presence of this old road grade, and the road surface is elevated above the flood-prone elevation, based on cross section measurements made on 20 July 2005. The cobble plane-bed channel is presently incised (IR_{HEF}= 2.6) below this left valley wall and an armored right bank adjacent to agricultural fields. A linear planform is also apparent for this section with negligible point or side bars evident. It is possible that portions of the segment were channelized historically to maintain the road along left bank and the agricultural fields along right bank. The upstream run-of-river dam (or a predecessor dam structure, present since 1792) may also have contributed to historic incision in Segment B. Upstream sediments would be trapped in the impoundment behind the dam, and "sediment-starved" waters downstream of the dam would theoretically have enhanced erosive powers to scour into the channel bed and banks.

Despite the substantial channel incision, this segment of reach T02.09-s1.01 is currently exhibiting minor degrees of widening, aggradation, and planform change. It is possible that boundary conditions of the channel and bed (i.e., coarse sediments, continuous woody buffers) have offered sufficient resistance to erosion. The upstream dam and former mill pond may also offer attenuation of flood flows that otherwise would contribute to increased hydraulic pressures on the downstream reach. At present, Segment B has characteristics of a transport-dominated channel, with an armored bed. Nevertheless, the entrenched channel is susceptible to sudden erosion in a flood event if hydraulic pressures increase and/or boundary conditions change in such a way as to reduce the erosion resistance.

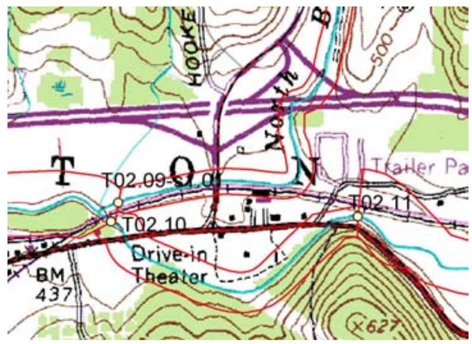
Habitat conditions were rated as "Fair", due to the lack of pool-riffle diversity and limited epiphaunal substrates. A moderate degree of sedimentation was indicated by measures of embeddedness. Sediments are likely being contributed from streambank erosion within the segment. Forested, riparian buffers are well developed along the left corridor, but less than optimal along the right corridor.

Segment A

Substantial floodplain encroachments and channel management activities are apparent for this segment (Subreach) of T02.09-s1.01 from field observations and historical research (see also discussion in Section 4.1 under reach T02.10). At present, North Bretton Brook tributary joins the Castleton main stem just downstream of the reach break between T02.10 and T02.09. Based on review of historical resources (Smith & Rann, 1886; Castleton Historical Society, 1998), it is apparent that this confluence was moved in 1850 to accommodate the Rutland and Washington Railroad (later Delaware & Hudson Railroad, now Clarendon-Pittsford Railroad) (Figure 39.a). "*On the north side of the railroad, and parallel with it, a new channel was cut by the company, at the same time, and Hubbardton Brook [North Bretton Brook] was turned into it, which saved building a railroad bridge across the old channel*, …" (Smith & Rann, 1886). The railroad grade is presently 10 to 15 feet in elevation above the North Bretton Brook and forms the left valley wall of the lower 1700 feet of Segment A. Substantial portions of the natural plateau formed by an alluvial fan from the North Bretton Brook were also excavated during construction of the railroad (Smith & Rann, 1886).



(a)



(b)

(c)

(d)

Figure 39. Planform of North Bretton Brook near confluence with Castleton River main stem. (a) 1897 Castleton 15-Min. USGS topographic map; (b) 1972 Poultney 7.5-Min. USGS topographic map; (c) 1962 aerial photograph; (d) 1994 orthophotograph.

In the 1960s, the Route 4 highway was constructed. The east and west-bound lanes, as well as the Exit 5 west-bound off-ramp, cross the North Bretton Brook at the upstream end of the segment. Construction of the highway resulted in significant changes to the planform for North Bretton Brook, and this channel is now directed through two long box culverts: one for the Exit 5 ramp, and the second for both the west-bound and east-bound lanes of the highway (Figure 40). These concrete box culverts, approximately 90 and 220 feet in length, serve as vertical and lateral grade controls for the channel. Scour holes have developed; one between the culverts and one at the downstream end of the highway culvert.

Figure 40. Route 4 highway box culvert crossing structures. View downstream; foreground is box culvert under exit ramp approximately 90 feet long; background is culvert under Route 4 east-bound and west-bound lanes, approximately 220 feet long.

Immediately downstream of the culverts, North Bretton Brook flows along the western boundary of the Fort Warren mobile home park. This park was developed within the left corridor of the tributary sometime between 1968 and 1994 (based on review of available aerial photographs). Town of Castleton annual reports note flood damages to the Fort Warren park during June of 1981 (Town of Castleton Annual Report, 1981).

Downstream of the park, the river has an opportunity to development some sinuosity where not constrained by channel armoring. Shortly thereafter, the channel is constrained along the left bank by the railroad grade for a distance of approximately 1,700 feet before joining the Castleton main stem immediately upstream of a low-head dam. The channel appears to have limited floodplain access through this downstream portion along the right corridor.

Despite the substantial channel management and floodplain encroachment along T02.09-s1.01, this segment is exhibiting minor adjustments, limited to some aggradation and planform adjustment in the mid-section alongside the Fort Warren park. The reach conditions are suggestive of a D reference stream that has been modified through a sequence of channel modifications and ongoing maintenance to a C stream type – thus, a Modified Reference Stream Type of C4-plane bed. Stability of this modified stream type has been afforded by grade controls including the box culvert crossings of the Route 4 highway. Channel slopes are also regulated by fixed elevations of the low-head dam on the Castleton main stem at reach T02.09 and by the Pelletier Dam at the upstream extent of reach T02.09-s1.01. Excess sediments from farther upstream in North Bretton Brook are impounded at the Pelletier Dam.

While the channel appears fairly stable in this segment, habitat conditions have been compromised by the substantial channel management, and the resulting lack of morphological diversity and epiphaunal substrates. Tree buffers are minimal in width along Segment A. The Route 4 highway crossing structures may serve as barriers to fish migration, given their length.

4.4 Pond Hill Brook (T02.08-s1)

Pond Hill Brook drains a 2.5-square-mile subwatershed in the southern portion of the Castleton River watershed (see Figure 41). This tributary joins the Castleton River main stem at the upstream end of reach T02.08 near the Cemetery Drive crossing of the Castleton River at the western end of Castleton village.

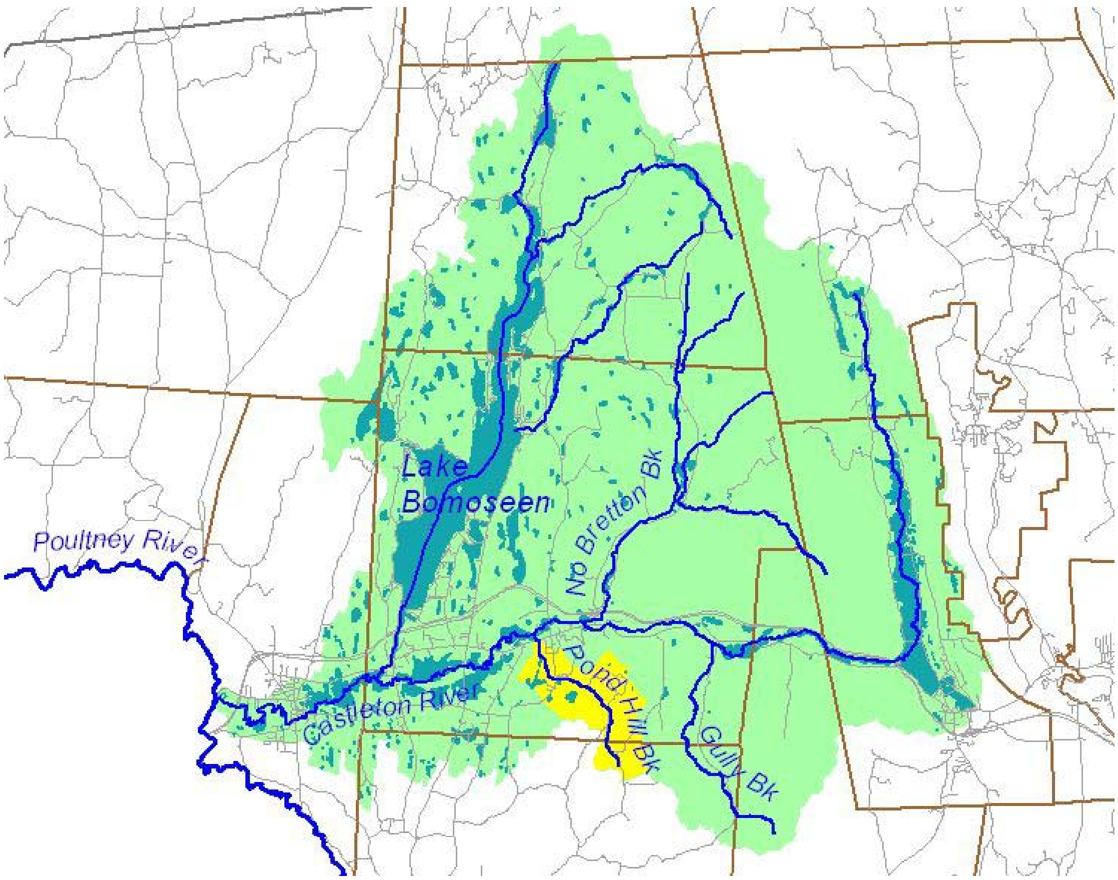


Figure 41. Pond Hill Brook subwatershed of the Castleton River watershed.

At 2.5 square miles in area, this tributary watershed accounts for about 2.5% of the 99-square-mile Castleton River watershed. Approximately 60.7% of the tributary watershed is in forest cover; 23.7% is in agricultural use; 8.1% is developed; and the remainder is water or wetlands.

Five reaches of the Pond Hill Brook were selected for Phase 2 field-based assessment; results are summarized in Table 9.

Table 9. Results of Phase 2 Geomorphic Assessments, Pond Hill Brook Tributary

Pond Hill Brook - Poultney, Castleton

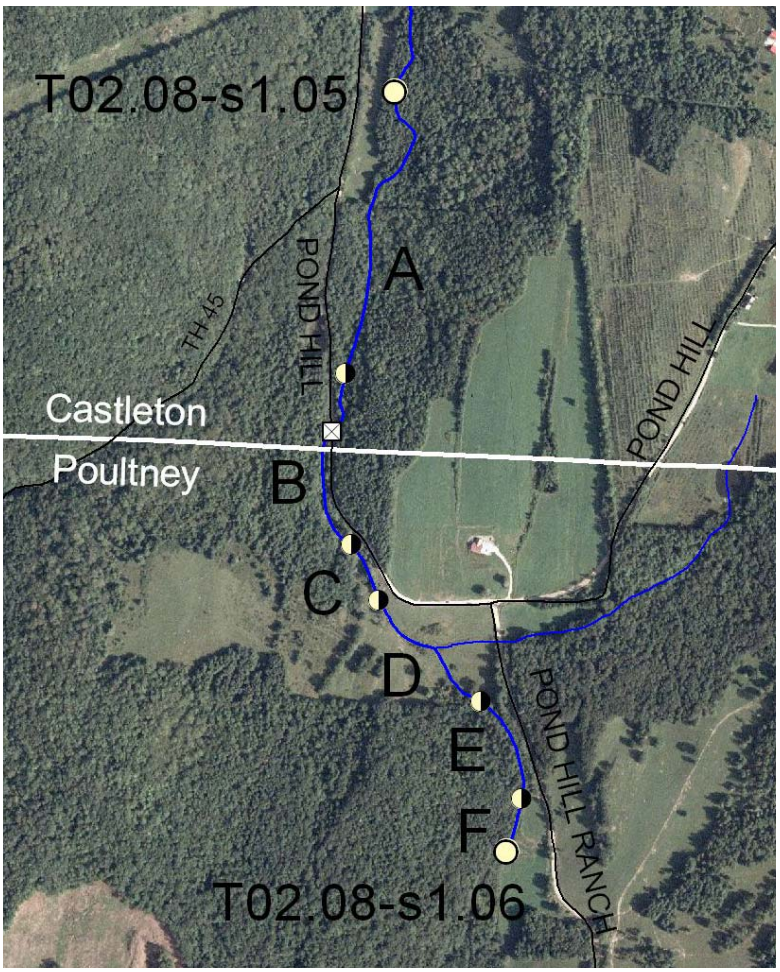
Reach	Seg-ment	Channel Length (ft)	Channel Slope (%)	Drainage Area (sq mi)	Stream Type	Incision Ratio	RHA Condition	RGA Condition	Adjustment	Vertical Stream Type Departure?	Channel Evolution Stage	Sensitivity
T02.08-s1.05	F	300	***1.0***		F5c-R/P	4.5 (RAF)	0.57 Fair	0.58 Fair	Wid, PF (min)	C to F	IIb [D]	Extreme
	E	613	***11.4***		A1-casc	Not Assessed - Bedrock Gorge						Low
	D	827	***3.0***		B4b-R/P	2.04 (RAF)	0.57 Fair	0.46 Fair	PF, Aggr, Wid (min)	Cb to B	V [F]	Extreme
	C	341	***7.6***		B1a-casc	Not Assessed - Bedrock Gorge						Low
	B	1,034	***3.7***		B4b-S/P	1.0 (RAF)	0.63 Fair	0.64 Fair	Aggr (min); Wid (min)	No	IIc [D]	High
	A	1,687	***4.8***	0.64	A1-casc	Not Assessed - Bedrock Gorge						Low
T02.08-s1.04	C	636	***6.9***		A1-casc	Not Assessed - Bedrock Gorge						Low
	B	1,405	***2.9***		F4b-R/P	2.2 (RAF)	0.57 Fair	0.43 Fair	Aggr, PF	Cb to F	IV [F]	Extreme
	A	384	***6.5***	0.89	B1a-casc	Not Assessed - Bedrock Gorge						Low
T02.08-s1.03	--	1,256	***8.8***	0.95	A1-casc	1.0 (RAF)	0.89 Ref	0.88 Ref	None	No	I [D]	Very Low
T02.08-s1.02	--	2,537	***2.0***	1.85	F4c-PB	6.2 (RAF)	0.53 Fair	0.53 Fair	Wid (min)	C to F	II [F]	Extreme
T02.08-s1.01	E	1,711	***1.5***		C4c-R/P	1.0 (RAF)	0.55 Fair	0.69 Good	PF (mod); Aggr (min)	No	V [D]	High
	D	1,622	***1.2***		C4c-R/P	1.0 (RAF)	0.59 Fair	0.66 Good	PF (mod)	No	IIc [D]	High
	C	677	***3.7***		B1b-casc	Not Assessed - Bedrock Gorge						Low
	B	927	***1.1***		C4c-R/P	1.13 (RAF)	0.61 Fair	0.81 Good	PF (min)	No	I [D]	High
	A	513	***2.1***	2.46	C4c-PB	1.4 (HEF)	0.44 Fair	0.63 Fair	Minor	No	IIb [D]	Very High

Notes / Abbreviations:

Channel Slope: Values in italic bold have been updated since the Phase 1 SGA, due to field-truthing and/or segmentation.
Stream Type: S/P = Step/Pool; R/P = Riffle/Pool; R/D = Ripple/Dune; PB = Plane Bed; Casc = Cascade; Ref = Reference
Incision Ratio: RAF = Recently Abandoned Floodplain; HEF = Human-elevated Floodplain (following protocols, VTANR, 2007).
Condition: RHA = Rapid Habitat Assessment; RGA = Rapid Geomorphic Assessment (VTANR, 2006).
Adjustment: PF = Planform Adjustment; Aggr = Aggradation; Wid = Widening; Deg = Degradation; NM = Not Measured.
Channel Evolution Stage: F = F-stage model; D = D-stage model (see Appendix C of protocols, VTANR, 2006).

T02.08-s1.05

The upstream-most delineated reach of Pond Hill Brook begins along Pond Hill Ranch Road, approximately 500 feet downstream from a wetland noted on the USGS topographic map. Generally, the reach flows through a narrowly-confined to semi-confined, steep valley in forest cover. For a majority of its length through reach T02.08-s1.05, Pond Hill Brook was observed to be flowing directly on bedrock ledge or cascading over bedrock waterfalls. In some discrete sections of the reach, channel gradients were less than 4% (but still greater than 2%), and valley widths were a bit more relaxed (semi-confined). This variability of valley confinement and gradient along with land use conditions led to segmentation of the reach in accordance with protocols (see Figure 42).



Segment (u/s to d/s)	Approximate Length (ft)	Phase 2 Updated Slope (%)
F	300	1.0
E	613	11.4
D	827	3.0
C	341	7.6
B	1,034	3.7
A	1,687	4.8

Figure 42. Segmentation of reach T02.08-s1.05.

Segment F

Segment F begins at the upstream reach break at the boundary between a hay field on the right and forest on the left. The segment is short (300 feet), and follows the hay field. In contrast to the overall reach, a reference stream type of C for Segment F is suggested by the unconfined valley setting, and the channel gradient of 1.0%.

This segment of the Pond Hill Brook appears dredged (ditched) to accommodate agricultural use of the field along the right bank. A quick cross section performed near this upstream end indicated that the stream is entrenched and has undergone a stream type departure to an F5c-riffle/pool, having lost access to its flood plain (IR = 4.5; ER = 1.4). The upstream wetland and downstream exposures of channel-spanning bedrock appear to have isolated this entrenched condition to a localized occurrence.

Segment F was assigned a "Fair" condition following the RGA; a sensitivity of "Extreme" was assigned by protocols, due to the stream type departure. Degradation appears historic in nature, as indications of active incision were not observed in the segment. A short section of channel-spanning bedrock was present mid-segment which would offer vertical stability to the channel. A minor degree of widening and planform adjustment are suggested by erosional scour along the streambanks and two small flood chutes on the inside of meander bends. The drainage area at this location on Pond Hill Brook is very small; thus flow velocities (and stream power to erode the bed and banks) are expected to be limited. Cohesive till soils exposed in the bed and banks may also be moderating incision and channel widening.

Habitat conditions were rated in "Fair" condition following the RHA. Conditions contributing to the low score included extensive channelization and straightening, which have led to minimal morphological diversity and epiphaunal substrates. Forested buffers are absent along the right bank, and the natural herbaceous buffer is very limited in width. On the other hand, wide forested buffers along the left bank offer some shading, detritus and organic materials.

Segment E

Proceeding downstream, the channel gradient picks up substantially, as Pond Hill Brook flows over bedrock ledge and waterfalls through hemlock forest to the west of Pond Hill Ranch Road. The topography and valley setting indicate a reference A1-cascade stream type.

Figure 43. T02.08-s1.05-E A1-cascade bedrock channel flows through a deciduous forest to the west of Pond Hill Ranch Road. View upstream, 25 July 2006. River staff is at approximate bankfull elevation.

The Pond Hill Ranch Road (gravel) passes parallel to the Pond Hill Brook within 25 to 50 feet of the right bank for a portion of the segment (although the road is elevated well above the bankfull or flood-prone-width elevations). Within this 210-foot length of channel, five separate occurrences of stormwater runoff were observed along right bank directed from road-side drainage and one culvert (not flowing on the date of assessment). A 7.3-foot drop was measured from the invert of this culvert to the channel bed. Road sediment, apparent roadside fill material (unconsolidated gravels and cobbles) and debris (tire, old culvert) were observed in small side bars, a mid-channel bar and one small delta in close proximity to these stormwater inputs. Also associated with these stormwater inputs were three mass failures ranging in height from 8 to 12 feet along the right bank. One slide had been stabilized with log cribbing. Three debris jams were also recorded in this segment. Two separate lengths of stone rip-rap (failing in spots) were present along the right bank.

A cross section performed mid-segment confirmed an A1-cascade stream type. Good connection to the narrow floodplain is apparent. Bedrock ledge is exposed along the majority of the channel length, punctuated by the occasional waterfall, ranging in height from 3 to 6 feet. The bedrock channel and near bank areas provide stability to the channel and dictate the linear planform. No signs of active incision, widening, or planform adjustments were observed in the segment. Minor signs of aggradation were indicated by the side bars, mid-channel bar and delta of stormwater-related sediment inputs. Depositional bars were essentially absent from channel sections upstream and downstream of the stormwater inputs. Segment E was characterized as a bedrock "gorge", and assigned a "Low" sensitivity, by protocols.

Segment E was ranked as "Good" for habitat conditions, following the RHA. Diversity of flow patterns and availability of epiphaunal substrates were limited by virtue of the steep, bedrock channel in this natural gorge setting. Close encroachment by the gravel road along the right-bank corridor, and the associated stormwater and sediment inputs and bank stability issues, are factors which further reduced the habitat score. Forested buffers are offering shading and LWD/detritus recruitment.

Segment E is operating as a transport reach. Sediments derived from the mass failures and stormwater channels may accumulate locally in the Pond Hill Brook channel during lower flow stages. During events of bankfull or higher flows, however, these are probably flushed through the segment to downstream reaches.

Segment D

Within Segment D, the Pond Hill Brook leaves the forest cover and flows through pasture southwest of the intersection of Pond Hill Ranch Rd and Pond Hill Road. The valley setting widens to a confinement of "semi-confined" (1 to 2 times bankfull width) to sometimes "narrow" (2 to 4 times bankfull width). The stream gradient is slightly lower through this section – 3.0%, or a "b" subclass slope. A reference Cb stream type is suggested by the valley setting and profile. Soil mapping indicates hydric soils with an alluvial origin in this segment (USDA, 1998). Wetland vegetation and saturated shallow soils over bedrock were observed contiguous to the downstream half of the channel. Channel-spanning bedrock (classified as "ledge" by protocols) is exposed in three separate locations near the upstream and downstream ends of the segment.

Dairy cattle have direct access to the stream along the full length of the pasture and downstream into the forested Segment C along the west side of Pond Hill Road. Two equipment fords were observed crossing Segment D; one appeared to be used more frequently and was associated with a gravel farm road which accesses upslope pastures to the southwest of the channel.

Historic channelization is indicated by the somewhat linear planform of this segment – although sinuosity was observed to be more pronounced in the field than is indicated on either the VHD surface water coverage or the topographic map coverage. A brief section of recent straightening was also observed in the downstream portion of the segment, just downstream of the active equipment ford, where channelization has effectively cut off a prominent meander bend.

An ephemeral stream flows from a culvert crossing under Pond Hill Ranch Road to join the Pond Hill

Brook mid-way through this pasture segment. Recent dredging (ditching) was suggested by the linear planform of this tributary, as well as observed head-cutting and active high-bank erosion upstream of the confluence. A small nick point of cobbles (a possible head cut) was observed in the Pond Hill Brook channel approximately 20 feet upstream of this confluence. It is possible that this nick point resulted from a slug deposit of relatively more coarse bed material. If the nick point represents a head cut characteristic of incision, it is bounded by exposures of channel-spanning bedrock within 350 feet upstream and 250 downstream.

Figure 44. T02.08-s1.05-D. Small "delta" of gravels and sands at confluence of right-bank ephemeral stream channel with Pond Hill Brook. View upstream, 25 July 2006.

A small delta of mixed sediment sizes is present at the confluence of the tributary channel with Pond Hill Brook. Several enlarged point bars were observed downstream of the confluence, particularly alongside the channel-contiguous wetlands where channel gradient (and presumably sediment transport capacity) was locally reduced.

A cross section was completed upstream of the tributary confluence and indicated a B4b-riffle/pool stream type. In the upstream end of the segment, substrates are dominated by a shallow step/pool form. In the channelized section at the downstream end, substrates are dominated by a plane-bed form. The channel has reasonable access to a steep-gradient, relatively narrow floodplain. A significant degree of vertical separation from a recently abandoned floodplain along the right-bank corridor is indicated by a measured incision ratio of 2.04. Incision is inferred to be historic, with the potential for current incision now moderated by the exposure of channel-spanning bedrock. Stage V of an F-stage CEM is suggested; the channel may have undergone historic incision, followed by widening, aggradation and planform adjustments which created a narrower floodplain at a lower elevation. The measured entrenchment ratio (1.94) indicates that the channel has evolved from the reference Cb stream type to a B stream type.

Overall, the segment was rated in "Fair" condition in accordance with RGA protocols, with an associated sensitivity rating of "Extreme" (due to the Stream Type Departure). Other than the subtle nick point near the tributary confluence, signs of active incision such as undercut banks, or abandoned floodplains, were not observed. It is likely that shallow bedrock and the relatively cohesive mix of silts, sands and angular gravels exposed in the bed and banks have moderated the potential for incision in response to historic and recent channelization. Localized widening is suggested by the somewhat high width/depth ratio (35.7) measured at the cross section site. Aggradation within the segment is suggested by presence of unvegetated mid-channel, point and side bars, as well as the small delta at the tributary confluence. Absence of tree buffers and direct pasturing are likely contributing to streambank erosion and localized widening and aggradation in this pasture section of the Pond Hill Brook. Based on comparison of 1994 and 2003 aerial photography to 2006 field observations, sinuosity of the channel planform has increased over the last few years following historic channelization. Planform adjustments are also indicated by the presence of an active flood chute. Developing sinuosity was recently reversed at the downstream end of the segment through active channelization.

Habitat conditions within the segment ("Fair") have been compromised by historic and recent channel modifications within the segment and an adjacent tributary; localized plane-bed features and lack of morphological diversity and epiphaunal substrates have resulted. Habitat has also been compromised by the removal of forested buffers and direct pasture access to the stream which have contributed to streambank erosion and localized widening, as well as a lack of shading. Habitat scores were also reduced as a result of sediment deposition from upstream stormwater inputs and within-reach streambank erosion.

Segment D appears to be operating as a local response reach to some degree. Channel-contiguous wetlands are likely serving a partial sediment and flow attenuation function, and may have potential for nutrient attenuation as well. Historic channelization activities appear to have reduced the degree of hydrologic connection between the channel and the wetlands. Pond Hill Brook presently flows in a linear channel along the western margin of the wetland area against the bedrock-controlled left valley wall.

Segment C

Segment C is a brief section of steep-gradient bedrock-controlled channel at the downstream end of the pasture southwest of Pond Hill Road. The valley setting narrows to a semi-confined, sometimes narrowly-confined width. Bedrock ("ledge", by protocols) is exposed in the channel for a majority of the length, with locally steeper sections of cascade bedform over bedrock waterfalls from 2.5 to 7 feet in height.

Cross section data from Segment E could be applied to Segment C, given their similarity in gradient, valley setting and channel characteristics. Since this segment was characterized as a "gorge" by protocols, a RGA and RHA were not completed, and a "Low" sensitivity was assigned.

The considerable slope of Segment C and the narrowly-confined valley suggest that this section of Pond Hill Brook is transport-dominated, with a high sediment transport capacity.

Segment B

Segment B is located to the west of Pond Hill Road and flows through a narrowly-confined to semi-confined valley setting of "b" slope through a thinly forested area. Worn trails and fencing patterns indicate that this stream corridor is accessed occasionally by livestock (either dairy cattle, or horses, or both). Bedrock controls the channel planform and dimensions. One waterfall (control height of 3 feet) and three separate sections of channel-spanning bedrock ledge (control heights less than 2 feet) were recorded in the reach, separated by brief sections of alluvium. A reference stream type of B-step/pool is suggested by the slope and valley confinement.

Encroachments within the corridor are limited to the above-mentioned pasture use, and a well-armored culvert crossing. Pond Hill Road follows parallel to the stream on the right bank upstream of the crossing and on the left bank downstream of the crossing. Except for the crossing location itself and a length of channel approximately 150 feet downstream of the culvert, the road passes outside of the Phase 2 belt-width derived corridor and at an elevation which appears to be above the flood-prone-derived elevation.

A cross section performed in the upstream half of the segment indicated a B4b-step/pool stream type, consistent with reference stream type. The channel has reasonable access to a narrow floodplain. Clearance and span of the squash-bottom culvert were measured as 4.0 feet and 5.7 feet, respectively. Comparison of these dimensions to the measured bankfull width of 16 feet at the nearby cross section, indicated this culvert crossing to be a constrictor of the bankfull and flood flows. Channel maintenance activities upstream and downstream of the crossing indicate past erosion issues associated with this crossing. A gravel and cobble berm of angular slate is present for 70 feet along the right top of bank leading to the culvert inlet, which pins the channel between the berm and the bedrock-controlled left valley wall. Slate rip-rap is also present along the left bank upstream of the culvert and along both banks downstream of the culvert. A drop of 1.7 feet from culvert inlet to the bed of the channel on the downstream side indicates possible vertical scour of the channel (or elevated culvert installation). An approximate 150-foot length of the Pond Hill Brook downstream of the crossing appears to have been channelized and shifted westward to flow directly alongside the road. The left bank of this channelized section has been heavily armored and the road surface is elevated well above the flood-prone-width elevation. Through this section, the channel appears somewhat entrenched below the surface of a right-bank floodplain terrace. Channel-spanning bedrock is exposed in the downstream portion of this channelized section, as the brook transitions to a downstream bedrock gorge (Segment A).

(a) (b)

Figure 45. T02.08-s1.05-B. Pond Hill Road crossing of Pond Hill Brook. (a) View upstream to the culvert outlet – rip-rap present on both banks; distance of 1.7 feet from culvert invert to channel bed. (b) View downstream from culvert along recently channelized and armored section parallel to Pond Hill Road..

The berm and armoring in vicinity of this crossing appear relatively recent in origin, and may have resulted from road and crossing repairs following recent flood events (e.g., 1981 or 1998 floods).

Habitat was rated in "Fair" condition following the RHA. Scores were reduced somewhat by the recent channelization and armoring downstream of the culvert crossing – also, by the reduced buffer widths along the Pond Hill Road.

In accordance with RGA protocols, Segment B was rated in "Fair" condition, on the cusp with a "Good" rating. The associated sensitivity rating for B4-S/P stream type in Fair condition is "High". Signs of active incision, such as undercut banks or abandoned floodplains, were not observed. It is likely that shallow bedrock and dense till sediments have moderated the potential for incision in response to recent channelization near the downstream end of the segment. A minor to moderate degree of aggradation within the segment is suggested by presence of multiple unvegetated mid-channel, point and side bars. Absence of tree buffers and direct pasturing are likely contributing to streambank erosion, and localized widening and aggradation in this pasture section of the Pond Hill Brook. While six active flood chutes were observed in the segment, these features are not uncommon in a semi-confined channel of moderately-steep slope. One flood chute appeared to be forming where vegetation had been trampled and soils were compacted along a livestock trail in close proximity to the channel.

The moderate degree of aggradation suggests that Segment B is functioning as a limited response segment between two transport-dominated bedrock-gorge segments. However, moderately steep gradients and a the narrowly- to semi-confined valley setting would be expected to constrain the potential for sediment attenuation.

Segment A

The downstream 1,687 feet of reach T02.08-s1.05 is a steep-gradient bedrock-controlled channel which flows through a narrowly-confined, forested valley east of Pond Hill Road. Bedrock is exposed in the channel bed and banks for a majority of the length. There are three separate occurrences of locally steeper gradient – "waterfalls" from 3 to 6 feet in height. Encroachments within the segment are very minor. Low-intensity pasture or hay fields are present along the left bank corridor. An animal crossing is present in the downstream third of the reach.

Cross section data from Segment E could be applied to Segment A, given the similarity in gradient, valley setting and channel characteristics. Since this segment was characterized as a "gorge" by protocols, a RGA and RHA were not completed, and a "Low" sensitivity was assigned.

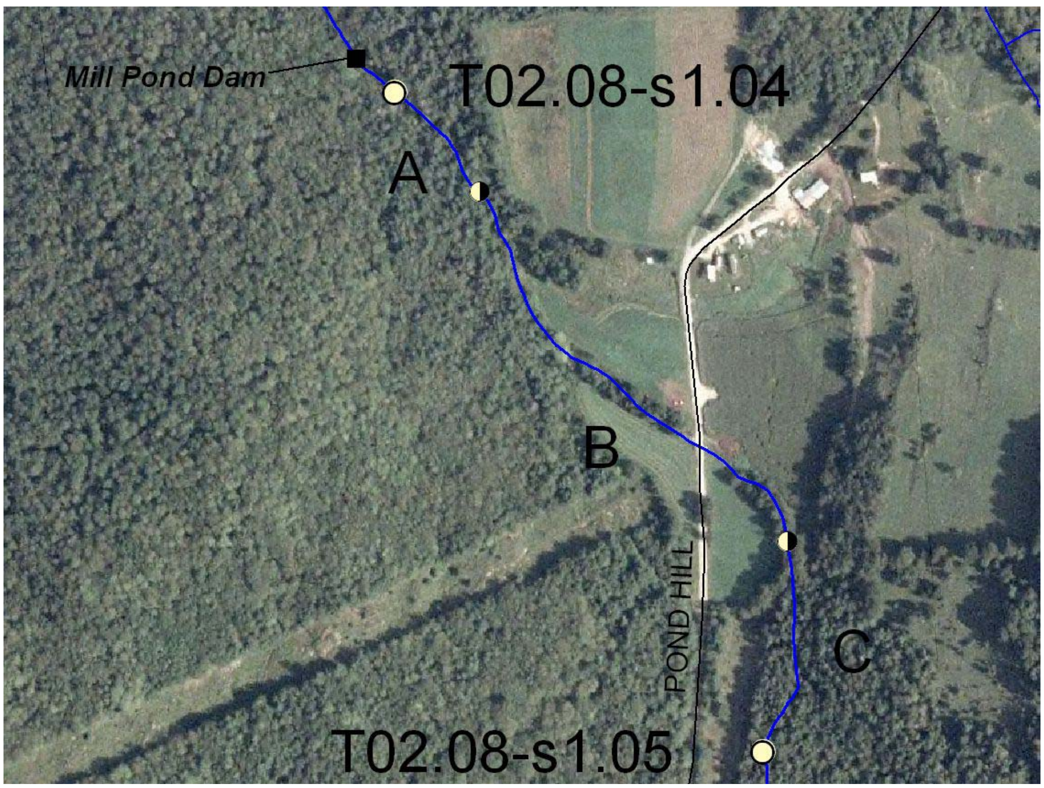
The considerable slope of Segment A and the narrowly-confined valley suggest that this section of Pond Hill Brook is transport-dominated, with a high sediment transport capacity.

Figure 46. T02.08-s1.05-A
A1-cascade bedrock channel flows through a coniferous and hemlock deciduous forest east of Pond Hill Road.
View upstream, 25 July 2006.

T02.08-s1.04

Reach T02.08-s1.04 is located in a high-elevation valley northwest of Pond Hill where the Pond Hill Brook crosses under Pond Hill Road through farm fields to continue downstream toward Castleton village. This reach flows over a local pocket of glacial-fluvial deposits surrounded by steeper slopes of shallow till over bedrock. Valley widths are very broad compared to the bankfull width and the reach represents a short section of unconfined valley setting between upstream and downstream bedrock gorges.

Given the limited resolution of the topographic coverage (20-foot contours), the reach delineation established during the Phase 1 Stream Geomorphic Assessment, inadvertently encompassed short sections of alternate stream type (bedrock gorge) at the upstream and downstream ends of the reach. Segmentation was required to delineate these subreaches (see Figure 47).



Segment (u/s to d/s)	Approximate Length (ft)	Phase 2 Updated Slope (%)
C	636	6.9
B	1,405	2.9
A	384	6.5

Figure 47. Segmentation of reach T02.08-s1.04, Pond Hill Brook, Castleton, VT. Flow is from south (bottom) to north (top).

Segment C

Segment C of T02.08-s1.04 is a continuation of upstream segment T02.08-s1.05-A, a narrowly-confined, steep-gradient, bedrock-controlled channel flowing through a forested valley. Bedrock ledge is exposed throughout the channel and in one location forms a waterfall with a control height of approximately 6 feet. Fine sediments were observed to have accumulated in occasional pools. Sources of this fine sediment may include stormwater runoff from the Pond Hill Road and Pond Hill Ranch Road in upstream reaches, and the previous wash-out of the Pond Hill Road culvert crossing (T02.08-s1.05-B). Low-intensity pasture or hay fields are present along the left bank corridor. Evidence of an animal crossing is present within the segment including fecal matter.

Since this segment was characterized as a "gorge" by protocols, an RGA and RHA were not completed, and a "Low" sensitivity was assigned. Cross section data from upstream Segment A of reach T02.08-s1.05 could be applied to this segment, given the similarity in gradient, valley setting and channel characteristics.

Segment B

Segment B of T02.08-s1.04 is characterized by a wide, unconfined valley setting and a moderate channel gradient (2.9%), suggestive of a Cb reference stream type. While Segment B has a notably lesser gradient than upstream Segment C, an alluvial fan-like feature was not evident. This may be due to cultivation of valley sediments over the years. Also, the sediment supply from the upstream bedrock channel appears relatively limited.

Encroachments within the segment include a culvert crossing of Pond Hill Road. This gravel road crosses Pond Hill Brook at an oblique angle. While this road reduces the valley width available to the channel to some degree, the encroachment is minimal and does not lead to a substantial change in valley confinement. Corn crops were observed along the right bank upstream of the Pond Hill Road crossing. Pasture and hay fields encroach along the left bank and the right bank downstream of the crossing. The linear planform of the brook, in absence of natural planform controls, suggests historic channelization. Two separate lengths of gravel berm were observed along the right bank downstream of the crossing (Figure 48). Channelization, berming and armoring may have resulted from repairs following past flood events (e.g., 1998, 1981, 1945) and they may also have been undertaken to maximize agricultural use of nearby lands.

Figure 48. T02.08-s1.04-B.

Pond Hill Brook has been historically channelized and bermed through farm fields in an unconfined valley setting between bedrock gorges.

View upstream to Pond Hill Road culvert crossing, 26 July 2006.

Clearance and span of the Pond Hill Road culvert were measured as 4.5 feet and 5.9 feet, respectively. Comparison of these dimensions to the measured bankfull width of 22.5 feet at the segment cross section, indicated this culvert crossing to be a constrictor of bankfull and flood flows. Cobble and boulder-sized rip-rap was observed along both banks at the culvert inlet and outlet, along both banks downstream of the culvert, and along right bank near the downstream end of the segment.

Visual observations and a cross section performed mid-segment indicated an entrenched channel with limited floodplain access. An incision ratio of 2.2 and entrenchment ratio of 1.13 were measured at the cross section approximately 500 feet downstream of the crossing. Measured channel dimensions indicate an F4b-riffle/pool stream type, constituting a stream type departure.

Signs of active incision were not observed along the segment, which is bounded by extensive bedrock vertical grade controls at both upstream and downstream ends. A moderate degree of aggradation was indicated by the presence of multiple, enlarged point and side bars, as well as mid-channel and transverse bars. Evidence of moderate planform adjustments, particularly in the downstream half of the segment, included active flood chutes, meander migration in the form of erosion along the outside of incipient meander bends, and an apparent neck cutoff near the downstream end of the segment. A wider-than-regime bankfull width of 22.5 feet, and a somewhat elevated width/depth ratio suggest widening within the segment. However, signs of active widening were minor (e.g., failing banks, leaning trees, exposed roots along both channel banks through a riffle section). This segment appears to be rebuilding an incipient floodplain at a lower elevation through aggradational processes and planform adjustments in response to historic degradation from channelization and berming (i.e., late stage III or early stage IV of an F-stage channel evolution model). A geomorphic score of "Fair" was assigned following the RGA. The stream type departure from Cb to F dictated an "Extreme" sensitivity rating.

Habitat conditions were rated in "Fair" condition following the RHA. The history of channel modifications has resulted in limited diversity of bed morphology, velocity patterns and epiphaunal substrates. Sedimentation has filled pools and resulted in 50% embeddedness of the larger cobbles. Tree buffers are absent upstream of the culvert crossing and limited in width along the remainder of the segment.

The natural valley setting of this lesser-gradient, unconfined valley setting between upstream and downstream bedrock gorges would suggest that this segment functions as a response segment of limited sediment transport capacity. Historic channelization of the segment would be expected to temporarily increase sediment transport capacity, by steepening channel gradients and increasing flow velocities. It is expected that this modified condition would be transient in nature and offset by the aggradation of sediments from upstream and within-segment erosion. As the channel continues to evolve, and in the absence of future channelization or dredging, the segment could evolve back toward a transport-limited channel (i.e., sediment attenuation area) consistent with its reference valley setting (in the current climate and sediment and hydrologic regimes).

Segment A

Segment A of T02.08-s1.04 marks the transition from the unconfined, moderate-gradient channel of Segment B to downstream reach T02.08-s1.03, a section of steep-gradient bedrock channel flowing through a narrowly-confining, forested valley. Valley width decreases sharply to a confinement ratio of 1 to 2 times channel width, with the occasional pocket of broader floodplain. Channel canopy changes from open to closed, as forested buffer widths increase to well beyond 100 feet along the left bank and 50 to 100 feet or more along the right bank. Bed substrates change abruptly from gravel-dominated alluvium to bedrock ledge and waterfalls. Channel gradient in Segment A was estimated as 6.5% (see Appendix F). Consequently, a B1a-cascade stream type was assigned.

Segment A was effectively grouped with the downstream bedrock gorge; consequently, a RGA and RHA were not completed (by protocols), and a "Low" sensitivity was assigned.

Figure 49.
Waterfall in Segment A of T02.08-s1.04, as Pond Hill Brook transitions from an unconfined valley setting back to a narrowly-confined steep bedrock channel.

View upstream, 26 July 2006.

T02.08-s1.03

This quarter-mile reach consists of a bedrock channel flowing from southeast to northwest through a steep, forested, narrowly-confined valley, ending near the eastern extent of the Hadeka Stone Corporation facilities off Staso Road. There are minimal encroachments through the reach, with the exception of two dams (Figure 50).

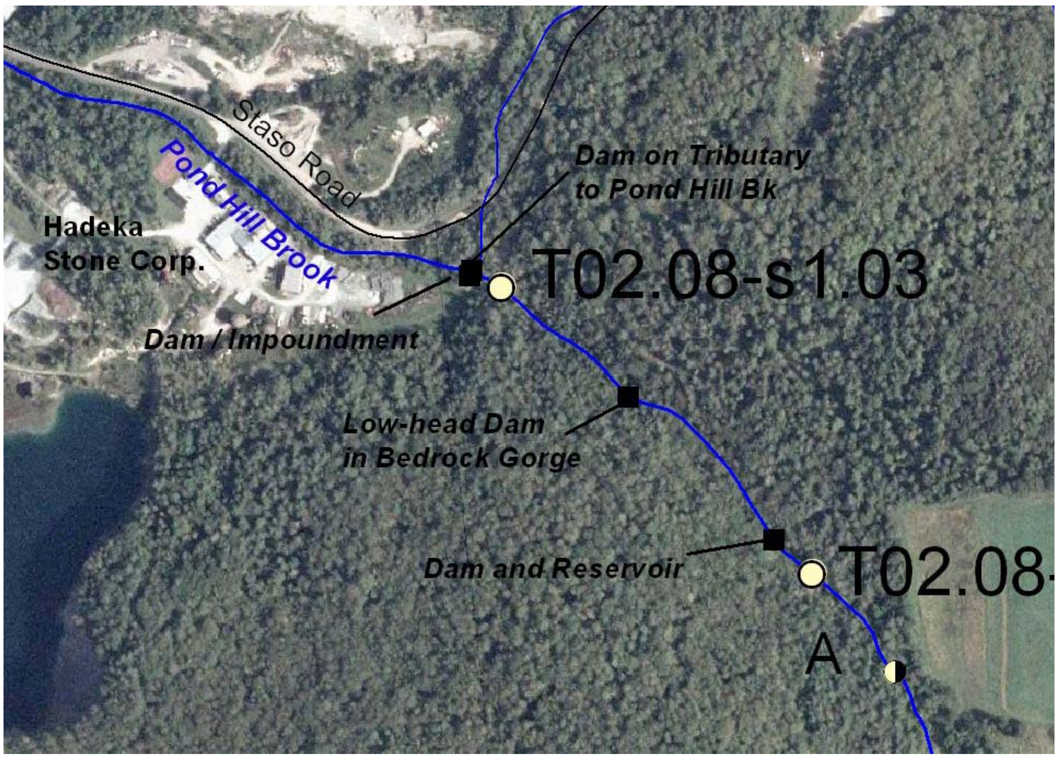


Figure 50. A former reservoir and dam and a small low-head dam were observed in reach T02.08-s1.03. Two additional dams were noted in the next downstream reach: one elongate concrete structure impounds the Pond Hill Brook and a tributary brook just upstream of their confluence. Flow in Pond Hill Brook is from lower right to upper left.

- ***Former Reservoir and Dam***

  A breached dam and former reservoir were encountered near the upstream extent of reach T02.08-s1.03. The concrete dam is constructed at the top of an 8-foot bedrock falls. Height of the structure varies from approximately 2 feet to 4.5 feet, over the top of an irregular bedrock surface. The dam extends from the left valley wall to the right valley wall, and is approximately 65 feet long (GIS estimate). The structure appears partially breached along the right side, which is obscured beneath significant woody debris, concrete blocks and boulders. Some water is seeping from beneath this rubble, but the majority of flow is over a short spillway in the middle of the span. Currently, this dam operates as a run-of-river structure; minimal water is impounded behind it.

  The former upstream reservoir (now filled with sediment) was approximately 300 feet long and a maximum of 90 feet wide (based on USGS topographic map depiction). The Phase 1 reach break between T02.08-s1.03 and the next upstream reach falls mid-way along this former pond. The upstream 150 feet of channel in reach T02.08-s1.02, flowing in the former reservoir area, exhibits a C-riffle/pool, gravel bed stream type. The channel meanders along the southern periphery of the former pond, and substantial aggradation is evident in the form of point bars greater than half bankfull height, mid-channel bars, transverse bars and side bars. Sediments in this brief section of channel were very loose under foot.

(a)

(b)

Figure 51. Former dam and reservoir on Pond Hill Brook at the upstream end of reach T02.08-s1.03. (a) view upstream from beneath the dam, average dam height of 3 feet from top of dam to bedrock foundation near spillway; (b) view upstream from dam into former reservoir now filled with sediment and re-vegetating.

- ***Low-head Dam***

  A low-head concrete dam approximately 2.5 feet thick with a control height of approximately 2 feet was observed mid-reach in the bedrock gorge.

*Figure 52.
Small low-head dam, located mid-reach, is constructed of concrete extending 13.5 feet from bedrock wall to bedrock wall.*

View upstream, 26 July 2006.

The exact construction date of these dams is not known. The reservoir is depicted on the 1964 Poultney, VT USGS 7.5-Minute topographic quadrangle map (photoinspected 1972), but is not present on the historic 1897 15-Minute Castleton, VT topographic map, suggesting that its construction occurred between those approximate dates. Limited historical research was conducted in the land records at the town of Castleton. A 1940 plan entitled "*Property Map: Staso Milling Company Plant 2, Castleton,* *Vermont*." depicts the larger dam and impounded reservoir, as well as the downstream, smaller low-head dam. Thus, these dams were apparently constructed prior to 1940.

A cross section was completed mid-reach just downstream of the low-head dam. Channel dimensions confirmed an A1-cascade stream type, consistent with the reference stream type. A bedrock channel is present along nearly the entire length of the reach, with two exceptions:

- a 150-foot section of channel through the former reservoir (which is now riffle-pool with a "c" slope (< 2%), locally; and

- a 200-foot section of gravel- and cobble-dominated channel near the downstream end of the reach between bedrock exposures. Piles of gravel- and cobble-sized sediments are present along the left top of bank, perhaps 5 to 10 feet from the channel, through this section and serve as a berm. The appearance of this "rubble" may also be related to a former foundation or quarrying waste.

Channel adjustments were minimal in reach T02.08-s1.03, due to the predominance of bedrock in the bed and banks. Erosion was negligible. The reach was rated in "Reference" geomorphic condition following the RGA, and a "Very Low" sensitivity was assigned.

A "reference" rating was also assigned for habitat conditions. Mature, coniferous forested buffers are providing shading to the channel and a source of LWD and detritus (DJs = 7; LW = 8). Buffer widths are well over 100 feet on either side of the channel. The two dams present no greater impediment to fish passage than the natural bedrock waterfalls.

This reach is transport-dominated and sediment supply limited. The former reservoir at the head of the reach appears to have impounded a great deal of sediment over the last few decades - possibly flood-related sediments from the 1945, 1981, 1998 and other flood events.

T02.08-s1.02

Within reach T02.08-s1.02, the Pond Hill Brook emerges from the steep, till-covered bedrock slopes at the northwestern flanks of Pond Hill to flow out onto a broad kame terrace deposit of glacial-fluvial sediments. This abrupt transition from a narrowly-confined to broader valley setting, along with the change in stream gradient (from 8.8% in s1.03 to 2.0% in s1.02), suggest an alluvial fan setting of locally reduced sediment transport capacity. In a broad sense, topographic contours in the vicinity suggest such an alluvial fan. A braided channel (D stream type) might be expected as the reference stream type in such a setting, if a high degree of upstream sediment loading was evident. A reference stream type of C could also be appropriate in a bedrock-dominated channel with relatively limited upstream sediment loading, as is the case for Pond Hill Brook under present sediment and hydrologic regimes. However, in direct vicinity of the brook through reach T02.08-s1.02, the presence of long-standing slate and sand and gravel quarrying operations have altered the natural topography as a result of excavations and piling of waste quarrying materials.

Over the years, various enterprises have encroached along the Pond Hill Brook through this section. The Staso Road follows the northern bank of the brook – a road is depicted in this approximate position on early town maps (Chase, 1854; Beers, 1869). The 1897 Castleton, VT USGS 15-Minute topographic map shows two railroad spurs leading from the Delaware and Hudson Railroad along Pond Hill Brook to the current location of Hadeka Stone Corporation. A railroad spur is also depicted on a 1976 survey plan of lands conveyed from "*Castleton Industries, Inc. to A. A. Hadeka Slate Company, Inc*." reviewed in the map files at the Castleton town clerk's office. This now inactive railroad grade is also visible on the 1994 orthophoto coverage (see Figure 53).

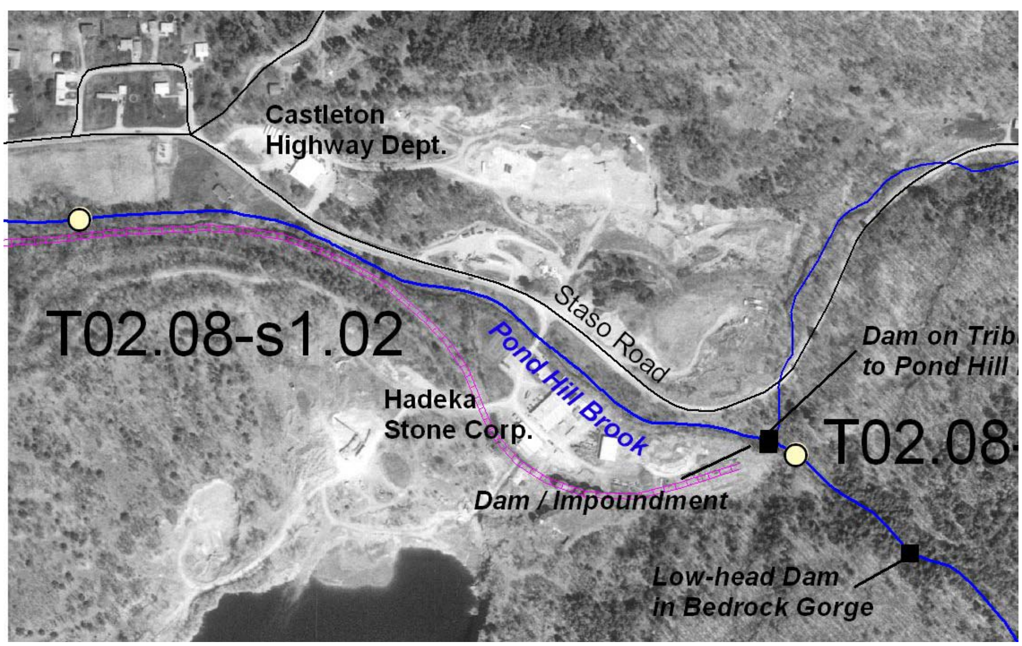


Figure 53. Reach T02.08-s1.02 of Pond Hill Brook flowing between Staso Road to the north and the slate quarry to the south, now occupied by Hadeka Stone Corporation. Flow is from lower right to upper left. Approximate location of historic railroad spur indicated in purple.

At the very upstream end of the reach, Pond Hill Brook spills over a 5-foot bedrock waterfall into a small impoundment above a concrete dam. This dam is an elongate concrete structure extending approximately 45 feet in a north-south orientation to impound both the Pond Hill Brook and a right-bank tributary just upstream of their confluence (Figure 54). It is unknown if these impoundments currently serve an active purpose. A representative of Hadeka Stone Corporation recalled that, under former operations of the Staso Quarry, the impoundments were used for process water to wash fine slurry from the quarried slate, when water supplies were low in the quarry itself. Staso Milling Company reportedly shut down operations around 1958 (personal communication, 2006).

(a)

(b)

Figure 54. Dam on Pond Hill Brook and a right-bank tributary at the upstream end of reach T02.08-s1.02. 26 July 2006.
(a) Concrete dam spillway (foreground), small impoundment, and bedrock falls (background) on Pond Hill Brook, view upstream.
(b) View to north along concrete dam –spillway from Pond Hill Brook impoundment in foreground; spillway over dam at right-bank tributary channel in background.

Rip-rap is present along right bank for approximately 400 feet. Nearly the entire length of the left bank is armored by rip-rap, fill material comprised of slate quarrying waste, or the railroad grade in the downstream half of the reach. Just downstream of the dams near the upstream end of the reach, massive rip-rap on both banks creates a constriction narrower than the bankfull width. Sediment is aggraded upstream of this area, and scour holes between large boulders of failed rip-rap are evident downstream.

One active culvert crossing was observed within the reach, providing driveway access to the Hadeka Stone Corporation from Staso Road. This culvert crossing is heavily reinforced with large boulder rip-rap and concrete blocks (Figure 55). A steep riffle of cobbles and boulders is present upstream of the inlet, and a moderate scour pool is present at the downstream culvert outlet. The span of this culvert (7.4 feet) is much narrower than the measured bankfull width, indicating that this structure is a constrictor of both the bankfull and flood flows.

Approximately 300 feet downstream of the culvert crossing are old concrete abutments inferred to be related to a historic crossing. The 1897 USGS topographic map seems to indicate that both the Staso Road (or a former alignment of this road) and a railroad spur crossed the Pond Hill Brook in this approximate vicinity. These old abutments may be related to either a road or railroad crossing.

However, the stream planform represented on historic USGS maps is often an approximation and should not be used infer the exact location of a stream relative to roads at the time the map was generated.

(a)

(b)

Figure 55. Constriction along reach T02.08-s1.02 of Pond Hill Brook. (a) Culvert crossing for driveway to Hadeka Stone Corporation off Staso Road; view downstream to the culvert inlet. (b) Old abutments approximately 300 feet downstream from culvert crossing; view downstream.

The Pond Hill Brook is entrenched well below the surrounding floodplain, to depths ranging from approximately 5 to perhaps 12 feet. The degree of channel degradation in this reach may be related, in part, to incision on a geologic scale several thousands of years ago, where the Pond Hill incised into underlying erodible gravels and cobbles of glacial kame terrace origin. However, the current degree of entrenchment is very likely a result of historic dredging, straightening, and armoring, as well as fill associated with the adjacent quarrying operations, maintenance of the Staso Road, and construction and maintenance of the railroad spur(s). It is also possible that impoundment of sediments in the upstream dams, particularly at the former reservoir in reach T02.08-s1.03, historically may have caused a condition of "hungry water", contributing to incision through downstream reach s1.02 below the bedrock channel.

A representative cross section was completed downstream of the old abutments across from the Town of Castleton Highway Department. The channel is highly entrenched below the floodplain and road on the right (north) bank and the railroad grade along left bank (IR = 6.2; ER = 1.26). A stream type departure from C to F was evident.

Despite the considerable, historic channel management, active signs of channel incision were not observed in the reach. The channel bed has the occasional step/pool or riffle/pool form, but overall is dominated by runs. The bed material is gravel-dominated with frequent collapsed rip-rap, slate or concrete fill material. The reach is bounded at the upstream end by considerable exposures of bedrock ledge and waterfalls. A short, low-gradient exposure of channel-spanning bedrock was also observed near the downstream end of the reach. These bedrock exposures serve as vertical grade controls for the reach, limiting the potential upstream migration of incision.

A minor degree of aggradation was indicated in the downstream third of the reach by the presence of multiple, unvegetated point and side bars (less than half bankfull stage). Evidence of minor planform adjustments included active flood chutes, and meander migration in the form of erosion along the outside of incipient meander bends. At the cross section, the measured bankfull width and width/depth ratio were consistent with expected values based on Vermont hydraulic geometry curves (VTDEC, 2006), indicating minor widening. Particularly, in the downstream third of the reach, there were isolated signs of active widening, such as scour along both banks simultaneously through riffle section. One right-bank mass failure was noted in this section up to 12 feet in height and 12 feet long, continuous with a 100-foot section of bank erosion, approximately 4 feet high. Near the downstream reach break, a stormwater channel was observed leading from the area of the Town of Castleton Highway Department, across Staso Road via a culvert and into the Pond Hill Brook. This channel appears to have formed a gully between the road and Pond Hill Brook, and failing banks have been reinforced with boulder and cobble rip-rap. A small "delta" (as defined by protocols) of gravel and cobble sediments extends out into the Pond Hill Brook from this gully.

With the exception of some more active lateral adjustments occurring in the downstream end, reach T02.08-s1.02 appears to be relatively stable in its entrenched planform. Bed and banks are armored with cobbles and boulders, many of which exceed the erosion threshold of a bankfull flow (based on estimates from the single cross section, only). However, given the high degree of entrenchment, the Pond Hill Brook cannot access its floodplain, and remains primed for "un-raveling" in a very large flood event, where shear stresses could exceed erosion thresholds for materials in the bed and banks. A geomorphic score of "Fair" was assigned following the RGA. The stream type departure from C to F indicated an "Extreme" sensitivity rating.

Habitat conditions were rated in "Fair" condition following the RHA. The history of channel modifications has resulted in limited diversity of bed morphology and epiphaunal substrates. Considering the road, railroad, quarrying and residential encroachments, tree and shrub/sapling buffers are minimal in width and occasionally absent along the left and right banks.

In its modified condition, this reach appears to be functioning as a transport reach, in contrast to the natural valley setting that would suggest an alluvial fan feature of braided or laterally-shifting channels and sediment accumulation. Erosive energies and sediment loads are effectively translated to downstream reaches.

Considering the nature and extent of commercial, municipal and residential investments along this reach, it is likely that the channel will continue to be artificially maintained with the current planform, profile and dimensions.

T02.08-s1.01

The downstream reach of Pond Hill Brook flows through Castleton State College and residential neighborhoods in Castleton village to join the Castleton River just downstream of the Cemetery Drive crossing. The Pond Hill Brook has undergone substantial channel management within this reach. There are also subreaches of variable stream type. The reach was therefore segmented to capture these variable natural and constructed features (see Figure 56).

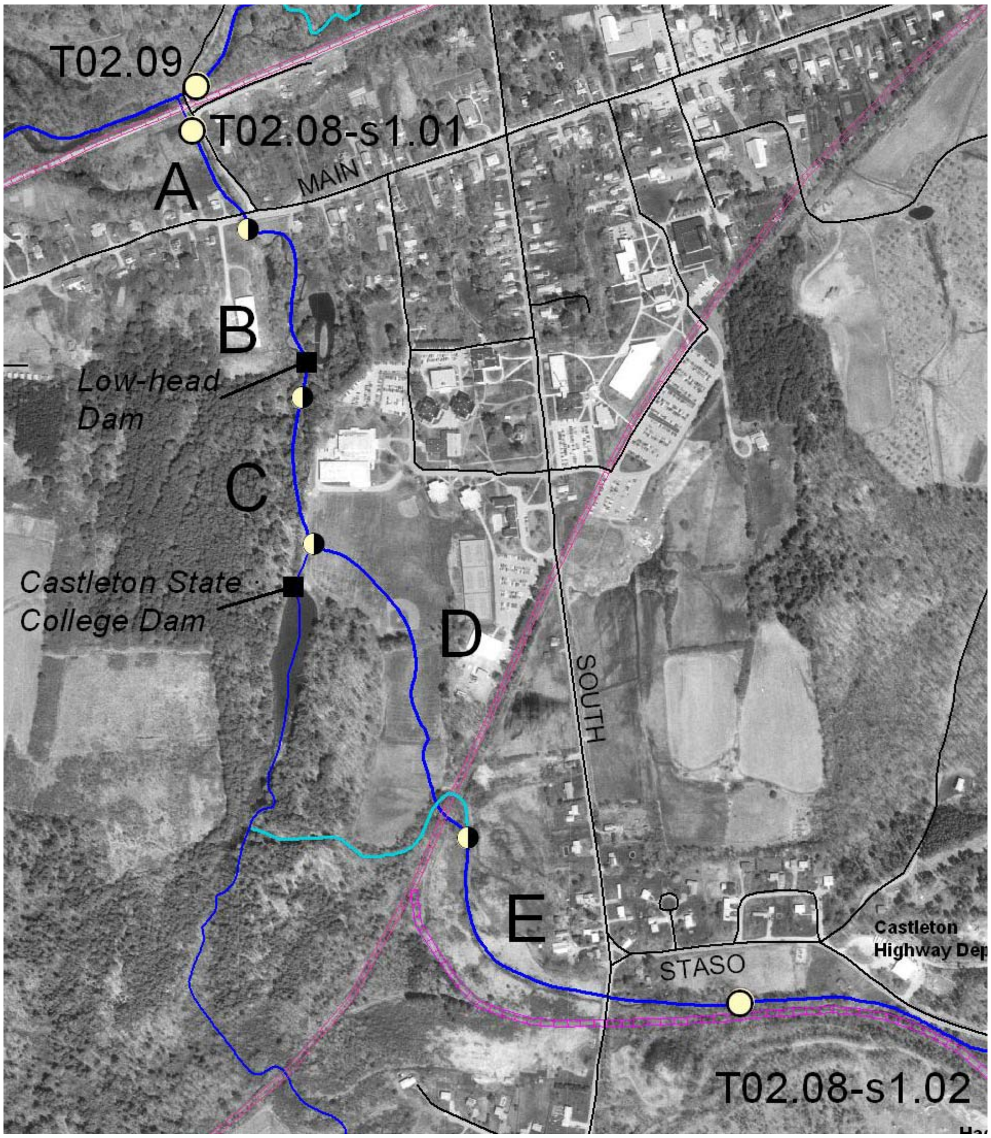


Figure 56. Segmentation of reach T02.08-s1.01 of Pond Hill Brook. Flow is from lower right to upper left. Light blue line depicts current planform of Segment D.

Segment (u/s to d/s)	Approximate Length (ft)	Phase 2 Updated Slope (%)
E	1,711	1.5
D	1,622	1.2
C	677	3.7
B	927	1.1
A	513	2.1

One of the earlier channel modifications to the Pond Hill Brook in this reach was apparent channelization along the railroad spur leading from the main rail line (Delaware and Hudson, formerly Washington RR) to the former Staso Milling Company. In the upper 1,700 feet of the reach (Segment E), the Pond Hill Brook flows parallel to the former spur. The main line of the railroad was constructed circa 1850, and this spur was present on an 1897 USGS topographic map, indicating that channelization of the Pond Hill Brook in this section probably took place in the mid- to late 1800s.

Another historic modification to this reach (in Segment A) was to move the confluence with the Castleton River to its current position from a point approximately 800 feet downstream. Early maps depict the former confluence position (Chace, 1854; Beers,1869; USGS, 1897). There is an abandoned erosional terrace in the approximate position of the former channel visible on the 1994 orthophotographs and the 1964 topographic map. The 1962 aerial photographic and the 1964 (photo-inspected 1972) USGS 7.5-Minute topographic map show the confluence in its current straightened position. This timeline suggests that channelization took place sometime between 1897 and 1962. According to Castleton town reports (year ending 1945) the flash flood of 1945 resulted in damages resulting from a washout at Cemetery Road and US Route 4. The town report makes reference to use of a power shovel to clean the brooks. It is possible that channelization of Pond Hill Brook in this downstream segment occurred in response to the 1945 flood. There were also substantial flood events in 1927 and 1936 and 1938; town reports from these years do not itemize specific areas of flood damage, as do later town reports.

More recently, a substantial portion of the mid-section of Pond Hill Brook reach "s1.01" (Segment D) was diverted to the west to permit construction of athletic fields on the Castleton State College campus (light blue line on Figure x marks current channel position). A dam was constructed on a small left-bank tributary to the Pond Hill Brook creating a 2.2-acre pond. When redirecting the Pond Hill Brook, this tributary confluence was effectively moved from a position downstream of the Castleton State College dam to a point upstream of the impoundment.

The exact date of diversion of the Pond Hill Brook is not known. According to the database of Vermont dams (EmergyOther_Dams), the Castleton State College dam was constructed circa 1967 and designed by NRCS. Consistent with this record, the impoundment and a nearby running track are depicted in purple coloring on the USGS 7.5-Minute topographic map (Figure 57), which indicates they were features identified in the 1972 photo-revision of this 1964 map. The Pond Hill Brook is depicted in its pre-diverted planform on this 1964 / 1972 topographic map, which might suggest that re-channelization of the Pond Hill Brook took place after 1972. However, the 1962 and 1968 aerial photographs reviewed at the Rutland County NRCS field office indicate a different timeline. In 1962 the area of the athletic fields is forested, and no pond appears in the present location of the impoundment. The 1968 photograph (although of limited resolution) shows the area of the athletic fields to be cleared; a portion of the re-channelized planform of the Pond Hill Brook is somewhat visible in the same approximate planform as present. A reflective white area is present in the approximate position of the impoundment. Thus, it would appear that channel redirection and impoundment occurred nearly at the same time, and coincident with the development of the athletic fields, on or around 1968.

And, in Segment B, the small constructed pond to the east of Pond Hill Brook downstream of the bedrock gorge appears to have been constructed sometime after 1972 and before 1994. This timeline is based on the absence of the pond in 1962 and 1968 aerial photographs, or as a revised feature on the 1964 topographic map, photoinspected in 1972. A low-head dam was observed on the Pond Hill Brook near the upstream end of this pond, which creates a very small impounded area. An inlet pipe leads from the small impoundment in the direction of the adjacent pond, and an outlet pipe leads from the downstream end of the pond back to the Pond Hill Brook. This small dam is not included on the EmergencyOther coverage, and no additional information was obtained concerning its construction or purpose.

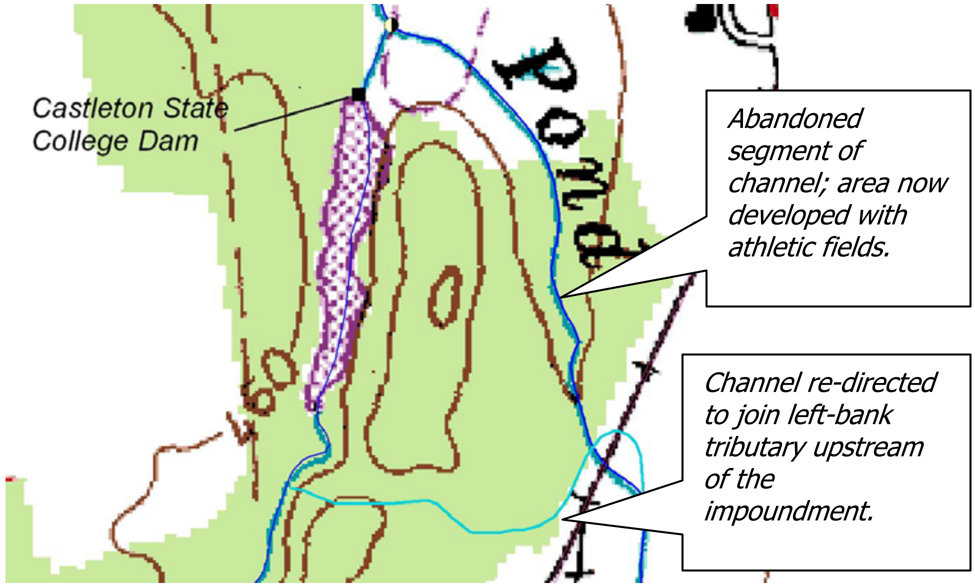


Figure 57. Portion of reach T02.08-s1.01 on Pond Hill Brook redirected to west to a constructed impoundment in the mid- to late-1960s. Base map is 1964 USGS 7.5-Minute topographic map (photoinspected 1972).

Segment E

Segment E of the reach extends from the upstream reach break to a point where the Pond Hill Brook crosses under the former Delaware & Hudson railroad. From the vicinity of the Hadeka Stone Corporation, Pond Hill Brook turns toward the north flowing parallel with the grade of the former railroad spur, through scrub/shrub cover, crossing under South Street and behind residential properties to reach the main railroad line.

The natural valley setting is unconfined and very broad, ranging from 450 to 1,000 feet in width, or more than 10 times the channel width. The valley setting and gradient would suggest a C-riffle/pool reference stream type. Segment E is at the downstream extent of an inferred alluvial fan structure where the Pond Hill Brook emerges from the steep, till-covered bedrock slopes at the northwestern flanks of Pond Hill to flow out onto a broad kame terrace deposit of glacial-fluvial sediments.

Historically valley widths have been reduced by the construction of the railroad grade along the left bank corridor, and by the Staso Road along the right bank in the upper half of the segment. However, valley confinement has not been substantially altered, as the channel still has a considerable floodplain width available to it, particularly along the right-bank corridor. The grade of the railroad spur is coincident with the left bank in the upper 100 feet of the segment, but gradually "pulls away" from the channel to a distance of greater than 100 feet with distance downstream (see segment map, Figure 56). Other development within the segment is minor, limited to the vicinity of the South Street arch crossing. Base materials for South Street fill the floodplain of Pond Hill Brook at this crossing, which is a corrugated steel arch set in concrete footers. The span of this arch (11.5 feet) was determined to be a constrictor of bankfull and flood flows. Moderate aggradation was apparent upstream and downstream of this structure.

Streambank erosion was evident, particularly along the left bank upstream of the South Street crossing, as the channel transitions from the entrenched, transport-dominated setting of upstream reach T02.08-s1.02 to the unconfined, non-entrenched and depositional wider valley setting below South Street. Pond Hill Brook is actively eroding the railroad berm at the upstream end of the reach (see Figure 58).

(a)

(b)

Figure 58. Pond Hill Brook is regaining sinuosity and building new floodplain through by actively eroding the bed of the abandoned railroad spur leading to the former Staso Milling Company (Segment E of reach T02.08-s1.01). (a) view downstream to left bank; (b) view upstream from left bank, railroad ties are undermined and collapsing into the channel. Viewed 31 July 2006.

Overall, a riffle-pool bedform was observed through Segment E with occasional plane bed form. Considerable sedimentation of the channel was apparent. Several transverse, point, mid-channel and side bars of unvegetated fine to coarse gravels were noted, many with steep bar faces. A few of these depositional bars were elevated more than half the bankfull height above the channel thalweg. One steep riffle and one short section of braided channel were observed. A cross section was completed near the downstream end of the segment, confirming a C4-riffle-pool stream type. Sediment sources appear to be from erosion in the upstream portion of the segment, as well as from erosion and stormwater / gully contributions in upstream reaches.

Indications of active incision were not observed along Segment E. The channel has good access to a wide floodplain, particularly downstream of the South Street crossing. A moderate degree of aggradation was indicated by the presence of multiple, enlarged depositional bars. Three active flood chutes were observed in the reach associated with depositional areas, indicating a minor to moderate degree of planform adjustment. Minimal widening is apparent, given the low width/depth ratio of 12 and a measured bankfull width (18.5 feet) consistent with VT hydraulic geometry curve predictions. Other signs of potential widening were minor to absent (e.g., undercut banks, leaning trees, exposed roots along both channel banks through a riffle section). This segment appears to be regaining a more sinuous planform and attenuating sediments through aggradational processes and planform adjustments. Though historic channelization would be expected to lead to channel incision, degradation (either current or historic) was not indicated. Bedrock may be close to the surface as suggested by channel-spanning exposures just above the upstream reach break, as well as in downstream segments. It is possible that shallow bedrock may have moderated the potential for channel incision. It is also likely that aggradational processes in this natural setting of reduced sediment transport capacity may have offset tendencies for channel incision. A geomorphic score of "Good" was assigned following the RGA.

Habitat conditions were rated in "Fair" condition following the RHA. The history of channel modifications and current aggradation have resulted in limited diversity of bed morphology, velocity patterns and epiphaunal substrates. On a positive note, natural vegetation (scrub/shrub with the occasional larger deciduous tree) is regenerating in wide, undisturbed buffers along both the left-bank and right-bank corridors, and encroachments are currently minimal within the segment. Detritus and LWD are actively being recruited through the segment (LWD = 8; DJs = 8), and are contributing to sediment deposition, increased sinuosity and restoration of a variable bed morphology.

Active planform adjustments and presence of unvegetated depositional bars suggest that Segment E is beginning to function as a local response reach between upstream and downstream managed channels. To the extent that future encroachments and channel manipulations are avoided, this area could serve an important role in sediment, flow and nutrient attenuation.

Segment D

Segment D of Pond Hill Brook consists of the section which was redirected to an impoundment west of the athletic fields on Castleton State College campus in the late 1960s. The VHD surface water coverage for the Castleton River watershed depicts Pond Hill Brook in the historic, pre-modified planform through this segment. Therefore, accurate feature indexing of this segment is not possible. Moreover, Segment D actually consists of several sub-segments of variable stream type. Since the segmentation tool of SGAT is geo-referenced to the VHD, it was not possible to segment this portion of the Pond Hill Brook to accurately represent conditions noted on the ground. Instead the features are described below in text and figures. Notations have been made in the DMS for this segment describing these limitations and referring the user to this report for more details.

As depicted in Figure 59, the re-directed portion of the Pond Hill Brook identified as Segment D consists of:

- approximately 960 feet of gravel-dominated, C-riffle/pool channel;
- a 300-foot length of narrowly-confined, bedrock cascade channel;
- approximately 485 feet of channel through wetlands, followed by
- approximately 695 feet of "channel" through the pond upstream of the dam, and
- approximately 215 feet of semi-confined B-step pool channel.

The Pond Hill Brook appears to have been directed under the Delaware & Hudson railroad track just north of the intersection with the former Staso Milling Company spur. Two crossing locations are noted in this vicinity. Each crossing is comprised of two concrete culverts. At present, the main channel is directed through the northern-most crossing. While two concrete culverts approximately 10 feet apart are present at this crossing, rip-rap and debris obstruct the inlet of the southernmost culvert, and flows are directed through the northernmost culvert. The span (4 feet) is a significant constrictor of bankfull and flood flows. Rip-rap armoring is present parallel to the railroad grade on the upstream and downstream sides of these culverts. Vertical scour is evident at the culvert inlet, and fine sediment buildup is present at the culvert outlet. The channel approaches these culverts at a pronounced angle. Channel gradient, however, is low (less than 1%, visual estimate). Therefore, a vertical scour pool has not developed despite the constricting nature of this crossing.

Approximately 120 feet downstream (south) of this crossing is an apparent former railroad crossing visible along left bank in the approximate position of the pre-channelized planform. The former crossing also consists of two concrete culverts located approximately 1 foot apart. Backwater was observed flowing from the main channel into these culverts. The eastern side (former inlet) of these culverts was not visible from the channel upstream. It appears that this area of the former channel planform is inundated at higher water stage, and may represent a potential channel avulsion site.

Directly across from this former crossing along right bank is a low gravel berm at the edge of the athletic fields – oriented normal to the inferred location of the former planform of Pond Hill Brook. The former stream valley to the north of this location is now filled entirely by graded fill for the athletic fields.

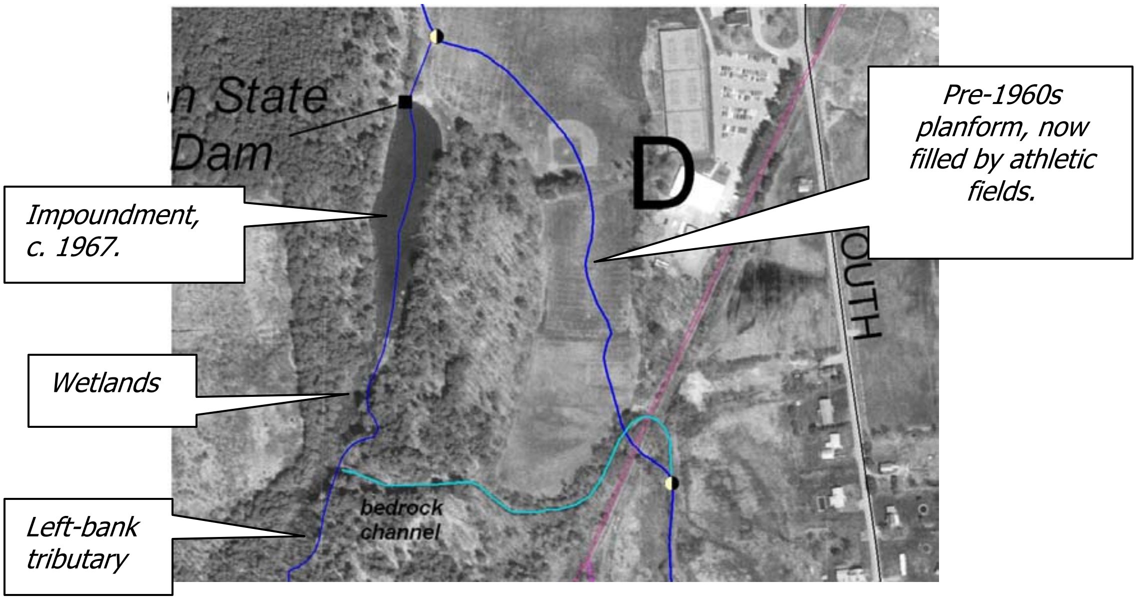


Figure 59. Variable stream types are present along the portion of Pond Hill Brook redirected to a constructed impoundment west of Castleton State College athletic fields in the mid- to late-1960s. Reach T02.08-s1.01. Base map is 1994 orthophotograph.

A cross section completed nearly 200 feet downstream of the railroad crossing confirmed a C4-riffle/pool stream type. The riffle/pool form is not well developed. Pools are absent and runs dominate the channel between short riffles. The measured channel cross section appears somewhat undersized, based on comparison to expected width, depth, and width/depth ratio for a reference C stream type with a drainage area of approximately 2 square miles (VT RHGC data, VTDEC, 2006). The measured bankfull width of 13.5 feet is significantly less than predicted (17.2 to 19.5 feet) and less than measured in upstream segments (18.5 feet in Segment E; 17.0 feet in reach T02.08-s1.02). The width/depth ratio of 9.9 is very low, more characteristic of an E stream type, but permissible for classification of a C stream type with consideration of the (+/- 2 units) permitted under protocols. It appears dredging to create this channel diversion resulted in a channel cross section which is somewhat undersized. The short berm and rip-rap near the upstream end of the segment suggest that channel avulsions may have been an issue in recent years.

The channel has reasonable access to a wide forested floodplain. Tree buffers along the left-bank corridor are predominantly greater than 100 feet; tree buffers along the right bank are approximately 25 to 50 feet wide along the southern edge of the athletic fields. A moderate degree of sinuosity appears to be developing, marked by low-level scour and undermining of tree roots on the outside of most meanders, as well as occasional flood chutes on the inside of meander bends. A minor to moderate degree of aggradation is indicated by the presence of a few unvegetated point bars, transverse bars and one side bar within the segment.

At the western extent of the ball fields, a recreational trail crosses the channel. On the date of assessment, wooden decking for a foot bridge was observed approximately 100 feet downstream of this crossing, perched at an angle along the right bank. The bridge appears to have washed out. No abutments are present at the crossing, but stream banks are reinforced by cobble- and boulder-sized rip-rap. At this point the channel gradient increased, valley walls closed in and the channel transitioned to a narrowly-confined bedrock gorge (estimated B1-cascade). Flows then merged with a left-bank tributary in a wetland complex west of a north-south trending bedrock knoll. The wetland subsequently flows into the 2-acre (+/-) impoundment behind the Castleton State College dam (Figure 60). Vermont Dam Inventory records (VCGI, 2005) indicate this dam to be 290 feet long and approximately 10 feet high.

(a)

(b)

Figure 60. Impoundment (approximately 2 acres) behind Castleton State College dam constructed circa 1967 – 1968. (Segment D of reach T02.08-s1.01). (a) view upstream (south) from dam; (b) view toward left bank, along dam. Viewed 31 July 2006.

Segment C

Segment C of reach T02.08-s1.01 is a bedrock gorge extending 677 feet in length, from just downstream of the dam / impoundment through a portion of the Castleton State College campus. Buildings and parking areas of the college are present along the right top of bank. Mid-way along the segment, a wooden foot bridge spans the top of the gorge to provide access to a forested area with trails west of the gorge (Figure 61).

Bedrock walls of the channel create a semi-confined to narrowly-confined valley setting. Bedrock ("ledge", by protocols) is exposed in the channel bed for a majority of the length, with locally steeper sections of cascade bedform over bedrock waterfalls. Since this segment was characterized as a "gorge", a RGA and RHA were not completed, and a "Low" sensitivity was assigned (by protocols). The considerable slope of Segment C and the narrowly-confined valley suggest that this section of Pond Hill Brook is sediment-supply limited, with a high sediment transport capacity.

*Figure 61.
Bedrock gorge (Segment C) of reach T02.08-s1.01.*

View downstream from footbridge, 31 July 2006.

Segment B

Segment B of reach T02.08-s1.01 flows to the north from the base of the bedrock gorge (Segment C) to the Route 4A (Main Street) crossing. Here the valley widens (from "narrow" to "broad") and the channel is unconfined, meandering through sparsely-developed residential and commercial properties with considerable forested areas.

A constructed pond with island in the middle is present along the right bank corridor. As discussed in earlier sections, this pond appears to have been constructed between 1972 and before 1994. A small portion of flow in Pond Hill Brook is diverted to this pond from a small impoundment behind a low-head dam (Figures 62 and 56). Water is returned from the pond to the channel via a corrugated steel culvert protruding from right bank, located approximately 400 feet downstream of the withdrawal site. It is unknown whether this constructed pond (by design) receives stormwater runoff from adjacent residential / commercial properties. New buildings were in the process of being constructed along the east side of this pond on the assessment date (31 July 2006). The pond does represent a local drainage "sink" for precipitation and runoff; therefore, the culvert draining the pond to Pond Hill Brook was identified as a stormwater input during the assessment.

Other than the small dam and constructed pond, there are relatively few encroachments within Segment B. A narrow forested buffer is present along left bank (ranging from 25 to 100 feet in width). A somewhat narrower-width buffer of trees, herbaceous and scrub/shrub vegetation is present along right bank. Habitat was rated in "Fair" condition, on the cusp with "Good", following the RHA. Factors contributing to a less than optimal rating were the limited right-bank buffers, a moderate degree of streambank erosion, and embeddedness.

The channel has good floodplain access within the segment; there are negligible signs of active incision. A limited cross section completed mid-segment confirmed a gravel-dominated C-riffle/pool stream type, consistent with reference stream type. Channel planform is more sinuous on the 1994 and 2003 aerial photos than indicated by the VHD surface water coverage. Moderate deposition of fine to coarse gravels and sands is occurring in the reach, as evidenced by several unvegetated point bars, and the occasional slug of unconsolidated sediments underfoot. Five debris jams were observed contributing to localized planform adjustments, sediment bar formation and maintenance of a riffle/pool bedform. Thus, this segment appears to serve a local flow and sediment attenuation role.

(a)

(b)

Figure 62. Water from Pond Hill Brook (Segment B) is diverted from a small impoundment behind a low-head dam and piped to a constructed pond along right bank, downstream of the Castleton State College campus and upstream of the Route 4A (Main Street) crossing. (a) view from right bank of low-head dam and pipe inlet accessed by wooden stairs; (b) view to north of constructed pond with island accessed by wooden footbridge. 31 July 2006.

Segment A

Segment A is the downgradient-most section of the reach from the Route 4A (Main Street) crossing downstream to the Castleton River. Based on review of historic maps, this section of the reach appears to have been channelized some time after 1897 and before 1964, to follow Cemetery Drive and join the Castleton River at a point 800 feet upstream of its former confluence (Figure 63a). While this modified planform would have shortened the segment length, it may not have substantially increased the channel gradient, since the Pond Hill Brook falls approximately 3 feet from an instream culvert under the railroad grade to join the Castleton River (Figure 63b).

(a)

(b)

Figure 63. In its last 500 feet downstream of the Main Street crossing, Pond Hill Brook is channelized along Cemetery Drive and flows under the Delaware & Hudson Railroad through an instream culvert to cascade into the Castleton River. (a) view upstream (south) from railroad crossing; (b) view to southwest from Cemetery Drive crossing of the Castleton River toward confluence of Pond Hill Brook. 31 July 2006.

In addition to the Main Street bridge crossing at the upstream end, the railroad crossing at the downstream end, and Cemetery Drive along the right bank, a residential outbuilding encroaches along the left bank in the upstream half of Segment A. The bridge and culvert crossings are each constrictors of bankfull and flood flows. A moderate degree of upstream sediment accumulation was present upstream of each of these structures. Rip-rap is evident along both banks, upstream and downstream of the crossings, suggesting past erosion concerns. In the lower half of the segment, where woody buffers have been removed, rip-rap is present along both banks, and continuously along left bank. A subtle berm appears to be present along left bank from the end of the tree line to the railroad crossing.

Segment A was rated in "Fair" condition following the RGA. Degradation appears historic in nature, based on the absence of features which would indicate active incision. A limited degree of floodplain access along the left-bank corridor is evident from a mid-segment cross section. The measured incision ratio (1.4) is in part due to elevation of the floodplain local to the channel - by road bed material of Cemetery Drive (along right bank) and by a shallow berm (along left bank). Evidence of active widening is minimal; presence of woody buffers in the upstream half of the segment and streambank armoring in the downstream half may have moderated the potential for widening. Aggradation is also minor in the segment; sediments from upwatershed sources have apparently been trapped in wetlands and the large impoundment above the Castleton State College dam (Segment D). Downstream of this dam and the bedrock gorge, sediment sources are limited to a small left-bank tributary "delta" and streambank erosion in upstream Segment B. Many of these sediments appear to be attenuating in Segment B in point bars, and upstream of the Main Street bridge crossing.

Habitat conditions within Segment A have been compromised by the extensive channel manipulations and resulting encroachments and loss of buffers. Pool/riffle diversity and epiphaunal substrates are essentially absent in the downstream half of the segment.

This downstream-most segment of Pond Hill Brook has been converted from an expected reference meandering riffle/pool channel to a linear, transport-dominated channel, with very limited opportunities for flow or sediment attenuation.

5.0 SUMMARY AND DISCUSSION

Phase 2 and updated Phase 1 assessment results have begun to characterize the watershed and channel stressors to the Castleton River watershed over time, and the spatial and temporal variability in adjustment processes, which together have resulted in the present day geomorphic conditions. These interpretations can be used by watershed stakeholders to identify possible consequences of land use and watershed management decisions on future geomorphic condition of the river to minimize erosion and flooding hazards and to optimize water quality and aquatic habitats.

5.1 Watershed and Channel Stressors

Various watershed-scale and channel-level disturbances have served as stressors to the Castleton River main stem and tributaries (Table 10). These stressors have been identified through direct observation, limited historical research, anecdotal accounts from landowners and local citizens, as well as remote sensing. This listing is not comprehensive, but it begins to characterize the degree of natural and anthropogenic disturbance to the watershed, that has caused variable and overlapping adjustment responses in the channel.

Channel and watershed disturbances that exceed thresholds for change can upset the dynamic equilibrium of stream systems. Imbalance in the channel affects the sediment transport capacity of the stream system, and has significant consequences for erosion hazards, water quality and riparian habitats. Equilibrium can be disturbed locally and result in channel adjustments that are limited in magnitude and extent (for example, scour at an undersized culvert crossing). Alternately, the disturbance (or an overlapping combination of disturbances) can be of sufficient size, duration, or frequency to cause substantial channel adjustments that result in a system-wide imbalance extending far upstream and downstream through the river network.

Such imbalances, whether localized or systemic, interfere with the river's ability to efficiently convey its water and sediment loads. These interruptions are either expressed as a sediment transport deficiency where sediment accumulates in the channel (which itself may lead to further imbalances - e.g., flow widens and splits to erode streambanks on either side, or flow may avulse or jump its banks in a flood event). Alternately, the imbalance can be expressed as an increased sediment transport capacity. For example, a channel that has been straightened, dredged, armored and bermed has a local increase in channel slope, which creates higher flow velocities, and an increased power to erode the streambed. The channel bed is scoured and this condition often leads to further channel adjustments including streambank collapse and widening.

Sediment transport capacity of the channel can be inferred from the geomorphic features observed during field work and from the stressors catalogued in Table 10. Even a qualitative understanding of these processes can help to identify and prioritize appropriate management strategies for the river that will facilitate a return toward a more balanced (dynamic equilibrium) condition.

Table 10. Summary of Watershed and Channel Stressors in Study Area Reaches / Segments.

Reach / Segments	Watershed			Channel - Reach Scale							Channel - Site Scale				
	Deforestation in 1800s	Transportation Networks (1700s, 1800	Flood events	Channelization / Straightening	Dredging	Berming	Bank Armoring	Floodplain Encroachment	Loss of Forested Buffers	Impoundment (dam)	Gravel extraction	Bankfull-constricting Bridge / Culvert	Other Bankfull Constrictor	Direct Pasturing by Livestock	Ford
Main Stem															
T02.12				√	√	√	√	√	√			√		√	
T02.11-B				√	√	√	√	√	√		√	√	√	√	√
T02.11-A				√		√	√	√	√		√	√			√
T02.10				√			√	√	√				√		
T02.09-B				√		√	√	√	√	√		√			
T02.09-A				√			√	√	√						
T02.06				√			√	√				√			
T02.05				√			√	√	√			√	√		
T02.04				√			√	√							
T02.03							√	√	√	√		√	√		
T02.02-B							√	√	√ (m)				√		
T02.02-A							√ (m)								
T02.01				√ (m)				√ (m)	√						√
Gully Brook															
T02.11-s1.04-D				√ (m)			√ (m)	√ (m)				√			√
T02.11-s1.04-C				√ (m)			√ (m)	√ (m)				√			
T02.11-s1.04-B				√ (m)				√	√						√
T02.11-s1.04-A										√ (B)			√		√
T02.11-s1.02-B								√							
T02.11-s1.02-A				√	√	√	√	√	√						√
T02.11-s1.01	↓	↓	↓	√	√	√			√		√				√

Notes: √ (H) = historic stressor; √ (m) = minor condition; √ (B) = breached

Table 10. (cont) Summary of Watershed / Channel Stressors in Study Area Reaches / Segments.

Reach / Segments	Deforestation in 1800s	Transportation Networks (1700s, 1800s)	Flood events	Channelization / Straightening	Dredging	Berming	Bank Armoring	Floodplain Encroachment	Loss of Forested Buffers	Impoundment (dam)	Gravel extraction	Bankfull-constricting Bridge / Culvert	Other Bankfull Constrictor	Direct Pasturing by Livestock	Ford
	Watershed			Channel - Reach Scale							Channel - Site Scale				
North Bretton Brook															
T02.09-s1.05				√			√		√			√			√
T02.09-s1.04-E				√			√								√
T02.09-s1.04-D				√	√	√									√
T02.09-s1.04-C															√
T02.09-s1.04-B															
T02.09-s1.04-A															√
T02.09-s1.02-B				√			√ (m)	√ (m)	√				√		√
T02.09-s1.02-A								√	√	√			√		
T02.09-s1.01-B				√			√	√	√						√
T02.09-s1.01-A				√			√	√	√			√			
Pond Hill Brook															
T02.08-s1.05-F				√	√				√						
T02.08-s1.05-E							√		√						
T02.08-s1.05-D				√	√				√					√	√
T02.08-s1.05-C									√					√ (m)	
T02.08-s1.05-B				√ (m)		√	√	√	√			√		√	√
T02.08-s1.05-A									√ (m)					√ (m)	√
T02.08-s1.04-C									√ (m)					√ (m)	
T02.08-s1.04-B				√		√	√		√			√		√	√
T02.08-s1.04-A															
T02.08-s1.03						√	√ (m)			√ (B)					
T02.08-s1.02				√	√		√	√	√	√		√	√		
T02.08-s1.01-E				√			√ (m)	√	√ (m)			√			
T02.08-s1.01-D				√	√	√	√	√	√	√		√			√
T02.08-s1.01-C								√ (m)	√						
T02.08-s1.01-B								√	√	√					
T02.08-s1.01-A				√	√	√	√	√	√			√			

Notes: √ (H) = historic stressor; √ (m) = minor condition; √ (B) = breached

5.2 Dominant Adjustment Processes and Reach Sensitivity

The Castleton River and tributary channels are responding to stressors through adjustment of their dimensions, planform, and profile. Adjustments have occurred to varying degrees, as dependent on multiple factors (including channel sediment types, vegetative cover type and density, presence of grade controls, etc.). The relative magnitude of these channel adjustment processes, together with the topographic, geologic, and vegetative settings define the sensitivity of each reach or segment to continuing and future stresses.

Generally speaking, channels with steeper gradients in confined valleys carrying coarser sediment loads (boulders, cobbles) and showing good vertical grade controls (e.g., channel-spanning bedrock) are considered to be most stable and least sensitive to vertical and lateral adjustments that may present conflicts with human investments in the corridor. In contrast, the more sensitive reaches (High, Very High, or Extreme), include the channels low- to moderate-gradient (less than 2%) dominated by gravels or sands, and absent of grade controls. These reaches are more susceptible to future adjustments in response to channel and watershed stressors.

Sensitivities of the study area reaches/segments as defined in VTANR protocols (2006) are presented in Figures 64 through 67. In general, this Phase 2 assessment purposely targeted lower-gradient, (reference C or E-stream-type) reaches that would be expected to exhibit higher sensitivity, and which have current constraints within the river corridor (and elevated impact ratings in the Phase 1; RRPC, 2005). Therefore, it is not unexpected that many of the study area reaches were defined as having sensitivities at the high end of the scale.

Exceptions to this generalization were the following **Moderate, Low,** and **Very Low** sensitivity segments and reaches. These segments are afforded greater stability by the underlying bedrock, and are less susceptible to lateral and vertical adjustments:

- main stem reach, T02.03 - the bedrock-controlled, relatively steep-gradient (2.4%) channel with three historic dams located in Fair Haven village (Low sensitivity) (Figure 65);
- a narrowly-confined, steep gradient (4.6%), bedrock segment of Gully Brook - T02.11-s1.04-A (Very Low sensitivity) (Figure 66);
- narrowly-confined to semi-confined, steeper-gradient (3.2 to 5.5%), cobble- to coarse-gravel-dominated segments of Gully Brook – T02.11-s1.04-D and -C, and T02.11-s1.02-B (Moderate sensitivity) (Figure 66);
- a short, semi-confined, steep-gradient (2.9%), bedrock-dominated segment B of North Bretton Brook reach T02.09-s1.04 (Low sensitivity) Figure 67); and
- narrowly-confined to semi-confined, steep gradient (3.7% to 11.4%), bedrock segments of Pond Hill Brook - T02.08-s1.05-E, C, and A; T02.08-s1.04-C and A; T02.08-s1.03; T02.08-s1.01-C (Low to Very Low sensitivities) (Figure 66);

In contrast, segments exhibiting a pervasive stream type departure (as compared to reference stream type) were assigned an **Extreme** sensitivity. Typically, these reaches/segments have lost access to their floodplains becoming entrenched within their banks, as a result of historic channelization and/or dredging. Occasionally, entrenchment has been exacerbated by road or railroad encroachments or sediment berms close to the channel. Dominant adjustment processes observed in these reaches were planform adjustment, aggradation and widening; none of the segments exhibited signs of system-wide active incision. Generally, these moderate- to lower-gradient (< 4%), cobble, gravel and sand channels showed stream type departures from C (or Cb) reference stream type to an entrenched F stream type (there was also one example each of a D to F departure and a Cb to B departure).

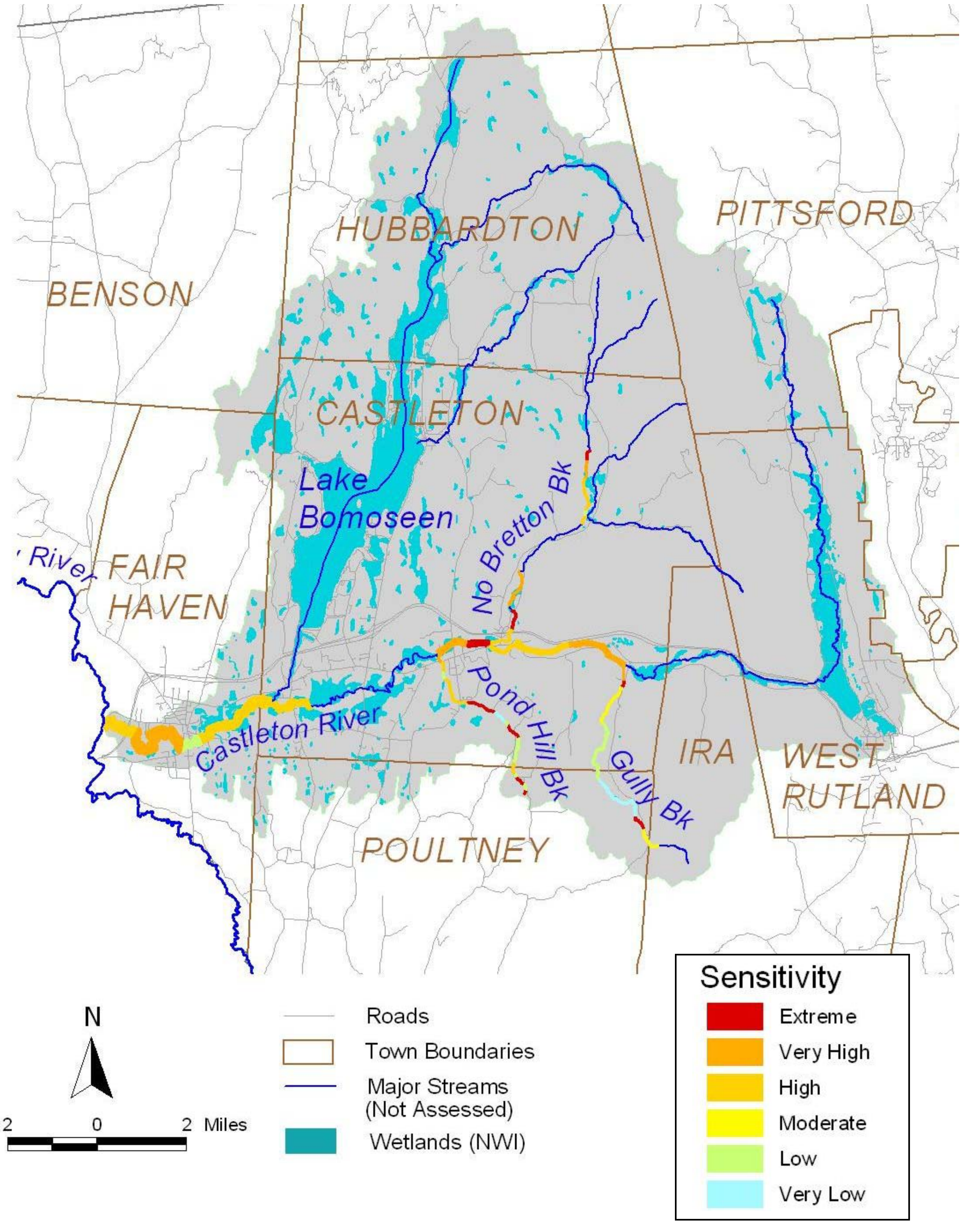


Figure 64. Reach / Segment Sensitivity, Castleton River Watershed, 2005 and 2006 Stream Geomorphic Assessments

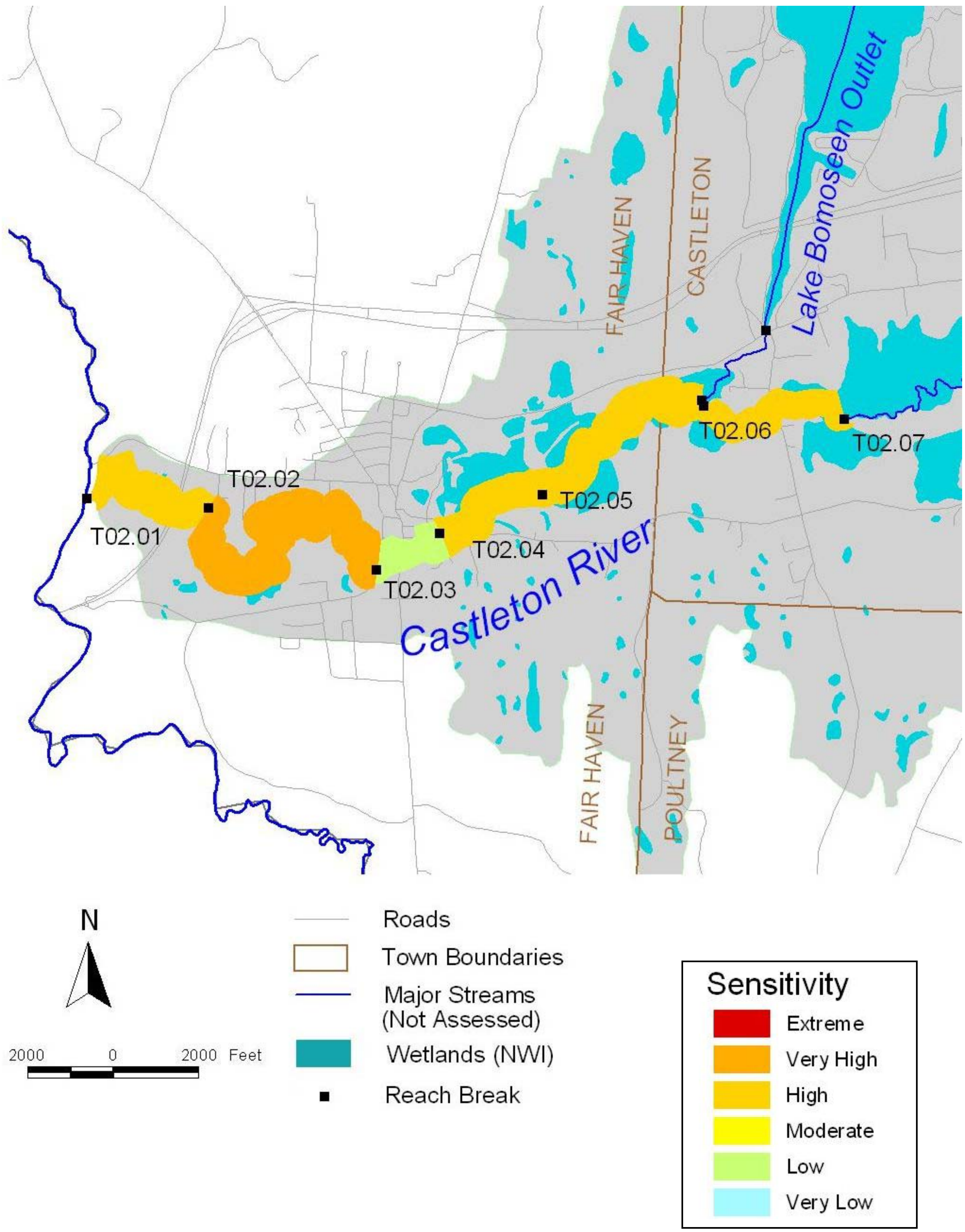


Figure 65. Reach / Segment Sensitivity, Lower Main Stem, Castleton River, 2005 and 2006 Stream Geomorphic Assessments

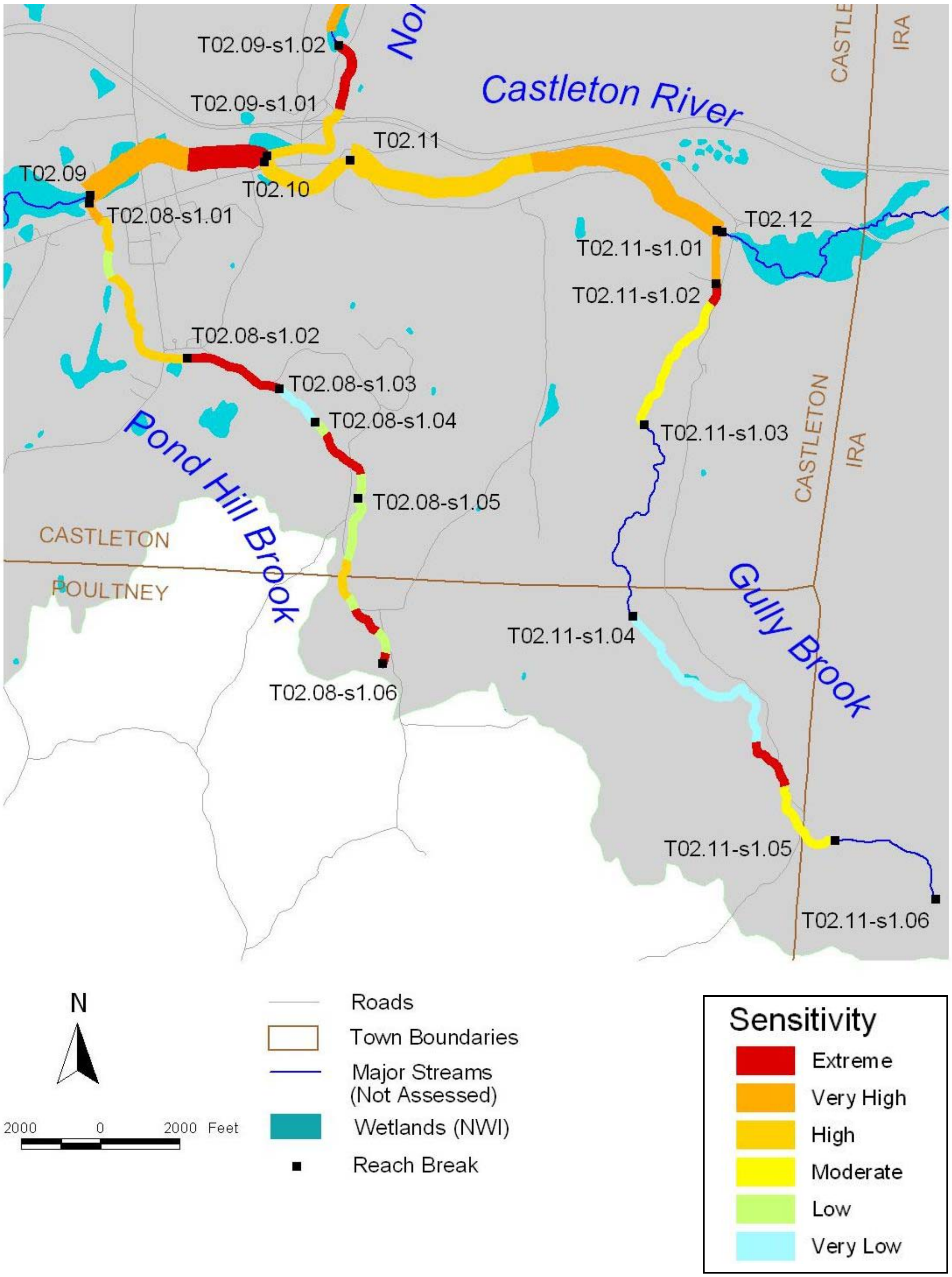


Figure 66. Reach / Segment Sensitivity, Upper Main Stem Castleton River, Pond Hill Brook, Gully Brook, 2005 and 2006 Stream Geomorphic Assessments

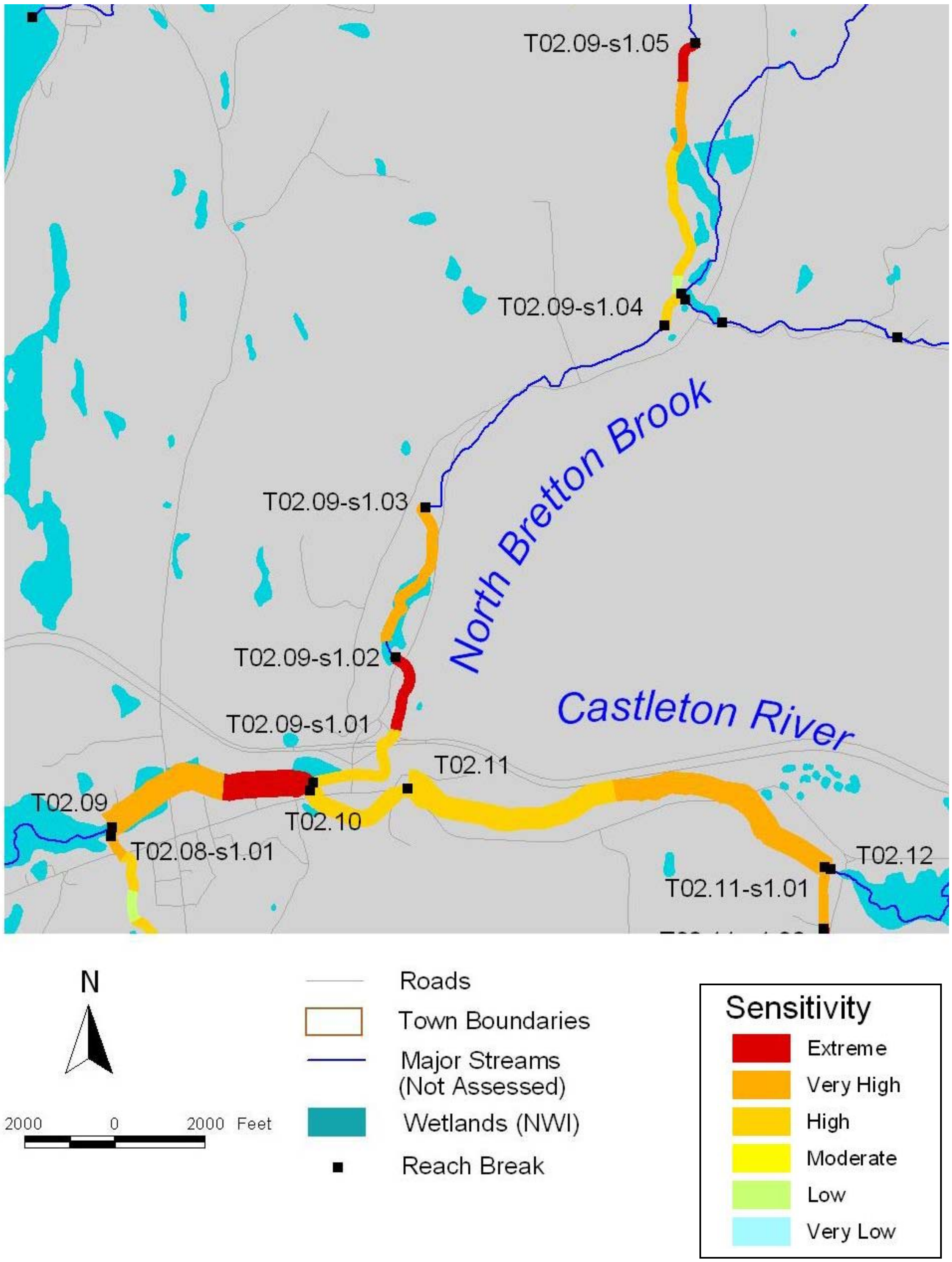


Figure 67. Reach / Segment Sensitivity, North Bretton Brook, 2005 and 2006 Stream Geomorphic Assessments

The following reaches/segments are in this category of **Extreme** sensitivity due to stream type departure and are depicted in red on Figures 64 through 67:

- Main Stem: T02.09-B
- Gully Brook: T02.11-s1.04-B, T02.11-s1.02-A
- North Bretton Brook: T02.09-s1.04-E, T02.09-s1.01-B
- Pond Hill Brook: T02.08-s1.05-F and –D, T02.08-s1.04-B, T02.08-s1.02,

The remaining study area reaches were unconfined, lower-gradient (generally <2%), gravel- and sand-dominated channels (with the exception of Pond Hill Brook segment T02.08-s1.05-B which is a semi-confined, steeper-gradient [3.7%], gravel-bed channel). They exhibited moderate to minor adjustments, and consequently were rated in Poor, Fair or Good condition. Some indicated a minor to moderate degree of historic incision, but none had lost access to their floodplain. Often lateral and vertical adjustments appear to have been moderated by the presence of exposed or shallow bedrock. The following reaches / segments in this grouping were assigned a **High** or **Very High** sensitivity, as prescribed in VTANR protocols, and are depicted in light orange or dark orange on Figures 64 - 67:

- Main Stem: T02.11-B and –A, T02.10, T02.09-A, T02.06, T02.05, T02.04, T02.02-B and –A, T02.01
- Gully Brook: T02.11-S1.01
- North Bretton Brook: T02.09-s1.04-D, -C, and –A, T02.09-s1.02-B, T02.09-s1.01-A
- Pond Hill Brook: T02.08-s1.05-B, T02.08-s1.01-E, -D, -B, and -A

6.0 PRELIMINARY PROJECT IDENTIFICATION

Landowners, community members, and resource agencies, including Poultney Mettowee Watershed Partnership, Poultney Mettowee NRCD, the Natural Resources Conservation Service, and Vermont Agency of Natural Resources, can use geomorphic data to inform future management strategies for the river corridor. For a given reach or segment, the active adjustment processes, degree of departure from reference, and sensitivity ranking will define the short-term compatibility and long-term sustainability of various restoration or conservation options and future land use or channel management activities.

The preliminary identification and prioritization of corridor restoration and protection projects and practices outlined below has been informed by:

- stream sensitivity data (Section 5.2);
- qualitative observations of sediment transport and attenuation characteristics (summarized for each reach in Sections 4.1 through 4.5); and
- preliminary departure analysis contained in Sections 4.1 and 4.5.

This provisional listing follows the outline of management actions identified in the *Step-Wise Procedure for Identifying Technically Feasible River Corridor Restoration and Protection Projects* included in VTANR guidance (11 July 2007 draft). Per VTANR guidance, the listed approaches can be classified under three broad management approaches:

<u>Active Geomorphic:</u> Restore or manage rivers to a geomorphic state of dynamic equilibrium through an **active** approach that may include the removal or reduction of human-placed constraints or the construction of meanders, floodplains, and bank stabilization techniques. Active riparian buffer revegetation and long-term protection of a river corridor is essential to this alternative.

Passive Geomorphic: Allow rivers to return to a state of dynamic equilibrium through a **passive** approach that involves the removal of constraints from a river corridor thereby allowing the river, utilizing its own energy and watershed inputs to re-establish its meanders, floodplains, and self maintaining equilibrium condition over an extended time period. Active riparian buffer revegetation and long-term protection of a river corridor is essential to this alternative.

Active-Passive Combination: Use a sequenced combination of active and passive approaches to accommodate the varying constraints that typically occur along a project reach.
(VTANR, 2007; 1 June draft)

The work scope for this Phase 2 Assessment has not included public outreach or analysis to determine the technical, financial and social feasibility and relative priorities of these listed project opportunities (corridor planning tasks for reaches T02.09, T02.10, T02.11, and T02.12 were addressed under a separate scope of work and are reported under separate cover). Instead, this listing will form the basis for future project development and implementation efforts in the context of watershed, community, and corridor planning projects. A few of these projects (e.g., buffer plantings) can be considered for immediate implementation, independent of other watershed projects, and will require only minimal feasibility analysis and project development activities. Other identified projects may require further evaluation and efforts to conduct alternatives analyses, conduct landowner outreach and negotiations, and identify potential stakeholders and funding sources.

Watershed stakeholders which may look to this data for guidance include (but are not necessarily limited to):

- landowners,
- towns of Castleton, Fair Haven, Ira, and Poultney,
- Poultney-Mettowee Natural Resources Conservation District,
- Poultney-Mettowee Watershed Partnership,
- VT Department of Environmental Conservation, Water Quality Division –
    - River Management Section and
    - Wetlands Section,
- Vermont Agency of Agriculture,
- Vermont Department of Transportation,
- Vermont Land Trust,
- Vermont River Conservancy,
- Northern Vermont Resource Conservation and Development Council (Better Back Roads),
- US Fish and Wildlife, and
- US Department of Agriculture, Natural Resources Conservation Service.

Note that Appendix G contains a listing of specific project opportunities for the Castleton and tributary reaches assessed in 2006. This listing was developed based on previous River Management Section guidance (VTDEC RMS, 2003; VTDEC RMS, 2005b). This previous guidance has now been superseded by newer guidance:

- *VTANR River Corridor Planning Guide to Identify and Develop River Corridor Protection and Restoration Projects* (1 June 2007 draft).

Nevertheless, the project listings in Appendix G may provide additional detail in support of this Section 6 and future watershed and corridor planning efforts.

6.1 Protecting River Corridors

Protection of river corridors is an essential element to all passive and active geomorphic restoration and conservation projects. River corridor protection can support multiple objectives:

- **Dynamic Equilibrium** - Preserve (or support a return to) reference sinuosity, slope, and channel dimensions through active or passive geomorphic approaches. Refrain from future channel management, such as channelization, dredging, berming, armoring.
- **Floodplain Access** – Preserve or restore a channel's access to its surrounding floodplain in bankfull and higher flow events through active or passive geomorphic approaches. Refrain from future channel management, such as channelization, dredging, berming, armoring.
- **Sediment Attenuation** – Preserve, restore, or enhance the storage of sediments (from in-reach or upstream sources) within the channel margins, floodplain, and channel-contiguous wetlands.
- **Flow Attenuation** – Preserve, restore, or enhance the storage and detainment of flood flows through overbank flooding, increased channel length (sinuosity), increased channel roughness (e.g., buffers), and inundation of channel-contiguous wetlands.
- **Avoidance** – Refrain from developments and infrastructure in the corridor to minimize future fluvial erosion losses

Under a passive geomorphic approach, the river channel is allowed to freely meander within the area defined as the belt-width-derived river corridor. For a reach that is already close to reference condition or exhibiting only minor adjustments, preserving a river corridor will ensure the river's ability to continue to meander through the valley unconstrained by human infrastructure. In turn, human investments in the landscape will be protected from future channel adjustments. For a reach that has seen significant channel management in the past, and has lost some degree of floodplain connection and some measure of its sinuosity and balanced planform and profile, the channel is allowed to adjust unimpeded to a more sinuous, meandering planform closer to regime conditions. During ongoing adjustments, the river will re-establish greater floodplain access (where access has been lost) and adjust channel dimensions for optimum conveyance of its water and sediment loads. Restoring channel equilibrium will reduce instream production of sediment and nutrients and enhance sediment and nutrient attenuation over the long term.

Under an active geomorphic approach, protection of the river corridor will prevent future channel management that might unravel constructed features of a recently restored reach.

Lower priority reaches for river corridor protection include "wooded corridors experiencing very little threat from encroachment and less sensitive reaches not playing a significant flow or sediment load attenuation role in the watershed (11 July 2007, VTANR guidance)". Of the Castleton watershed reaches assessed, this category would include:

- the bedrock reaches and subreaches of the:
  - main stem (T02.03),
  - Gully Brook (T02.11-s1.04-A),
  - North Bretton Brook (T02.09-s1.04-B), and
  - Pond Hill Brook (T02.08-s1.05-E, C, and A; T02.08-s1.04-C and A; T02.08-s1.03; T02.08-s1.01-C)

- narrowly-confined to semi-confined, steeper-gradient (3.2 to 5.5%), cobble- to coarse-gravel-dominated segments of Gully Brook – (T02.11-s1.04-D and -C, and T02.11-s1.02-B).

Highest priority reaches for river corridor protection include "highly sensitive reaches critical for flow and sediment attenuation from upstream sources or sensitive reaches where there is a major departure from equilibrium conditions and threats from encroachment (11 July 2007, VTANR guidance)". Limited term or permanent corridor easements are possible mechanisms for corridor protection, with the willingness of landowners.

Table 11. High-priority River Corridor Protection Sites, Castleton River watershed Assessed to Date.

Rationale	Tributary	Reach / Segment	Town
Protection Upstream of Constrained / Altered Reaches to attenuate flows/ sediment and reduce impacts to T02.11-B	Castleton River main stem	Protection of T02.12	Ira, Castleton
to support passive redevelopment of meander beltwidth; attenuate flows/ sediment from T02.11-B and Gully Brook; to reduce impacts to T02.10, T02.09-B		Protection of T02.11-A	Castleton
to attenuate flows/ sediment from T02.11-B and Gully Brook; to reduce impacts to T02.09-B. (See separate CPP for more project development details.)		Protection of T02.10 and existing well-defined tree buffers and active LWD recruitment	Castleton
Sediment /flow attenuation areas - preservation and enhancement. Corridor protection including contiguous wetlands, well-defined forested buffers and active LWD recruitment to; attenuate flows/ sediments delivered from upstream reaches and tributaries. (See separate CPP for more project development details related to segments T02.11-B and T02.09-A).	Castleton River main stem	T02.11-B upstream of Route 4A T02.09-A T02.06 T02.05 T02.04	Castleton Fair Haven
	Gully Brook	Protection of T02.11-s1.01 to support active floodplain restoration project already implemented. – see CPP.	Castleton
Protection Downstream of Constrained / Altered Reaches Attenuate sediments / flows transported through the channelized / managed / constrained segment.	Gully Brook	Protection of T02.11-s1.01 to offset managed, channelized, entrenched, and bermed segment T02.11-s1.02-A. (significant floodplain restoration has already occurred in T02.11-s1.01 – see CPP).	Castleton

Reduction of Fluvial Erosion Hazards Corridor protection in these reaches, enabled by FEH mapping and zoning, can:			
(a) Inform residents of FEH hazards in village areas.	Castleton River main stem	T02.10	Castleton
(b) reduce future fluvial erosion hazards along highly "sensitive **reaches where there is a major departure from equilibrium** conditions and threats from encroachment" (VTANR, 2007)	Castleton River main stem	T02.11-B upstream of Route 4A	Castleton
(c) reduce future fluvial erosion hazards along reaches at **alluvial fans or points of marked valley slope reduction** that contributes to increased sediment aggradation and planform adjustment. Carefully manage land use changes in the upstream watershed to reduce the potential for increases in sediment or flows that may induce channel adjustments in the subject reach/segment.	Gully Brook	T02.11-s1.02-A T02.11-s1.01	Castleton

6.2 Planting Stream Buffers

Forested riparian buffers serve to improve water quality and contribute to greater flow and sediment attenuation in the floodplain. They will also help to restore and maintain dynamic equilibrium of the channel by increasing resistance to boundary shear stresses along the channel margins. Tree buffers will provide the additional benefits of organic matter, detritus, and LWD recruitment for aquatic and riparian habitats, as well as increased shading to reduce river temperatures. Connectivity of buffer areas from reach to reach along a river network is also supportive of mammalian terrestrial habitats by providing wildlife corridors. The column heading "Loss of Forested Buffers" in Table 10 (Section 5.1) highlights the Castleton River reaches which would benefit most from buffer plantings. Highest priority should be given to higher sensitivity reaches (see Figure 64-67) which are vertically stable.

Associated with buffer restoration in select watershed reaches is the exclusion of livestock to reduce channel trampling and allow trees and other native species to re-vegetate the channel margins. Opportunities for livestock exclusion in the Castleton River watershed were noted on the following reaches / segments:

Table 12. Livestock Exclusion Opportunities in the Castleton River Watershed

Tributary	Reach / Segment	Town
Castleton main stem	T02.12	Ira
	T02.11-B	Castleton
Pond Hill Brook	T02.08-s1.05-D	Castleton
	T02.08-s1.05-C	Castleton
	T02.08-s1.05-B	Castleton
	T02.08-s1.05-A	Castleton
	T02.08-s1.04-C	Castleton
	T02.08-s1.04-B	Castleton

6.3 Stabilizing Stream Banks

Streambank stabilization can be considered in "laterally-unstable, [but vertically stable] reaches where human-placed structures are at high risk and not taking action may result in increased risk of erosion, to not only the structure, but lands that would provide the opportunity to establish a buffer (11 July 2007 draft VTANR guidance)".

Any bank stabilization project should be considered in the broader context (both in time and space) for the channel adjustment processes such management will set in motion and for the consequences to upstream and downstream reaches.

Table 13. Potential Bank Stabilization Sites in the Castleton River Watershed

Tributary	Reach / Segment	Town	Description
Castleton main stem	T02.11-A	Castleton	Streambank stabilization may be warranted at the landslide failure site along LB at the downstream end of the segment to protect Route 4A located within 20 feet of the top of bank (see Section 4.1). Further site investigation would be required to confirm local channel dynamics and the causes of the mass failure. (see further project development notes in separate Corridor Protection Plan document).

6.4 Arresting Head Cuts and Nick Points

Head cut sites were noted in two assessed reaches/segments of the Castleton River watershed:

- Castleton River main stem segment T02.09-A (see Section 4.1) - this head cut was located in the laterally-adjusting area downstream of the North Street bridge crossing, where wetland conditions are present contiguous to the channel, and splitting flows are apparent. Several debris jams in this area appear to have diverted portions of the channel flow into former flood chutes. The head cut was observed in a recent channel avulsion, and is thought to represent a localized phenomenon related to the recent breaching of a debris jam and does not appear to indicate system-wide incision. It is expected that this head cut site will aggrade naturally in the short term. Therefore, no active measures are proposed to arrest this head cut site.

- Pond Hill Brook segment T02.08-s1.05-D (see Section 4.4) - It is possible that this nick point resulted from a slug deposit of relatively more coarse bed material. If the nick point represents a head cut characteristic of incision, it is bounded by exposures of channel-spanning bedrock within 350 feet upstream and 250 feet downstream. These occurrences of channel-spanning bedrock should serve to limit the potential for further migration of incision. Since the bedrock grade controls are located within one meander wavelength (14 x bankfull width) of this potential head cut site, no active measures are proposed to arrest the head cut. Livestock exclusion (Table 12), and river corridor protection including buffer restoration (Sections 6.1 and 6.2) will accelerate the recovery of this segment which has begun to build an incipient floodplain at a lower elevation.

6.5 Removing Berms / Other Constraints to Flood & Sediment Load Attenuation

Removing berms or other constraints to the full meander expression and floodplain connection of a river channel may accelerate a return to dynamic equilibrium in the channel, and reduce impacts to downstream segments, by creating more opportunities for sediment and flow attenuation along the corridor. Further study is necessary to evaluate the feasibility of various active geomorphic and engineering techniques. The benefits of such projects would need to be evaluated in light of the costs and potential short-term consequences in terms of sediment and nutrient mobilization, and risk to infrastructure and public safety.

Table 14. Potential Berm Removal Sites, Castleton River watershed.

Reach/ Seg	**T02.12 – mid-reach** **Castleton River main stem** **T02.11-B – upstream of Rt 4A**
Location	Along former trolley grade, Ira, Castleton.
Rationale	Restore floodplain access and remove constraints to full meander expression for increased flow and sediment load attenuation
Description	Evaluate the feasibility of lowering trolley grade elevation where it presently constrains the channel and limits floodplain access.
Priority	**High.** (see CPP).
Other Considerations	Accompanied by corridor protection (see Section 6.1) and buffer maintenance.

Reach/ Seg	**T02.11-B** downstream of Route 4A crossing **Castleton River main stem**
Location	Along former trolley grade, Castleton.
Rationale	Evaluate the feasibility of lowering trolley grade elevation (RB) and removing berms (LB) where they presently constrain the channel and limit floodplain access. Restore floodplain access and remove constraints to full meander expression for increased flow and sediment load attenuation.
Description	Downstream of Route 4A crossing, the Castleton River is confined between berms along LB and the historic trolley grade along RB. A plane-bed, transport-dominated channel directs sediments to the vicinity of the Ward and O'Rourke properties where sediment is locally aggrading and apparent avulsions are active. Channel management activities attempted in the Ward / O'Rourke vicinity have not been sustainable, and there are ongoing land use conflicts with the river channel. A recent channel avulsion has resulted in the River flowing through active horse pasture close to a manure storage area. With landowner willingness and appropriate compensation, it may be possible to provide for increased floodplain access, and sediment /flow attenuation through berm (trolley grade) removal along RB on the Ruby parcels. This action may reduce conflicts through the Ward / O'Rourke parcels - especially if in combination with floodplain / channel restoration upstream of the Route 4A crossing.
Priority	**High.** See CPP.
Other Considerations	Accompanied by corridor protection (see Section 6.1) and buffer maintenance.

Reach/ Seg	**T02.09-s1.04-D, North Bretton Brook**
Location	West of Hubbardton Road, between LB & RB crop fields.
Rationale	Restore access to narrow forested floodplain and remove berm constraints to full meander expression for increased flow and sediment load attenuation.
Description	Remove the gravel berm / windrow materials along approximately 750 ft of channel (both LB and RB) without cutting / removing young tree growth in a moderately-wide strip of buffer between crop fields. (Hand excavating likely or small equipment access to the stream during baseflow time of year when channel typically dries up).

Priority	**Very High.** Cost/benefit ratio of active measures to restore floodplain access would be relatively low. Valuable tree buffer is already present to provide ample roughness along the channel margins, offer LWD recruitment for habitat restoration, and reduce the potential for sudden / accelerated lateral adjustments (i.e., protecting adjacent crop land uses). A restored Segment D floodplain would assist in attenuating sediments from upstream incised Segment E which is building an incipient floodplain at a lower elevation and will be generating sediments from streambank erosion over the short term as it recovers (see Section 6.7).
Other Considerations	Accompanied by corridor protection (see Section 6.1) and buffer maintenance. Critical to secure landowner agreement to refrain from future channelization / dredging / windrowing.

Reach/ Seg	**T02.08-s1.04-B Pond Hill Brook**
Location	Crosses Pond Hill Road, through crop fields on LB and RB.
Rationale	Restore floodplain access and remove berm constraints to full meander expression for increased flow and sediment load (and nutrient) attenuation.
Description	Evaluate the feasibility of active geomorphic measures (e.g., lowering elevation of near-bank areas along both banks) in this partly incised channel.
Priority	**Moderate.** Segment is actively building new floodplain at lower elevation near downstream end, assisted by limited LWD recruitment, so restoration may be achieved passively. On the other hand, berm removal (if done without disturbing single- to double-tree buffer) could remove a source of sediment to downstream reaches.
Other Considerations	Passive or active restoration could be accelerated by buffer enhancements, increased cropping setbacks, corridor protection, and replacement of the undersized culvert crossing of Pond Hill Road with a wider span structure at the next opportunity.

Reach/ Seg	**T02.08-s1.01-E Pond Hill Brook**
Location	Downstream of Hadeka Stone, upstream of South Street crossing.
Rationale	Restore floodplain access and remove abandoned railroad spur grade which serves as berm to LB and constrains full meander expression. Goal: accelerate return to equilibrium, thereby increasing flow and sediment load (and nutrient) attenuation.
Description	Evaluate the feasibility of active geomorphic measures (e.g., berm removal and lowering elevation of near-bank area).
Priority	**Moderate.** Section of berm is short (100 to 200 ft) and segment is actively building new floodplain at lower elevation near downstream end, assisted by LWD recruitment, so restoration may be achieved passively. On the other hand, berm removal could remove a significant source of sediment to downstream reaches, as the channel is actively eroding and undermining the former railroad grade.
Other Considerations	Accompanied by corridor protection (see Section 6.1).

6.6 Removing / Replacing Structures

Human-placed structures which span and “constrain the vertical and lateral movement of the channel and/or result in a significant constriction of the floodplain” can be considered for removal or replacement to support a return toward dynamic equilibrium of the channel.

6.6.1 Dams

Eleven dams are located on Castleton River watershed reaches assessed to date.

Table 15. Dams Located on Reaches Assessed to date in the Castleton River Watershed

List No.	Tributary	Reach / Segment	Town	Dam Name	Status
1	Castleton main stem	T02.09-B	Castleton	Unknown	Not Used
2		T02.03	Fair Haven	Water Street Dam	Not Used
3		T02.03	Fair Haven	Structural Slate Dam	Not Used (breached)
4		T02.03	Fair Haven	Shirt Factory Dam	Not Used
5	Gully Brook	T02.11-s1.04-A	Poultney	Unknown	Not Used, Breached
6	North Bretton Brook	T02.09-s1.02-A	Castleton	Pelletier Dam	Not Used (Recreation)
7	Pond Hill Brook	T02.08-s1.03	Castleton	Unnamed, w/ reservoir	Not Used (Breached)
8		T02.08-s1.03	Castleton	Unnamed (low-head, historic)	Not Used
9		T02.08-s1.02	Castleton	Near Hadeka Stone	Not Used
10		T02.08-s1.01-D	Castleton	Castleton State College	Recreation
11		T02.08-s1.01-B	Castleton	Unnamed, low-head dam	Not Used

Some, but not all of the dams are identified on the Vermont Dam Inventory (VCGI, 2005) of the Dam Safety Section. Some, but not all of the dams have been evaluated to classify the potential hazard they pose to public safety in the event of a sudden breach.

To varying degrees, these dams are have interrupted the natural flow and sediment transport functions of the Castleton River main stem and tributaries. Dam numbers 3, 5, 7, 8, and 11 in Table 15 above are either breached or are small enough in size and/or low enough in profile that sediment (and water) impounding effects in the river channel are considered minor under the current configuration.

The remaining dams listed in Table 15 are likely to have a significant volume of sediment in their upstream impoundments. Depending on the unique history of corridor and watershed land uses in vicinity and upstream of each dam, impounded sediments may be associated with a legacy of nutrients, and potentially toxic or hazardous constituents.

Each of these dams serves as a vertical grade control; the local base level of the river channel is tied to the impoundment height of the structure. If a catastrophic flood event were to breach a dam, or if a dam were to be removed, the flow and sediment regime of the impounded channel would be altered. Depending on the construction of the dam, the topographic setting (e.g., channel gradient, valley confinement) and nature of the nearby stream bed and banks (e.g., bedrock versus erodible sediments), channel alterations may be minor in degree and extent, or far-reaching. Dam removal may be beneficial in restoring channel equilibrium and the natural flow and sediment regime. Instream and riparian habitats (e.g., fish passage) may be improved by the removal of dams that have historically limited the migration of aquatic organisms. On the other hand, wetland conditions and associated habitats that may have developed upstream of a dam may be compromised as that dam is removed and upstream river stages (and groundwater levels) are reduced. Impounded sediments that are released upon dam breach or removal could occlude fish habitats or lead to increased sedimentation, widening or planform adjustments in downstream reaches. The change in base level occurring upon dam breach or removal could lead to upstream incision and streambank erosion.

Dams that are currently not serving a useful purpose should be considered for removal to restore the natural flow and sediment transport functions of the channels that they now impound and for the potential benefits to instream and riparian habitats. However, comprehensive study should precede any potential dam removal to consider the potential impacts on river stability and habitats (as well as other relevant environmental, flooding hazard, cultural, historical, and archaeological consequences).

6.6.2 Bridges and Culverts

Several bridge and culvert crossings were encountered during this study. Their status as either a bankfull or flood-prone-width constrictor is addressed under Step 4.8 of the Phase 2 assessment (see Appendix B). Additional bridge and culvert assessment data are provided in Appendices D and E. These data can be utilized by landowners, town road crews and regional planning commissions when establishing schedules and budgets for crossing rehabilitation and replacement.

In general, the geomorphic context should be considered when designing new and rehabilitated structures.

- New or replacement bridges should ideally have openings which pass the bankfull width to flood-prone-width without constriction.

- Bridges and culverts should be designed to cross the river without creating channel approaches at an angle to structures. Such sharp angles can lead to undermining of fill materials and structural components.

- The historic channel migration pattern of the river should be considered when installing new or replacement crossing structures, and when constructing new roads, driveways, and buildings.

- Planned build-out for watershed communities and resultant channel enlargement (from increased percent imperviousness) should be considered when designing new or replacement bridges and crossing structures.

- Divert road ditch runoff to side-slopes where energy can be dissipated, stormwaters can infiltrate, and sediment / detritus loads can be deposited on the land and not directly to streams.

6.6.3 Old Abutments

The old abutments for a former alignment of Route 4A are present near the upstream end of Castleton River reach T02.10. The old abutments are contributing to channel avulsions. Mass failures along LB just downstream of the abutments have the potential to impact Route 4A; erosion and inundation along RB have potential to impact driveway access to Dumas property. Streambank stabilization should only occur in combination with other upstream, reach-wide opportunities to enhance sediment attenuation and improve woody riparian buffers. (High Priority. See separate CPP for further project development details).

6.7 Restoring Incised Reaches

Further study could evaluate the feasibility of various active geomorphic and engineering techniques to restore incising reaches which could accelerate a return to dynamic equilibrium of the channel, and reduce impacts to downstream segments, by creating more opportunities for sediment and flow attenuation along the corridor. The benefits of such active geomorphic measures would need to be evaluated in light of the costs, risks and potential short-term consequences in terms of sediment and nutrient mobilization.

Based on the Phase 2 geomorphic assessments in the Castleton River watershed to date, five possible segments have been identified for potential restoration of incised conditions (see Table 16 below). Further, project development activities would be required (and possibly more detailed geomorphic assessments [Phase 3]) to evaluate:

- The history of incision and causal factors (e.g., increased peak flows, gravel extraction, channel manipulations, other);
- The feasibility of controlling the stressor(s) that resulted in the incision;
- The feasibility of restoring equilibrium channel dimensions, slope and profile;
- The feasibility of removing corridor constraints to floodplain access and full meander expression;
- Landowner willingness to participate in a potential restoration project.

Table 16. Potential Restoration of Incised Reaches
In the Castleton River watershed reaches assessed to date.

Reach/ Seg	**T02.11-s1.04-B Gully Brook**
Location	West of Birdseye Road, near Traverse Park.
Rationale	Restore floodplain access and remove constraints to full meander expression for increased flow and sediment load attenuation.
Description	Evaluate the feasibility of active geomorphic measures (e.g., lowering elevation of near-bank areas along LB) and/or adding structures or Large Woody Debris to locally aggrade the channel.
Priority	**Low.** Restoration segment is short; ample floodplain access and sediment/flow attenuation opportunities are present in upstream and downstream segments. Thus, cost/benefit ratio of active measures to restore floodplain access would be relatively high. Segment is actively building new floodplain at lower elevation near downstream end, assisted by active LWD recruitment, so restoration may be achieved passively.
Other Considerations	Accompanied by corridor protection (see Section 6.1) and buffer enhancements & road maintenance practices that reduce sedimentation and stormwater runoff to the Brook.

Reach/ Seg	**T02.09-s1.04-E North Bretton Brook**
Location	West of Hubbardton Road, alongside LB crop fields.
Rationale	Restore floodplain access and remove constraints to full meander expression for increased flow and sediment load attenuation.
Description	Evaluate the feasibility of active geomorphic measures (e.g., lowering elevation of near-bank areas) and/or adding structures or Large Woody Debris to locally aggrade the channel.
Priority	**Low.** Restoration segment is short; ample floodplain access and sediment/flow attenuation opportunities are present downstream in segment T02.09-s1.04-C. Thus, cost/benefit ratio of active measures to restore floodplain access in T02.09-s1.04-E would be relatively high. Segment is

	actively building new floodplain at lower elevation, so restoration may be achieved passively. Ability to discontinue downstream channel management in Segment D (that is inferred to have contributed to incision in Segment E) is undetermined at this time.
Other Considerations	Accompanied by corridor protection (see Section 6.1) and buffer maintenance for both this segment and downstream Segment D.

Reach/ Seg	**T02.09-s1.01-B & T02.09-s1.01-A No. Bretton Bk**
Location	East of Hubbardton Road, alongside LB old road grade (unused) and RB crop fields.
Rationale	Potentially restore floodplain access and remove constraints to full meander expression for increased flow and sediment load attenuation in a location of notable reduction in valley gradient.
Description	Evaluate the feasibility of active geomorphic measures (e.g., lowering elevation of near-bank areas) and/or adding structures or Large Woody Debris to locally aggrade the channel. This would need to be considered alongside longterm management objectives for (1) the upstream Pelletier Dam which presently impounds the North Bretton Brook, attenuating flows and trapping sediment; and (2) the downstream low-head dam at the North Bretton Brook confluence with Castleton River main stem.
Priority	**Low.** The cost/benefit ratio of active measures to restore floodplain access in this segment would be quite high and significantly complicated by management of upstream and downstream dams. Feasibility assessment would require comprehensive hydraulic and hydrologic evaluation of various scenarios involving alternative management options for these dams, in conjunction with restoration alternatives for Segments B and A. Potential flooding and sediment deposition impacts to downstream semi-permanent infrastructure including the Route 4 highway, Fort Warren mobile home park, and the railroad.
Other Considerations	Accompanied by corridor protection (see Section 6.1) and buffer maintenance.

Reach/ Seg	**T02.08-s1.05-F Pond Hill Brook**
Location	West of Pond Hill Ranch Road, alongside RB hay field.
Rationale	Restore floodplain access and remove constraints to full meander expression for increased flow and sediment load attenuation.
Description	Evaluate the feasibility of active geomorphic measures (e.g., lowering elevation of near-bank areas) and/or adding structures or Large Woody Debris to locally aggrade the channel.
Priority	**Low.** Restoration segment is short (300 ft); channel is very small and probably ephemeral. Cost/benefit ratio of active measures to restore floodplain access would be relatively high. Ample floodplain access and sediment/flow attenuation opportunities are present in downstream segments.
Other Considerations	Accompanied by corridor protection (see Section 6.1), buffer establishment (RB) and increased agricultural field setbacks.

Reach/ Seg	**T02.08-s1.05-D Pond Hill Brook**
Location	West of Pond Hill Ranch Road, through pasture with direct livestock access.
Rationale	Restore floodplain access and remove constraints to full meander expression for increased flow and sediment load (and nutrient) attenuation.

Description	Evaluate the feasibility of active geomorphic measures (e.g., lowering elevation of near-bank areas along LB) and/or adding structures or Large Woody Debris to locally aggrade the channel.
Priority	**Low.** Restoration segment is short; thus, cost/benefit ratio of active measures to restore floodplain access would be relatively high. Segment is actively building new floodplain at lower elevation near downstream end, assisted by active LWD recruitment, so restoration may be achieved passively.
Other Considerations	Passive restoration could be accelerated by livestock exclusion, and buffer establishment. Should also consider restoration of contiguous wetland near downstream end.

6.8 Restoring Aggraded Reaches

Further study could evaluate the feasibility of various active geomorphic and engineering techniques to restore aggraded reaches which could accelerate a return to dynamic equilibrium of the channel, by restoring equilibrium of sediment transport processes. The benefits of such active geomorphic measures would need to be evaluated in light of the costs, risks and potential short-term consequences in terms of sediment and nutrient mobilization. No substantially aggrading reaches were identified for active restoration during this study.

7.0 RECOMMENDATIONS

7.1 Corridor Planning Projects

In addition to corridor planning projects that are ongoing in reaches T02.09 through T02.12, corridor planning projects should be undertaken in the following locations to identify landowner-approved restoration and conservation projects that will protect the river corridor and generally support the restoration or preservation of dynamic equilibrium. Public and private benefits associated with dynamic equilibrium of the river include reduced fluvial erosion hazards, and improved water quality and instream and riparian habitats.

Recommended Corridor Planning Projects, Castleton River Watershed

Tributary	Reach / Segment	Town
Pond Hill Brook	T02.08-s1.05 – s1.01	Poultney, Castleton

Phase 2 geomorphic assessment data can be used to define a Fluvial Erosion Hazard corridor overlay district for consideration in town zoning regulations. Currently, funding and technical resources are available to the watershed towns for such planning processes through the Governor’s Clean and Clear Action program.

7.2 Project Development / Implementation

With the appropriate local, regional, state and federal partners, the individual projects outlined in Section 6.0 should be implemented, pending available funding. In addition to the financial and technical resources which may be available from the relevant partner organizations, River Corridor Grant funds available from the VTDEC Water Quality Division are an important source of funding for high-priority projects.

7.3 Buffer Restoration

Buffer plantings should be implemented in the watershed, with landowner approval, to support dynamic equilibrium conditions, reduce erosion, and improve water quality (including thermal) and riparian habitats (see Section 6.2 for locations). Technical and financial resources are currently available from various regional, state and federal agencies for buffer plantings. In addition to the agricultural resource agencies of and programs listed under Section 7.4 for lands in agricultural use, the following agencies / programs can provide resources to landowners and towns for buffer plantings.

- Vermont Department of Environmental Conservation (Vermont Watershed Grant Program, Nonpoint Source Management Grant [Section 319] Program, River Corridor Grant Program)
- USDA Natural Resources Conservation Service (Wildlife Habitat Incentives Program)
- US Fish & Wildlife (Partners Program)

7.4 Water Quality

Restoration and preservation of geomorphic equilibrium in the Castleton River and its tributaries will contribute to water quality improvements and reduced sediment loading in the long term. In the short term, resources in this watershed can be directed toward preventing sediments and nutrients from entering the tributaries and main stem of the Castleton River at their source. This can be accomplished on multiple fronts:

1. Address increased flows to the Castleton River from drainage ditches, erosional gullies, and stormwater runoff.

   a. In the residential, commercial and municipal arenas, stormwater flows can be managed through compliance with state regulations. The towns of Castleton, Fair Haven, Poultney, and Ira can consider local ordinances to provide more stringent controls on stormwater runoff and which could apply to smaller developments and road / driveway installations that may not be subject to state stormwater regulations.

   b. Road maintenance practices to mitigate for stormwater and sediment runoff to the Castleton River and tributaries may include: stabilization of road surfaces (different gravel materials), improvement of roadside ditches (excavation, stone lining and/or seeding and mulching), alternative grading practices (turnouts, check-basins); re-orientation of culvert crossings; protection of culvert headers; and gully stabilization. Technical and financial resources are available to the towns through the Better Back Roads program (Northern Vermont Resource Conservation and Development Council) as well as the VT Department of Transportation.

   c. In agricultural settings, increased flows from drainage tiles, ditches and erosional gullies can be addressed through design and retrofitting of tile networks to provide for energy dissipation at tile outlets; gully stabilization; and consideration of crop rotation or alternative farming practices that reduce the need for drainage tiles. Considerable technical and financial resources are available to farmers to implement these practices (see below).

2. Exclude livestock from direct access to stream channels (see Section 6.2). Livestock exclusion (fencing) can be accompanied by provisions for alternative water sources and installation of stabilized livestock crossings. Technical and financial resources are available to farmers to implement these practices (see below).

3. Implement changes in cropping practices to reduce direct runoff of fine sediments (and nutrients) to drainage ditches, surface swales, and the Castleton River and tributary channels. Possible measures include crop rotation, filter strips, grass buffers, cover cropping, interseeding, and no-till options in the fall of the year. At a minimum, improved compliance with current agricultural regulations, including Accepted Agricultural Practices (AAPs), Large Farm Operation (LFO) rules, and Medium Farm Operations (MFO) rules, will begin to address reduction in sediment and nutrient mobilization from agricultural sources.

   Substantial technical and financial resources are currently available to farmers from various regional, state and federal agencies to implement the above changes in farming practices. Resource agencies and programs include, but are not necessarily limited to:

   - Vermont Agency of Agriculture
     - Conservation Reserve Enhancement Program
     - Best Management Practices cost-share program
     - Integrated Crop Management cost-share program
     - Nutrient Management Plan incentive grants

   - Vermont Natural Resources Conservation Districts
     - Agricultural Resource Specialists

   - USDA Natural Resources Conservation Service
     - Agricultural Management Assistance
     - Conservation Reserve Program
     - Environmental Quality Incentives Program

7.5 Dam Evaluations

The Dam Safety & Hydrology Section of the VT Agency of Natural Resources, Department of Environmental Conservation should be notified of the existence and location of the dams identified during this study, so that those dams which are not currently in the inventory can be inspected and a hazard rating assigned (where appropriate). A Dam and Impoundment Assessment should be completed per VTANR SGA protocols. The owner of each dam should be researched, where it is unknown. (Note: efforts are currently underway to address this recommendation under a separate scope of work by the PMNRCD).

Dams that are currently not serving a useful purpose should be considered for removal to restore the natural flow and sediment transport functions of the channels that they now impound and for the associated benefits to instream and riparian habitats.

Dam removal options should carefully consider the:

- Impacts to flow and sediment regimes upstream and downstream and the potential for increased fluvial erosion;
- Impacts to instream and riparian habitats that may affect fish and other aquatic organisms;
- Consequences related to flooding of upstream or downstream communities;
- Consequences of potential groundwater elevation changes upstream and downstream of the structure;
- Potential contaminant legacy of impounded sediments; and
- Impacts to cultural / historical / archaeological resources.

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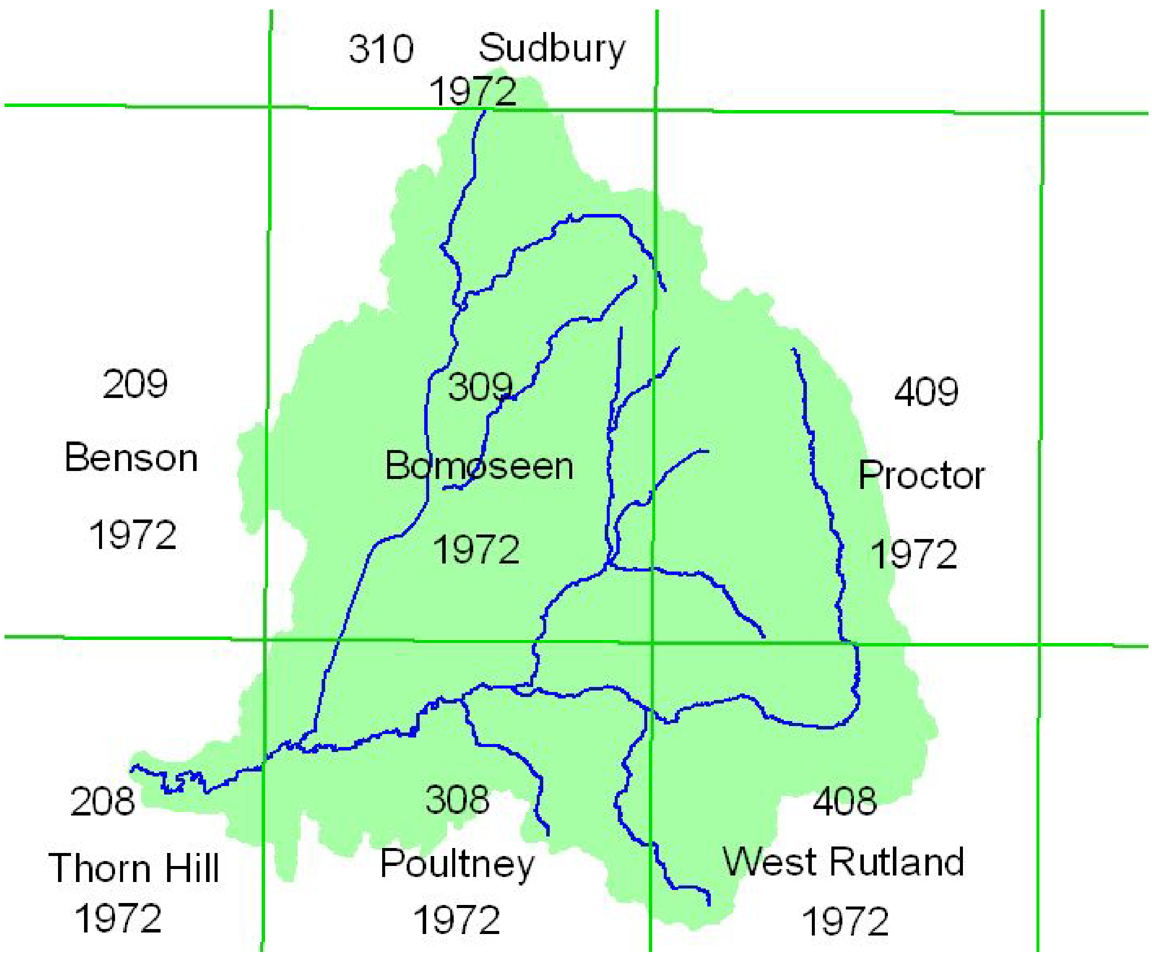
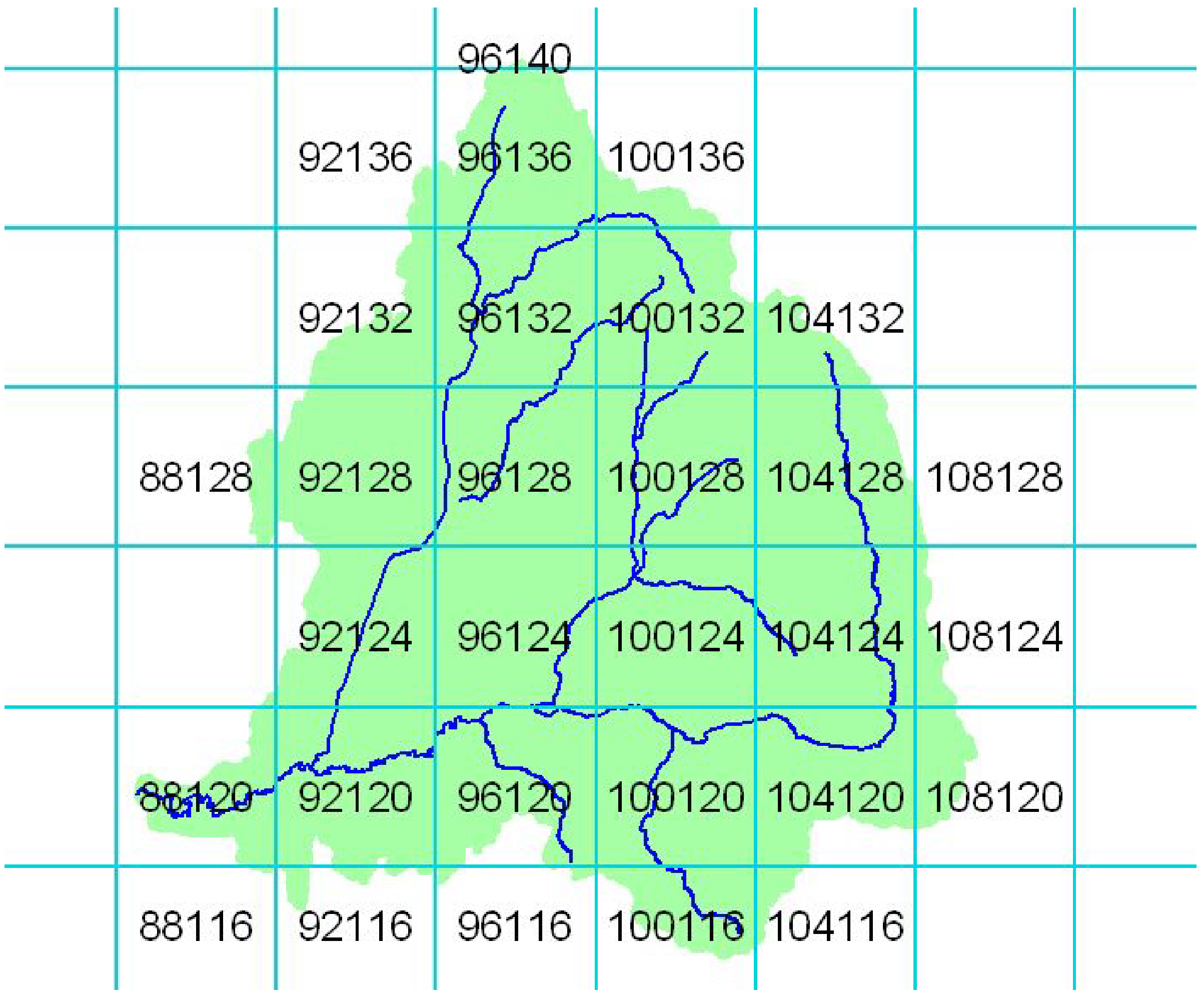
APPENDIX A

Index Maps for Remote Sensing Resources
Castleton River Watershed

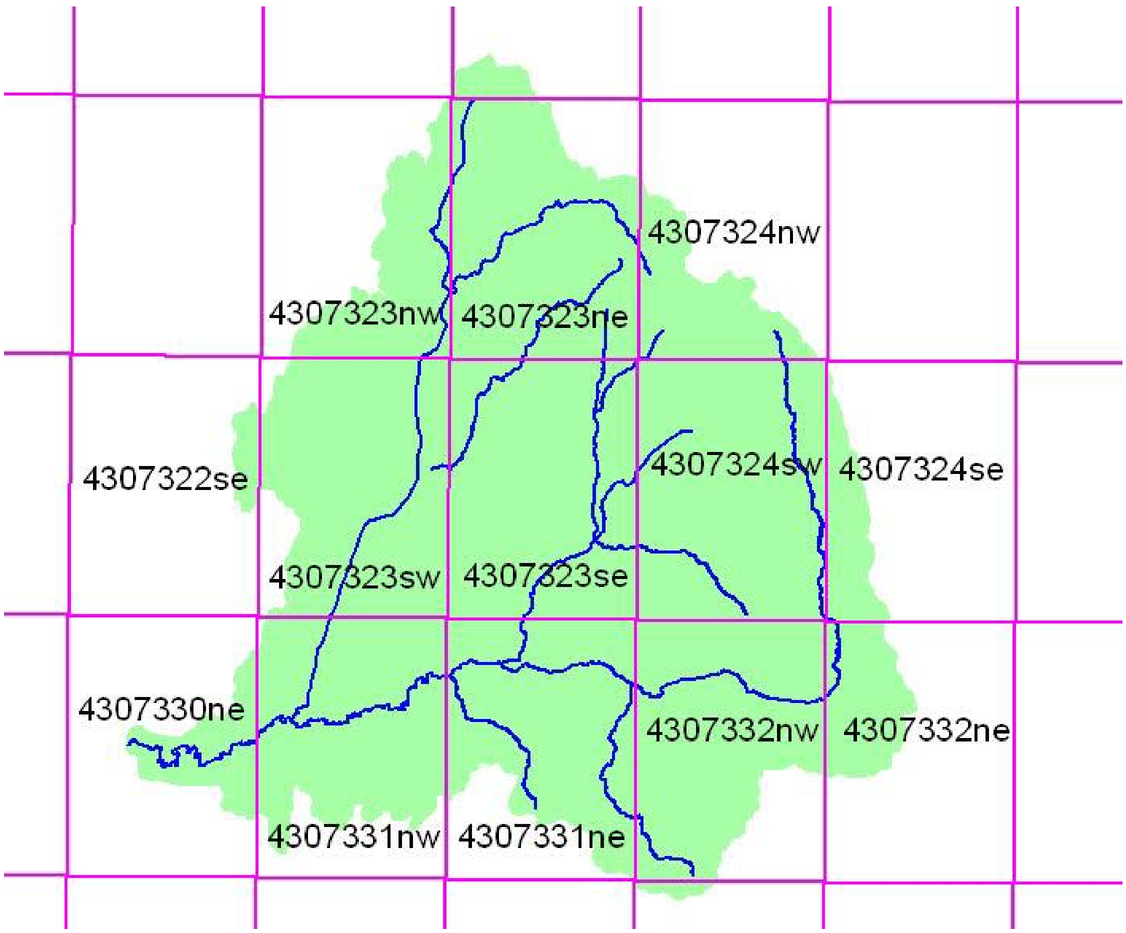
Identification of USGS 7.5-Minute (1:24,000) Topographic Quadrangles (VCGI Tiles)
Castleton River Watershed, Rutland County, VT.



Identification of Vermont Mapping Program (1:5,000) Digital Orthophotograph Quadrangle (VCGI Tiles), Castleton River Watershed, Rutland County, VT.
(all dated 1994)



Identification of 2003 National Aerial Imagery Program Coverage (1:24,000)
Castleton River Watershed, Rutland County, VT.



APPENDIX B

Phase 2 Stream Geomorphic Assessment
Reach Summary Reports

Stream:	**Castleton River**	Reach #	**T02.01**	Segment: **0**	Completion Date: **July 13, 2006**
Organization:	**Poultney/Mettowee NRCD**	Observers:	**KLU, HS**		Rain: **Yes**
Segment Length (ft):	**3,626**	Segment Location:	**From Fair Haven WWTF downstream to confluence with Poultney River.**		

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	**Downstream**	**2.00**	**1.00**	**Yes**	**Yes**

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**260.**	**Yes**	**Yes**	**No**	**Yes**
	Problem	**Deposition Below**			
Bridge	**260.**	**Yes**	**Yes**	**No**	**Yes**
	Problem	**Deposition Below**			

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**13**	**None**	**Yes**
7.2 Channel Aggradation	**18**	**None**	**No**
7.3 Widening Channel	**18**		**No**
7.4 Change in Planform	**13**		**No**
Total Score	**62**		
Geomorphic Rating	**0.775**		

Channel Evolution Model **D**
Channel Evolution Stage **I**
Geomorphic Condition **Good**
Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	**8**
6.2 Pool Substrate	**16**
6.3 Pool Variability	**13**
6.4 Sediment Deposition	**15**
6.5 Channel Flow Status	**16**
6.6 Channel Alteration	**13**
6.7 Channel Sinuosity	**8**
6.8 Bank Stability	**Left: 9 Right: 9**
6.9 Bank Vegetation Protection	**Left: 8 Right: 8**
6.10 Riparian Vegetation Zone Width	**Left: 9 Right: 6**
Total Score	**138**
Habitat Rating	**0.69**

Habitat Stream Condition **Good**

Narrative:
Minor planform adjustment (meander migration) and minor historic incision in this geologically-incised (100s to 1000s years) reach. Silty-clay lacustrine sediments appear to be moderating incision / widening. See report.

Project:	**Castleton River**		**Phase 2 Reach Summary**		April 15, 2008
Stream:	**Castleton River**	Reach #	**T02.02**	Segment: **A**	Completion Date: **July 13, 2006**
Organization:	**Poultney/Mettowee NRCD**	Observers:	**KLU, HS, ES**		Rain: **Yes**
Segment Length (ft):	**5,292**	Segment Location:	**From vicinity of Fair Haven WWTF d/s toward US Route 4.**		

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**18**	**None**	**No**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**8**		**No**
Total Score	**50**		
Geomorphic Rating	**0.625**		

Channel Evolution Model **D**
Channel Evolution Stage **I**
Geomorphic Condition **Fair**
Stream Sensitivity **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	**13**
6.2 Pool Substrate	**13**
6.3 Pool Variability	**11**
6.4 Sediment Deposition	**13**
6.5 Channel Flow Status	**18**
6.6 Channel Alteration	**18**
6.7 Channel Sinuosity	**18**
6.8 Bank Stability	**Left: 4 Right: 5**
6.9 Bank Vegetation Protection	**Left: 6 Right: 7**
6.10 Riparian Vegetation Zone Width	**Left: 9 Right: 9**
Total Score	**144**
Habitat Rating	**0.72**

Habitat Stream Condition **Good**

Narrative:

Active planform adjustments (meander extension and translation). Minor aggradation and widening. Geologically incised reach (100s to 1000s years). See report. Condition on the cusp with "Good".

Stream: **Castleton River** Reach # **T02.02** Segment: **B** Completion Date: **July 13, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS, ES** Rain: **Yes**

Segment Length (ft): **6,938** Segment Location: **From Adams St Xg downstream to Fair Haven WWTF**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	**Downstream**	**1.00**	**0.00**	**No**	**Yes**

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Other	**45.0**	**Yes**	**Yes**	**Yes**	**Yes**

Problem **Scour Below**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**

	Score	STD	Historic
7.1 Channel Degradation	**16**	**None**	**No**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**8**		**No**
Total Score	**48**		
Geomorphic Rating	**0.6**		

Channel Evolution Model **D**

Channel Evolution Stage **I**

Geomorphic Condition **Fair**

Stream Sensitivity **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	**15**
6.2 Pool Substrate	**15**
6.3 Pool Variability	**13**
6.4 Sediment Deposition	**13**
6.5 Channel Flow Status	**18**
6.6 Channel Alteration	**13**
6.7 Channel Sinuosity	**13**
6.8 Bank Stability	**Left: 7 Right: 7**
6.9 Bank Vegetation Protection	**Left: 5 Right: 5**
6.10 Riparian Vegetation Zone Width	**Left: 9 Right: 9**
Total Score	**142**
Habitat Rating	**0.71**

Habitat Stream Condition **Good**

Narrative:

Active planform adjustments (meander extension, translation). Minor aggradation, widening. Geologically incised reach (100s to 1000s years). See report. Increased senstivity rating to C4-like channel in Fair due to c slope and fine sed in bed.

Stream: **Castleton River** Reach # **T02.03** Segment: **0** Completion Date: **August 23, 2006**
Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS, SH** Rain: **Yes**
Segment Length (ft): **1,996** Segment Location: **From Depot Street Xg downstream to Adams Street Xg.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Dam	**Mid-Segment**	**9.00**	**7.00**	**Yes**	**Yes**
Waterfall	**Mid-Segment**	**12.00**	**7.00**	**Yes**	**No**
Dam	**Downstream**	**4.00**	**3.00**	**Yes**	**No**
Waterfall	**Downstream**	**5.00**	**4.00**	**Yes**	**No**
Dam	**Upstream**	**4.00**	**4.00**	**Yes**	**No**
Waterfall	**Upstream**	**14.00**	**12.00**	**Yes**	**No**
Ledge	**Mid-Segment**	**2.00**	**2.00**	**Yes**	**No**

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**64.0**	**Yes**	**Yes**	**No**	**No**
	Problem	**None**			
Other	**5.00**	**Yes**	**Yes**	**Yes**	**Yes**
	Problem	**Scour Below,Alignment**			
Bridge	**50.0**	**Yes**	**Yes**	**No**	**No**
	Problem	**None**			
Bridge	**52.0**	**Yes**	**Yes**	**No**	**No**
	Problem	**None**			
Bridge	**52.0**	**Yes**	**No**	**No**	**No**
	Problem	**None**			

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**

Channel Evolution Model
Channel Evolution Stage
Geomorphic Condition
Stream Sensitivity **Low**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**11**
6.2 Embeddedness	**15**
6.3 Velocity/Depth Patterns	**18**
6.4 Sediment Deposition	**15**
6.5 Channel Flow Status	**13**
6.6 Channel Alteration	**16**
6.7 Frequency of Riffles/Steps	**3**
6.8 Bank Stability	**Left: 9 Right: 9**
6.9 Bank Vegetation Protection	**Left: 2 Right: 2**
6.10 Riparian Vegetation Zone Width	**Left: 1 Right: 1**
Total Score	**115**
Habitat Rating	**0.575**
Habitat Stream Condition	**Fair**

Narrative:

None (minor, localized aggradation, widening, planform adjustments). Extensive bedrock vertical and lateral controls.

Stream: **Castleton River** Reach # **T02.04** Segment: **0** Completion Date: **September 1,**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, ES, SH, SL** Rain: **Yes**

Segment Length (ft): **3,389** Segment Location: **From the vicinity of the Clarendon-Pittsford Railroad crossing downstream to the River**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**79.0**	**Yes**	**Yes**	**No**	**Yes**

Problem **Scour Above,Alignment**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**16**	**None**	**No**
7.2 Channel Aggradation	**16**	**None**	**No**
7.3 Widening Channel	**18**		**No**
7.4 Change in Planform	**16**		**No**
Total Score	**66**		
Geomorphic Rating	**0.825**		

Channel Evolution Model **F**

Channel Evolution Stage **I**

Geomorphic Condition **Good**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	**18**
6.2 Pool Substrate	**18**
6.3 Pool Variability	**13**
6.4 Sediment Deposition	**18**
6.5 Channel Flow Status	**18**
6.6 Channel Alteration	**13**
6.7 Channel Sinuosity	**13**
6.8 Bank Stability	**Left: 6 Right: 7**
6.9 Bank Vegetation Protection	**Left: 6 Right: 6**
6.10 Riparian Vegetation Zone Width	**Left: 9 Right: 9**
Total Score	**154**
Habitat Rating	**0.77**

Habitat Stream Condition **Good**

Narrative:

Negligible channel adjustments. Reach is dominated by wetlands. Dams(3) in immediately downstream reach likely influencing flow and sediment transport in this reach.

Stream: **Castleton River** Reach # **T02.05** Segment: **0** Completion Date: **September 1,**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, ES, SH, SL** Rain: **Yes**

Segment Length (ft): **7,849** Segment Location: **From the confluence of Lake Bomoseen outlet channel downstream nearly to the**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**18.0**	**Yes**	**Yes**	**Yes**	**Yes**
Problem **None**					
Old	**18.0**	**Yes**	**Yes**	**Yes**	**Yes**
Problem **Scour Below**					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**16**	**None**	**No**
7.2 Channel Aggradation	**16**	**None**	**No**
7.3 Widening Channel	**18**		**No**
7.4 Change in Planform	**12**		**No**
Total Score	**62**		
Geomorphic Rating	**0.775**		

Channel Evolution Model **F**

Channel Evolution Stage **I**

Geomorphic Condition **Good**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	**18**
6.2 Pool Substrate	**18**
6.3 Pool Variability	**13**
6.4 Sediment Deposition	**18**
6.5 Channel Flow Status	**18**
6.6 Channel Alteration	**13**
6.7 Channel Sinuosity	**13**
6.8 Bank Stability	**Left: 6 Right: 6**
6.9 Bank Vegetation Protection	**Left: 7 Right: 6**
6.10 Riparian Vegetation Zone Width	**Left: 10 Right: 6**
Total Score	**152**
Habitat Rating	**0.76**

Habitat Stream Condition **Good**

Narrative:

Minor planform change (e.g., one recent, and one pending neck cutoff) at active debris jam sites. Also, historic straightening likely along railroad in one discrete section.

Stream: **Castleton River** Reach # **T02.06** Segment: **0** Completion Date: **September 1,**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, ES, SH, SL** Rain: **Yes**

Segment Length (ft): **5,302** Segment Location: **From wetlands upstream of the Blissville Road crossing downstream to the confluence**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**92.0**	**Yes**	**No**	**No**	**Yes**
Problem **Scour Below**					
Bridge	**24.0**	**Yes**	**Yes**	**Yes**	**Yes**
Problem **None**					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**17**	**None**	**No**
7.2 Channel Aggradation	**17**	**None**	**No**
7.3 Widening Channel	**14**		**No**
7.4 Change in Planform	**14**		**Yes**
Total Score	**62**		
Geomorphic Rating	**0.775**		

Channel Evolution Model **F**

Channel Evolution Stage **I**

Geomorphic Condition **Good**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**18**
6.2 Embeddedness	**13**
6.3 Velocity/Depth Patterns	**11**
6.4 Sediment Deposition	**13**
6.5 Channel Flow Status	**18**
6.6 Channel Alteration	**13**
6.7 Frequency of Riffles/Steps	**13**
6.8 Bank Stability	**Left: 4 Right: 4**
6.9 Bank Vegetation Protection	**Left: 6 Right: 6**
6.10 Riparian Vegetation Zone Width	**Left: 9 Right: 5**
Total Score	**133**
Habitat Rating	**0.665**

Habitat Stream Condition **Good**

Narrative:

No significant adjustment processes active. Slight planform adjustment (one neck cutoff, meander migration) is evident, along with slight widening. If 1972 topo is accurate, channel has a different planform in 1994, 2003, and 2005 than in 1972.

Stream: **Castleton River** Reach # **T02.07** Segment: **0** Completion Date:

Organization: **Poultney/Mettowee NRCD** Observers: **Kari Dolan, RMP** Rain:

Segment Length (ft): **0** Segment Location:

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Narrative:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Good**

Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Stream: **Castleton River** Reach # **T02.08** Segment: **0** Completion Date:

Organization: **Poultney/Mettowee NRCD** Observers: **Kari Dolan, RMP** Rain:

Segment Length (ft): **0** Segment Location:

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Narrative:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Good**

Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Stream: **Pond Hill Brook** Reach # **T02.08-s1.01** Segment: **A** Completion Date: **July 31, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Rain: **Yes**

Segment Length (ft): **513** Segment Location: **Downstream segment of the reach, from Route 4A (Main Street) Xg to confluence with**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**11.0**	**Yes**	**Yes**	**Yes**	**Yes**
Problem	**Scour Above,Alignment**				
Culvert	**6.00**	**Yes**	**No**	**Yes**	**Yes**
Problem	**Deposition Above,Scour Above**				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**11**	**None**	**Yes**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**13**		**Yes**
Total Score	**50**		
Geomorphic Rating	**0.625**		

Channel Evolution Model **D**
Channel Evolution Stage **IIb**
Geomorphic Condition **Fair**
Stream Sensitivity **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**8**
6.2 Embeddedness	**13**
6.3 Velocity/Depth Patterns	**8**
6.4 Sediment Deposition	**11**
6.5 Channel Flow Status	**15**
6.6 Channel Alteration	**3**
6.7 Frequency of Riffles/Steps	**6**
6.8 Bank Stability	**Left: 9 Right: 9**
6.9 Bank Vegetation Protection	**Left: 7 Right: 4**
6.10 Riparian Vegetation Zone Width	**Left: 1 Right: 1**
Total Score	**95**
Habitat Rating	**0.475**

Habitat Stream Condition **Fair**

Narrative:

Channel has degraded some due to channelization, RB road encroachment, and LB berm. Widening or PF shift has been constrained by maintainance of armoring and RB road. Incision appears moderated by resistant bed materials. Low width/depth channel.

Stream: **Pond Hill Brook** Reach # **T02.08-s1.01** Segment: **B** Completion Date: **July 31, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Rain: **Yes**

Segment Length (ft): **927** Segment Location: **Segment northwest of Castleton State College campus downstream of bedrock gorge,**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Dam	**Upstream**	**1.00**	**1.00**	**Yes**	**Yes**

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Narrative:

Minor planform adjustment.

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**18**	**None**	**No**
7.2 Channel Aggradation	**16**	**None**	**No**
7.3 Widening Channel	**18**		**No**
7.4 Change in Planform	**13**		**No**
Total Score	**65**		
Geomorphic Rating	**0.8125**		

Channel Evolution Model **D**

Channel Evolution Stage **I**

Geomorphic Condition **Good**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**13**
6.2 Embeddedness	**10**
6.3 Velocity/Depth Patterns	**11**
6.4 Sediment Deposition	**11**
6.5 Channel Flow Status	**13**
6.6 Channel Alteration	**15**
6.7 Frequency of Riffles/Steps	**13**
6.8 Bank Stability	**Left: 7 Right: 6**
6.9 Bank Vegetation Protection	**Left: 7 Right: 7**
6.10 Riparian Vegetation Zone Width	**Left: 6 Right: 3**
Total Score	**122**
Habitat Rating	**0.61**

Habitat Stream Condition **Fair**

Project: **Castleton River** | **Phase 2 Reach Summary** | | April 15, 2008

Stream: **Pond Hill Brook** Reach # **T02.08-s1.01** Segment: **C** Completion Date: **July 31, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Rain: **Yes**

Segment Length (ft): **677** Segment Location: **Bedrock gorge west of Castleton State College campus.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**30.0**	**No**	**Yes**	**No**	**No**

Problem **None**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition

Stream Sensitivity **Low**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Segment is bedrock gorge. No RGA completed.

Project:	**Castleton River**	**Phase 2 Reach Summary**	April 15, 2008
Stream:	**Pond Hill Brook**	Reach # **T02.08-s1.01**	Segment: **D** Completion Date: **July 31, 2006**
Organization:	**Poultney/Mettowee NRCD**	Observers: **KLU, HS**	Rain: **Yes**
Segment Length (ft):	**1,622**	Segment Location: **From railroad crossing, south and west of athletic fields, through Castleton State Dam**	

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken
Ledge	**Mid-Segment**	**1.00**	**0.00**	**No**	**Yes**
Dam	**Downstream**	**10.00**	**2.00**	**Yes**	**Yes**

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Culvert	**4.00**	**Yes**	**Yes**	**Yes**	**Yes**

Problem **Scour Above,Alignment**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**16**	**None**	**No**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**16**		**No**
7.4 Change in Planform	**8**		**Yes**
Total Score	**53**		
Geomorphic Rating	**0.6625**		

Channel Evolution Model **D**
Channel Evolution Stage **IIc**
Geomorphic Condition **Good**
Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**8**
6.2 Embeddedness	**13**
6.3 Velocity/Depth Patterns	**8**
6.4 Sediment Deposition	**11**
6.5 Channel Flow Status	**13**
6.6 Channel Alteration	**8**
6.7 Frequency of Riffles/Steps	**8**
6.8 Bank Stability	**Left: 8 Right: 8**
6.9 Bank Vegetation Protection	**Left: 8 Right: 8**
6.10 Riparian Vegetation Zone Width	**Left: 9 Right: 7**
Total Score	**117**
Habitat Rating	**0.585**

Habitat Stream Condition **Fair**

Narrative:

Moderate planform adjustment (meander extension and translation, flood chutes) as channel shifts laterally in response to historic channelization. Incision may be moderated by shallow bedrock. Widening may be moderated by forested buffers.

Stream: **Pond Hill Brook** Reach # **T02.08-s1.01** Segment: **E** Completion Date: **July 31, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Rain: **Yes**

Segment Length (ft): **1,711** Segment Location: **Upstream end of reach to railroad Xg.**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Other	**11.5**	**Yes**	**Yes**	**Yes**	**Yes**

Problem **Deposition Above,Deposition Below**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**18**	**None**	**No**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**16**		**No**
7.4 Change in Planform	**10**		**No**
Total Score	**55**		
Geomorphic Rating	**0.6875**		

Channel Evolution Model **D**

Channel Evolution Stage **V**

Geomorphic Condition **Good**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**8**
6.2 Embeddedness	**10**
6.3 Velocity/Depth Patterns	**8**
6.4 Sediment Deposition	**8**
6.5 Channel Flow Status	**11**
6.6 Channel Alteration	**5**
6.7 Frequency of Riffles/Steps	**13**
6.8 Bank Stability	**Left: 7 Right: 9**
6.9 Bank Vegetation Protection	**Left: 7 Right: 7**
6.10 Riparian Vegetation Zone Width	**Left: 8 Right: 9**
Total Score	**110**
Habitat Rating	**0.55**

Habitat Stream Condition **Fair**

Narrative:

Moderate planform adjustments (meander extension, flood chutes, bifurcations) and minor aggradation in response to minor to moderate upstream sediment loading and historic channelization.

Stream: **Pond Hill Brook** Reach # **T02.08-s1.02** Segment: **0** Completion Date: **July 31, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Rain: **Yes**

Segment Length (ft): **2,537** Segment Location: **Reach along the south side of Staso Road between slate quarry on left bank and**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Waterfall	**Upstream**	**5.00**	**4.00**	**Yes**	**Yes**
Dam	**Upstream**	**3.00**	**3.00**	**Yes**	**Yes**
Ledge	**Downstream**	**1.00**	**0.00**	**No**	**Yes**

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Other	**16.0**	**Yes**	**Yes**	**Yes**	**Yes**
Problem	**Deposition Above,Scour Below**				
Culvert	**7.40**	**Yes**	**Yes**	**Yes**	**Yes**
Problem	**Deposition Above,Scour Below**				
Old	**7.00**	**Yes**	**Yes**	**Yes**	**Yes**
Problem	**Scour Below,Alignment**				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**5**	**C to F**	**Yes**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**11**		**No**
7.4 Change in Planform	**13**		**No**
Total Score	**42**		
Geomorphic Rating	**0.525**		

Channel Evolution Model **F**

Channel Evolution Stage **II**

Geomorphic Condition **Fair**

Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**11**
6.2 Embeddedness	**13**
6.3 Velocity/Depth Patterns	**13**
6.4 Sediment Deposition	**11**
6.5 Channel Flow Status	**16**
6.6 Channel Alteration	**3**
6.7 Frequency of Riffles/Steps	**8**
6.8 Bank Stability	**Left: 8 Right: 7**
6.9 Bank Vegetation Protection	**Left: 2 Right: 7**
6.10 Riparian Vegetation Zone Width	**Left: 3 Right: 3**
Total Score	**105**
Habitat Rating	**0.525**

Habitat Stream Condition **Fair**

Narrative:

Minor widening in response to hist deg. Channel adjustments moderated by few bedrock exposures, armored streambed and banks. Remains senstive to future adjustments during threshold-exceeding flows, given high entrenchment .

Stream: **Pond Hill Brook** Reach # **T02.08-s1.03** Segment: **0** Completion Date: **July 26, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Rain: **Yes**

Segment Length (ft): **1,256** Segment Location: **Quarter mile of steep, forested bedrock channel upstream of Hadeka Stone**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Dam	**Upstream**	**12.00**	**3.00**	**Yes**	**Yes**
Waterfall	**Upstream**	**5.00**	**4.00**	**Yes**	**Yes**
Dam	**Mid-Segment**	**2.00**	**2.00**	**Yes**	**Yes**
Waterfall	**Downstream**	**15.00**	**15.00**	**Yes**	**Yes**
Waterfall	**Downstream**	**6.00**	**4.00**	**Yes**	**Yes**

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Narrative:

None. Bedrock-controlled channel.

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**

	Score	STD	Historic
7.1 Channel Degradation	**18**	**None**	**No**
7.2 Channel Aggradation	**16**	**None**	**No**
7.3 Widening Channel	**18**		**No**
7.4 Change in Planform	**18**		**No**
Total Score	**70**		
Geomorphic Rating	**0.875**		

Channel Evolution Model **D**

Channel Evolution Stage **I**

Geomorphic Condition **Referenc**

Stream Sensitivity **Very Low**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**15**
6.2 Embeddedness	**18**
6.3 Velocity/Depth Patterns	**18**
6.4 Sediment Deposition	**18**
6.5 Channel Flow Status	**13**
6.6 Channel Alteration	**18**
6.7 Frequency of Riffles/Steps	**18**
6.8 Bank Stability	**Left: 10 Right: 10**
6.9 Bank Vegetation Protection	**Left: 10 Right: 10**
6.10 Riparian Vegetation Zone Width	**Left: 10 Right: 10**
Total Score	**178**
Habitat Rating	**0.89**

Habitat Stream Condition **Referen**

Stream: **Pond Hill Brook** Reach # **T02.08-s1.04** Segment: **A** Completion Date: **July 26, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Rain: **Yes**

Segment Length (ft): **384** Segment Location: **Upstream end of bedrock gorge west of Pond Hill Road.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Waterfall	**Upstream**	**3.00**	**3.00**	**Yes**	**Yes**
Ledge	**Upstream**	**1.00**	**0.00**	**No**	**Yes**
Waterfall	**Downstream**	**15.00**	**14.00**	**Yes**	**Yes**

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Narrative:

Bedrock in channel bed and banks. Negligible adjustments.

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition

Stream Sensitivity **Low**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Stream: **Pond Hill Brook** Reach # **T02.08-s1.04** Segment: **B** Completion Date: **July 26, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Rain: **Yes**

Segment Length (ft): **1,405** Segment Location: **Section of Pond Hill Brook which crosses Pond Hill Road at farm.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	**Downstream**	**1.00**	**0.00**	**Yes**	**Yes**

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Culvert	**5.90**	**Yes**	**Yes**	**Yes**	**Yes**

Problem **Deposition Above,Scour Below**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**5**	**C to F**	**Yes**
7.2 Channel Aggradation	**8**	**None**	**No**
7.3 Widening Channel	**11**		**No**
7.4 Change in Planform	**10**		**No**
Total Score	**34**		
Geomorphic Rating	**0.425**		

Channel Evolution Model **F**
Channel Evolution Stage **IV**
Geomorphic Condition **Fair**
Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**8**
6.2 Embeddedness	**10**
6.3 Velocity/Depth Patterns	**13**
6.4 Sediment Deposition	**10**
6.5 Channel Flow Status	**13**
6.6 Channel Alteration	**8**
6.7 Frequency of Riffles/Steps	**15**
6.8 Bank Stability	**Left: 9 Right: 9**
6.9 Bank Vegetation Protection	**Left: 7 Right: 7**
6.10 Riparian Vegetation Zone Width	**Left: 3 Right: 2**
Total Score	**114**
Habitat Rating	**0.57**

Habitat Stream Condition **Fair**

Narrative:

Historically entrenched due to inferred channelization and berming, resulting in stream type departure from Cb to F. Segment rebuilding an incipient floodplain at a lower elevation through aggradational processes and planform adjustments .

Stream: **Pond Hill Brook** Reach # **T02.08-s1.04** Segment: **C** Completion Date: **July 26, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Rain: **Yes**

Segment Length (ft): **636** Segment Location: **Downstream end of bedrock gorge east of Pond Hill Road.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Waterfall	**Downstream**	**6.00**	**5.00**	**No**	**Yes**
Ledge	**Mid-Segment**	**1.00**	**0.00**	**No**	**Yes**

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition

Stream Sensitivity **Low**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Subreach of steep gradient, narrowly-confined bedrock channel; adjustments minor.

Stream: **Pond Hill Brook** Reach # **T02.08-s1.05** Segment: **A** Completion Date: **July 25, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Rain: **Yes**

Segment Length (ft): **1,687** Segment Location: **Bedrock channel along East side of Pond Hill Road.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	**Upstream**	**1.00**	**0.00**	**No**	**Yes**
Ledge	**Upstream**	**1.00**	**0.00**	**No**	**Yes**
Waterfall	**Mid-Segment**	**3.00**	**3.00**	**Yes**	**Yes**
Waterfall	**Mid-Segment**	**6.00**	**6.00**	**Yes**	**Yes**
Waterfall	**Downstream**	**5.00**	**5.00**	**Yes**	**Yes**

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition

Stream Sensitivity **Low**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Negligible channel adjustments. Bedrock banks and bed, steep gradient, narrowly confined.

Stream: **Pond Hill Brook** Reach # **T02.08-s1.05** Segment: **B** Completion Date: **July 25, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Rain: **Yes**

Segment Length (ft): **1,034** Segment Location: **Segment downstream of pasture in scattered forest along Pond Hill Road.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	**Upstream**	**1.00**	**0.00**	**No**	**Yes**
Waterfall	**Upstream**	**3.00**	**3.00**	**Yes**	**Yes**
Ledge	**Upstream**	**1.00**	**0.00**	**No**	**Yes**
Ledge	**Mid-Segment**	**1.00**	**0.00**	**No**	**Yes**
Ledge	**Downstream**	**1.00**	**0.00**	**No**	**Yes**

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Culvert	**5.70**	**Yes**	**Yes**	**Yes**	**Yes**

Problem **Deposition Below,Scour Below,Alignment**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**

	Score	STD	Historic
7.1 Channel Degradation	**16**	**None**	**No**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**11**		**No**
Total Score	**51**		
Geomorphic Rating	**0.6375**		

Channel Evolution Model **D**

Channel Evolution Stage **IIc**

Geomorphic Condition **Fair**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**13**
6.2 Embeddedness	**11**
6.3 Velocity/Depth Patterns	**13**
6.4 Sediment Deposition	**11**
6.5 Channel Flow Status	**13**
6.6 Channel Alteration	**10**
6.7 Frequency of Riffles/Steps	**13**
6.8 Bank Stability	**Left: 8 Right: 7**
6.9 Bank Vegetation Protection	**Left: 7 Right: 7**
6.10 Riparian Vegetation Zone Width	**Left: 8 Right: 5**
Total Score	**126**
Habitat Rating	**0.63**

Habitat Stream Condition **Good**

Narrative:

Minor widening, aggradation in response to limited channelization and upstream erosion and stormwater sediment inputs. Potential incision / widening moderated by shallow and exposed bedrock. Condition score is on the cusp with "Good".

Stream: **Pond Hill Brook** Reach # **T02.08-s1.05** Segment: **C** Completion Date: **July 25, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Rain: **Yes**

Segment Length (ft): **341** Segment Location: **Short bedrock-controlled section downstream of pasture, southwest of Pond Hill Rd.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	**Upstream**	**1.00**	**0.00**	**No**	**Yes**
Waterfall	**Downstream**	**7.00**	**6.00**	**Yes**	**Yes**
Waterfall	**Downstream**	**3.00**	**2.00**	**No**	**Yes**

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition

Stream Sensitivity **Low**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Bedrock-controlled "gorge" per protocols; no RGA/RHA completed.

Stream: **Pond Hill Brook** Reach # **T02.08-s1.05** Segment: **D** Completion Date: **July 25, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Rain: **Yes**

Segment Length (ft): **827** Segment Location: **Pasture segment southwest of Junction between Pond Hill Road and Pond Hill Ranch**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	**Upstream**	**1.00**	**0.00**	**No**	**Yes**
Ledge	**Upstream**	**1.00**	**0.00**	**No**	**Yes**
Ledge	**Downstream**	**1.00**	**0.00**	**No**	**Yes**

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**5**	**C to B**	**Yes**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**11**		**No**
7.4 Change in Planform	**10**		**No**
Total Score	**37**		
Geomorphic Rating	**0.4625**		

Channel Evolution Model **F**
Channel Evolution Stage **V**
Geomorphic Condition **Fair**
Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**11**
6.2 Embeddedness	**10**
6.3 Velocity/Depth Patterns	**13**
6.4 Sediment Deposition	**10**
6.5 Channel Flow Status	**15**
6.6 Channel Alteration	**8**
6.7 Frequency of Riffles/Steps	**16**
6.8 Bank Stability	**Left: 9 Right: 7**
6.9 Bank Vegetation Protection	**Left: 6 Right: 6**
6.10 Riparian Vegetation Zone Width	**Left: 1 Right: 1**
Total Score	**113**
Habitat Rating	**0.565**

Habitat Stream Condition **Fair**

Narrative:

Minor planform, aggradation, and widening in response to historic channelization and u/s sediment sources aggravated by direct pasturing and absence of tree buffers. Current incision now moderated by ch-sp bedrock. Extreme sens due to STD.

Project: **Castleton River** | **Phase 2 Reach Summary** | April 15, 2008

Stream: **Pond Hill Brook** | Reach # **T02.08-s1.05** | Segment: **E** | Completion Date: **July 25, 2006**

Organization: **Poultney/Mettowee NRCD** | Observers: **KLU, HS** | Rain: **Yes**

Segment Length (ft): **613** | Segment Location: **Bedrock-controlled channel in hemlock forest along west side of Pond Hill Ranch Rd.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Waterfall	**Mid-Segment**	**6.00**	**6.00**	**Yes**	**Yes**
Waterfall	**Downstream**	**4.00**	**3.00**	**Yes**	**Yes**
Ledge	**Upstream**	**1.00**	**0.00**	**Yes**	**Yes**
Waterfall	**Upstream**	**3.00**	**2.00**	**Yes**	**Yes**

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition

Stream Sensitivity **Low**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**3**
6.2 Embeddedness	**15**
6.3 Velocity/Depth Patterns	**8**
6.4 Sediment Deposition	**13**
6.5 Channel Flow Status	**15**
6.6 Channel Alteration	**18**
6.7 Frequency of Riffles/Steps	**16**
6.8 Bank Stability	**Left: 10 Right: 8**
6.9 Bank Vegetation Protection	**Left: 10 Right: 9**
6.10 Riparian Vegetation Zone Width	**Left: 10 Right: 5**
Total Score	**140**
Habitat Rating	**0.7**

Habitat Stream Condition **Good**

Narrative:

Bedrock channel.

Stream: **Pond Hill Brook** Reach # **T02.08-s1.05** Segment: **F** Completion Date: **July 25, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Rain: **Yes**

Segment Length (ft): **300** Segment Location: **From upstream end of reach, along hay field to edge forest.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	**Mid-Segment**	**1.00**	**0.00**	**Yes**	**Yes**

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**5**	**C to F**	**Yes**
7.2 Channel Aggradation	**15**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**13**		**No**
Total Score	**46**		
Geomorphic Rating	**0.575**		

Channel Evolution Model **D**
Channel Evolution Stage **IIb**
Geomorphic Condition **Fair**
Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**8**
6.2 Embeddedness	**13**
6.3 Velocity/Depth Patterns	**13**
6.4 Sediment Deposition	**13**
6.5 Channel Flow Status	**13**
6.6 Channel Alteration	**3**
6.7 Frequency of Riffles/Steps	**13**
6.8 Bank Stability	**Left: 9 Right: 4**
6.9 Bank Vegetation Protection	**Left: 7 Right: 7**
6.10 Riparian Vegetation Zone Width	**Left: 10 Right: 1**
Total Score	**114**
Habitat Rating	**0.57**

Habitat Stream Condition **Fair**

Narrative:

Minor wid, planform adjust in resp to entrenched condition from historic dredging / STR (ditching). Entrenchment likely from dredging rather than active incis, given very small DA (low stream power). Bedrock and cohesive soils. See report.

Stream: **Castleton River** Reach # **T02.09** Segment: **A** Completion Date: **August 11, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, ES, SL** Rain: **No**

Segment Length (ft): **3,190** Segment Location: **From former mills along LB below Mill Street crossing downstream nearly to Cemetery**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**73.0**	**Yes**	**Yes**	**No**	**Yes**

Problem **Deposition Above,Deposition**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**16**	**None**	**No**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**11**		**No**
7.4 Change in Planform	**8**		**No**
Total Score	**46**		
Geomorphic Rating	**0.575**		

Channel Evolution Model **F**

Channel Evolution Stage **IV**

Geomorphic Condition **Fair**

Stream Sensitivity **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**15**
6.2 Embeddedness	**13**
6.3 Velocity/Depth Patterns	**18**
6.4 Sediment Deposition	**10**
6.5 Channel Flow Status	**13**
6.6 Channel Alteration	**8**
6.7 Frequency of Riffles/Steps	**15**
6.8 Bank Stability	**Left: 6 Right: 6**
6.9 Bank Vegetation Protection	**Left: 5 Right: 4**
6.10 Riparian Vegetation Zone Width	**Left: 9 Right: 9**
Total Score	**131**
Habitat Rating	**0.655**

Habitat Stream Condition **Good**

Narrative:

Substantial planform adjustment where unconstrained by corridor encroachments. Moderate aggradation, widening. Good floodplain access.

Stream: **Castleton River** Reach # **T02.09** Segment: **B** Completion Date: **August 11, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, ES, SL** Rain: **No**

Segment Length (ft): **2,045** Segment Location: **From railroad crossing above low-head dam downstream to area of former mills along**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Dam	**Upstream**	**5.00**	**2.00**	**Yes**	**Yes**
Ledge	**Upstream**	**2.00**	**1.00**	**Yes**	**Yes**

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**60.0**	**Yes**	**No**	**No**	**Yes**
Problem	**None**				
Bridge	**47.0**	**Yes**	**Yes**	**Yes**	**Yes**
Problem	**Deposition Above,Scour Below**				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

Channel Evolution Model **F**

Channel Evolution Stage **II**

Geomorphic Condition **Fair**

Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**11**
6.2 Embeddedness	**13**
6.3 Velocity/Depth Patterns	**13**
6.4 Sediment Deposition	**13**
6.5 Channel Flow Status	**16**
6.6 Channel Alteration	**5**
6.7 Frequency of Riffles/Steps	**11**
6.8 Bank Stability	**Left: 6 Right: 7**
6.9 Bank Vegetation Protection	**Left: 5 Right: 5**
6.10 Riparian Vegetation Zone Width	**Left: 7 Right: 4**
Total Score	**116**
Habitat Rating	**0.58**

Habitat Stream Condition **Fair**

Narrative:

Administrative judgment - since cross section not available. Based on visual observations, 2005. Active widening, historic incision, minor planform adjustment (localized meander extension); historic channelization.

Stream: **North Breton Brook** Reach # **T02.09-s1.01** Segment: **A** Completion Date: **July 20, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, SHPytlik** Rain: **Yes**

Segment Length (ft): **2,745** Segment Location: **From Exit 5 ramp downstream to confluence of Castleton River main stem.**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Culvert	**17.0**	**Yes**	**No**	**Yes**	**Yes**
Problem	**Deposition Above,Scour Below**				
Culvert	**16.0**	**Yes**	**Yes**	**Yes**	**Yes**
Problem	**Scour Below**				
Bridge	**68.0**	**Yes**	**No**	**No**	**Yes**
Problem	**Deposition Above,Scour Below,Alignment**				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**16**	**None**	**No**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**11**		**Yes**
Total Score	**53**		
Geomorphic Rating	**0.6625**		

Channel Evolution Model **F**

Channel Evolution Stage **V**

Geomorphic Condition **Good**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**8**
6.2 Embeddedness	**10**
6.3 Velocity/Depth Patterns	**13**
6.4 Sediment Deposition	**10**
6.5 Channel Flow Status	**13**
6.6 Channel Alteration	**1**
6.7 Frequency of Riffles/Steps	**6**
6.8 Bank Stability	**Left: 9 Right: 7**
6.9 Bank Vegetation Protection	**Left: 7 Right: 7**
6.10 Riparian Vegetation Zone Width	**Left: 1 Right: 2**
Total Score	**94**
Habitat Rating	**0.47**

Habitat Stream Condition **Fair**

Narrative:

Minor degree of adjustment. Planform adjustment was historic. Modified Reference Stream Type.

Stream: **North Breton Brook** Reach # **T02.09-s1.01** Segment: **B** Completion Date: **July 20, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, SHPytlik** Rain: **Yes**

Segment Length (ft): **1,762** Segment Location: **From Pelletier Dam downstream to Route 4 westbound Exit 5 off ramp.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	**Upstream**	**1.00**	**0.00**		

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**49.0**	**Yes**	**Yes**	**No**	**Yes**

Problem **Deposition Below**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**3**	**C to F**	**Yes**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**13**		**No**
Total Score	**42**		
Geomorphic Rating	**0.525**		

Channel Evolution Model **F**

Channel Evolution Stage **III**

Geomorphic Condition **Fair**

Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**8**
6.2 Embeddedness	**13**
6.3 Velocity/Depth Patterns	**13**
6.4 Sediment Deposition	**10**
6.5 Channel Flow Status	**13**
6.6 Channel Alteration	**10**
6.7 Frequency of Riffles/Steps	**8**
6.8 Bank Stability	**Left: 7 Right: 8**
6.9 Bank Vegetation Protection	**Left: 7 Right: 7**
6.10 Riparian Vegetation Zone Width	**Left: 9 Right: 7**
Total Score	**120**
Habitat Rating	**0.6**

Habitat Stream Condition **Fair**

Narrative:

Minor widening, aggradation and planform adjustment in response to historic incision. Channel has appearance of stability, but could unravel if boundary conditions change and/or if hydraulic stresses increase. Extreme sens. due to STD (C to F).

Stream: **North Breton Brook** Reach # **T02.09-s1.02** Segment: **A** Completion Date: **July 20, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, SHPytlik** Rain: **Yes**

Segment Length (ft): **434** Segment Location: **Downstream end of reach comprised of wetlands (former mill pond) and small**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Dam	**Downstream**	**15.00**	**10.00**		

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Other	**4.00**	**Yes**	**Yes**	**Yes**	**Yes**

Problem **Deposition Above**

Narrative:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition

Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Project: **Castleton River**	**Phase 2 Reach Summary**		April 15, 2008
Stream: **North Breton Brook**	Reach # **T02.09-s1.02**	Segment: **B**	Completion Date: **July 20, 2005**
Organization: **Poultney/Mettowee NRCD**	Observers: **KLU, SHPytlik**		Rain: **Yes**
Segment Length (ft): **3,530**	Segment Location: **Segment flows parallel to and west of Hubbardton Rd and ends just upstream of**		

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken
Ledge	**Mid-Segment**	**1.00**	**0.00**		

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bedrock	**7.00**	**Yes**	**Yes**	**Yes**	**Yes**

Problem **Scour Below**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**18**	**None**	**No**
7.2 Channel Aggradation	**8**	**None**	**No**
7.3 Widening Channel	**11**		**No**
7.4 Change in Planform	**8**		**No**
Total Score	**45**		
Geomorphic Rating	**0.5625**		

Channel Evolution Model **F**
Channel Evolution Stage **IV**
Geomorphic Condition **Fair**
Stream Sensitivity **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**13**
6.2 Embeddedness	**11**
6.3 Velocity/Depth Patterns	**18**
6.4 Sediment Deposition	**8**
6.5 Channel Flow Status	**13**
6.6 Channel Alteration	**18**
6.7 Frequency of Riffles/Steps	**13**
6.8 Bank Stability	**Left: 7 Right: 7**
6.9 Bank Vegetation Protection	**Left: 8 Right: 8**
6.10 Riparian Vegetation Zone Width	**Left: 9 Right: 9**
Total Score	**142**
Habitat Rating	**0.71**

Habitat Stream Condition **Good**

Narrative:

Moderate aggradation and substantial planform adjustment. Bedrock in bed and banks at discrete locations offering some vertical and lateral grade control to the reach - moderating incision and widening. Good floodplain access.

Stream: **North Breton Brook** Reach # **T02.09-s1.04** Segment: **A** Completion Date: **August 2, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, SHPytlik** Rain: **Yes**

Segment Length (ft): **827** Segment Location: **Short remaining section at downstream-most end of reach below the bedrock gorge.**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Narrative:

Aggradation (minor).

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**18**	**None**	**No**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**18**		**No**
Total Score	**60**		
Geomorphic Rating	**0.75**		

Channel Evolution Model **F**

Channel Evolution Stage **I**

Geomorphic Condition **Good**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**8**
6.2 Embeddedness	**13**
6.3 Velocity/Depth Patterns	**8**
6.4 Sediment Deposition	**13**
6.5 Channel Flow Status	**13**
6.6 Channel Alteration	**18**
6.7 Frequency of Riffles/Steps	**13**
6.8 Bank Stability	**Left: 9 Right: 9**
6.9 Bank Vegetation Protection	**Left: 9 Right: 9**
6.10 Riparian Vegetation Zone Width	**Left: 9 Right: 10**
Total Score	**141**
Habitat Rating	**0.705**

Habitat Stream Condition **Good**

Project: **Castleton River** | **Phase 2 Reach Summary** | | April 15, 2008

Stream: **North Breton Brook** Reach # **T02.09-s1.04** Segment: **B** Completion Date: **August 2, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, SHPytlik** Rain: **Yes**

Segment Length (ft): **342** Segment Location: **Short section of bedrock gorge near downstream end of reach.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	**Mid-Segment**	**1.00**	**0.00**		

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition

Stream Sensitivity **Low**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

	Score	
6.1 Epifaunal Substrate - Available Cover	**0**	
6.2 Embeddedness (high) Pool	**0**	
6.3 Velocity/Depth Patterns (high)<br	**0**	
6.4 Sediment Deposition	**0**	
6.5 Channel Flow Status	**0**	
6.6 Channel Alteration	**0**	
6.7 Frequency of Riffles/Steps (high)<br	**0**	
6.8 Bank Stability	**Left: 0**	**Right: 0**
6.9 Bank Vegetation Protection	**Left: 0**	**Right: 0**
6.10 Riparian Vegetation Zone Width	**Left: 0**	**Right: 0**
Total Score	**0**	
Habitat Rating	**0**	

Habitat Stream Condition

Narrative:

Bedrock gorge - assigned "Low" sensitivity following protocols.

Project: **Castleton River** | **Phase 2 Reach Summary** | | April 15, 2008

Stream: **North Breton Brook** Reach # **T02.09-s1.04** Segment: **C** Completion Date: **August 2, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, SHPytlik** Rain: **Yes**

Segment Length (ft): **2,960** Segment Location: **West of Hubbarton Rd. 2960 ft downstream to bedrock gorge.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	**Mid-Segment**	**1.00**	**0.00**		
Ledge	**Mid-Segment**	**1.00**	**0.00**		
Ledge	**Mid-Segment**	**1.00**	**0.00**		
Ledge	**Mid-Segment**	**1.00**	**0.00**		

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**18**	**None**	**No**
7.2 Channel Aggradation	**10**	**None**	**No**
7.3 Widening Channel	**11**		**No**
7.4 Change in Planform	**13**		**No**
Total Score	**52**		
Geomorphic Rating	**0.65**		

Channel Evolution Model **F**
Channel Evolution Stage **IV**
Geomorphic Condition **Good**
Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**16**
6.2 Embeddedness	**13**
6.3 Velocity/Depth Patterns	**18**
6.4 Sediment Deposition	**8**
6.5 Channel Flow Status	**13**
6.6 Channel Alteration	**18**
6.7 Frequency of Riffles/Steps	**18**
6.8 Bank Stability	**Left: 8 Right: 8**
6.9 Bank Vegetation Protection	**Left: 8 Right: 8**
6.10 Riparian Vegetation Zone Width	**Left: 9 Right: 9**
Total Score	**154**
Habitat Rating	**0.77**

Habitat Stream Condition **Good**

Narrative:
Minor to moderate aggradation, widening. Good floodplain access. Stability offered by bedrock in downstream end of segment.

Stream: **North Breton Brook** Reach # **T02.09-s1.04** Segment: **D** Completion Date: **August 2, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, SHPytlik** Rain: **Yes**

Segment Length (ft): **1,566** Segment Location: **Channelized and bermed segment between agricultural fields west of Hubbarton Road.**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**8**	**None**	**No**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**11**		**No**
Total Score	**43**		
Geomorphic Rating	**0.5375**		

Channel Evolution Model **F**

Channel Evolution Stage **II**

Geomorphic Condition **Fair**

Stream Sensitivity **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**3**
6.2 Embeddedness	**13**
6.3 Velocity/Depth Patterns	**1**
6.4 Sediment Deposition	**13**
6.5 Channel Flow Status	**3**
6.6 Channel Alteration	**3**
6.7 Frequency of Riffles/Steps	**3**
6.8 Bank Stability	**Left: 8 Right: 8**
6.9 Bank Vegetation Protection	**Left: 8 Right: 8**
6.10 Riparian Vegetation Zone Width	**Left: 7 Right: 7**
Total Score	**85**
Habitat Rating	**0.425**

Habitat Stream Condition **Fair**

Narrative:

Minor aggradation and planform adjustment. Incision or widening may be moderated by presence of (young) tree buffers, and reduced flows in this losing reach.

Stream: **North Breton Brook** Reach # **T02.09-s1.04** Segment: **E** Completion Date: **August 2, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, SHPytlik** Rain: **Yes**

Segment Length (ft): **1,014** Segment Location: **Upper sixth of the reach.**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**5**	**C to F**	**Yes**
7.2 Channel Aggradation	**15**	**None**	**No**
7.3 Widening Channel	**3**		**No**
7.4 Change in Planform	**8**		**No**
Total Score	**31**		
Geomorphic Rating	**0.3875**		

Channel Evolution Model **F**
Channel Evolution Stage **III**
Geomorphic Condition **Poor**
Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**3**
6.2 Embeddedness	**13**
6.3 Velocity/Depth Patterns	**8**
6.4 Sediment Deposition	**8**
6.5 Channel Flow Status	**8**
6.6 Channel Alteration	**3**
6.7 Frequency of Riffles/Steps	**10**
6.8 Bank Stability	**Left: 4 Right: 6**
6.9 Bank Vegetation Protection	**Left: 4 Right: 6**
6.10 Riparian Vegetation Zone Width	**Left: 7 Right: 10**
Total Score	**90**
Habitat Rating	**0.45**

Habitat Stream Condition **Fair**

Narrative:

Active widening and planform adjustment accompanied by minor aggradation (transport-dominated). Historic incision. Extreme sensitivity due to stream type departure.

Stream: **North Breton Brook** Reach # **T02.09-s1.05** Segment: **0** Completion Date: **August 2, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, SH** Rain: **Yes**

Segment Length (ft): **3,458** Segment Location: **Wetlands-dominated reach west of and parallel to East Hubbardton Rd extending**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	**Downstream**	**1.00**	**0.00**		

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**17.8**	**No**	**Yes**	**Yes**	**Yes**

Problem **Deposition Below**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition

Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Stream: **Castleton River** Reach # **T02.10** Segment: **0** Completion Date: **August 11, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, ES, SL** Rain: **No**

Segment Length (ft): **2,626** Segment Location: **From the Route 4A crossing by Dumas to the second Route 4A crossing downstream of**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	**Mid-Segment**	**0.00**	**0.00**		

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**43.0**	**Yes**	**No**	**No**	**Yes**
Problem	**Deposition Above,Alignment**				
Bedrock	**45.0**	**Yes**	**Yes**	**Yes**	**Yes**
Problem	**Deposition Above,Scour Below**				
Bridge	**69.0**	**Yes**	**No**	**No**	**Yes**
Problem	**Deposition Above,Alignment**				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**13**	**None**	**Yes**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**13**		**Yes**
Total Score	**52**		
Geomorphic Rating	**0.65**		

Channel Evolution Model **F**

Channel Evolution Stage **IV**

Geomorphic Condition **Good**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**20**
6.2 Embeddedness	**15**
6.3 Velocity/Depth Patterns	**18**
6.4 Sediment Deposition	**13**
6.5 Channel Flow Status	**18**
6.6 Channel Alteration	**13**
6.7 Frequency of Riffles/Steps	**18**
6.8 Bank Stability	**Left: 6 Right: 7**
6.9 Bank Vegetation Protection	**Left: 8 Right: 9**
6.10 Riparian Vegetation Zone Width	**Left: 9 Right: 8**
Total Score	**162**
Habitat Rating	**0.81**

Habitat Stream Condition **Good**

Narrative:

Minor degree of each channel adjustment process noted. Incision and PF change appear historic. Reach in late stages of channel evolution.

Stream: **Castleton River** Reach # **T02.11** Segment: **A** Completion Date: **June 30, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, ES** Rain: **Yes**

Segment Length (ft): **5,145** Segment Location: **From a point just downstream of Pond Hill Stables downstream to Rt. 4 A crossing**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**11.5**	**Yes**	**Yes**	**Yes**	**Yes**
Problem	**Deposition Above,Scour Below,Alignment**				
Bridge	**9.50**	**Yes**	**Yes**	**Yes**	**Yes**
Problem	**Scour Below**				
Bridge	**11.0**	**No**	**Yes**	**Yes**	**Yes**
Problem	**None**				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**16**	**None**	**No**
7.2 Channel Aggradation	**10**	**None**	**No**
7.3 Widening Channel	**16**		**No**
7.4 Change in Planform	**15**		**Yes**
Total Score	**57**		
Geomorphic Rating	**0.7125**		

Channel Evolution Model **F**
Channel Evolution Stage **V**
Geomorphic Condition **Good**
Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**8**
6.2 Embeddedness	**8**
6.3 Velocity/Depth Patterns	**11**
6.4 Sediment Deposition	**8**
6.5 Channel Flow Status	**18**
6.6 Channel Alteration	**3**
6.7 Frequency of Riffles/Steps	**3**
6.8 Bank Stability	**Left: 8 Right: 8**
6.9 Bank Vegetation Protection	**Left: 7 Right: 7**
6.10 Riparian Vegetation Zone Width	**Left: 2 Right: 2**
Total Score	**93**
Habitat Rating	**0.465**

Habitat Stream Condition **Fair**

Narrative:
Aggradation.

Stream: **Castleton River** Reach # **T02.11** Segment: **B** Completion Date: **June 30, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, ES** Rain: **Yes**

Segment Length (ft): **5,876** Segment Location: **From Gully Brook confluence to just downstream of Pond Hill Stables**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**56.0**	**Yes**	**Yes**	**No**	**Yes**
Problem **None**					
Other	**30.5**	**Yes**	**Yes**	**Yes**	**Yes**
Problem **Deposition Above**					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**13**	**None**	**Yes**
7.2 Channel Aggradation	**5**	**None**	**No**
7.3 Widening Channel	**8**		**No**
7.4 Change in Planform	**5**		**No**
Total Score	**31**		
Geomorphic Rating	**0.3875**		

Channel Evolution Model **F**
Channel Evolution Stage **IV**
Geomorphic Condition **Poor**
Stream Sensitivity **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**13**
6.2 Embeddedness	**13**
6.3 Velocity/Depth Patterns	**18**
6.4 Sediment Deposition	**3**
6.5 Channel Flow Status	**8**
6.6 Channel Alteration	**5**
6.7 Frequency of Riffles/Steps	**13**
6.8 Bank Stability	**Left: 8 Right: 7**
6.9 Bank Vegetation Protection	**Left: 8 Right: 7**
6.10 Riparian Vegetation Zone Width	**Left: 4 Right: 2**
Total Score	**109**
Habitat Rating	**0.545**

Habitat Stream Condition **Fair**

Narrative:

Aggradation and planform change with moderate widening in response to historic channelization and recent avulsion. Upstream (i.e., Gully Brook) and instream sediment sources (i.e., streambank eros) are contributing to aggradation, wid, and PF.

Project:	**Castleton River**		**Phase 2 Reach Summary**	page 2 of 2	April 15, 2008
Stream:	**Gully Brook**	Reach #	**T02.11-s1.01**	Segment: **0**	Completion Date: **August 8, 2006**
Organization:	**Poultney/Mettowee NRCD**	Observers:	**KLU, MS, SH**		Rain: **Yes**
Segment Length (ft):	**1,346**	Segment Location:	**From Woodbury Road crossing downstream to confluence with Castleton River. Site of**		

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**16**	**None**	**No**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**11**		**No**
7.4 Change in Planform	**10**		**Yes**
Total Score	**48**		
Geomorphic Rating	**0.6**		

Channel Evolution Model **F**
Channel Evolution Stage **IV**
Geomorphic Condition **Fair**
Stream Sensitivity **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**5**
6.2 Embeddedness	**10**
6.3 Velocity/Depth Patterns	**6**
6.4 Sediment Deposition	**8**
6.5 Channel Flow Status	**6**
6.6 Channel Alteration	**3**
6.7 Frequency of Riffles/Steps	**3**
6.8 Bank Stability	**Left: 9 Right: 9**
6.9 Bank Vegetation Protection	**Left: 8 Right: 8**
6.10 Riparian Vegetation Zone Width	**Left: 7 Right: 7**
Total Score	**89**
Habitat Rating	**0.445**

Habitat Stream Condition **Fair**

Narrative:

Minor-moderate planform adjustment (flood chutes, meander extens), minor aggradation & widening. Floodplain connection has been restored to previously entrenched channel through restoration project. Channel beginning to build sinuosity, riffles.

Stream: **Gully Brook** Reach # **T02.11-s1.02** Segment: **A** Completion Date: **August 8, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, MS, SH** Rain: **Yes**

Segment Length (ft): **529** Segment Location: **From power line crossing downstream to Woodbury Road bridge crossing.**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**37.0**	**Yes**	**Yes**	**No**	**Yes**

Problem **Deposition Above**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**5**	**Other**	**Yes**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**8**		**No**
Total Score	**37**		
Geomorphic Rating	**0.4625**		

Channel Evolution Model **F**
Channel Evolution Stage **III**
Geomorphic Condition **Fair**
Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**8**
6.2 Embeddedness	**8**
6.3 Velocity/Depth Patterns	**8**
6.4 Sediment Deposition	**8**
6.5 Channel Flow Status	**10**
6.6 Channel Alteration	**5**
6.7 Frequency of Riffles/Steps	**10**
6.8 Bank Stability	**Left: 6 Right: 6**
6.9 Bank Vegetation Protection	**Left: 8 Right: 8**
6.10 Riparian Vegetation Zone Width	**Left: 8 Right: 7**
Total Score	**100**
Habitat Rating	**0.5**

Habitat Stream Condition **Fair**

Narrative:

Historic degradation and loss of floodplain connection due to channelization, windrowing, dredging, and berming. Stream type departure from D to F. Currently, moderate planform adjustments (flood chutes, meander extension) and minor aggradation.

Stream: **Gully Brook** Reach # **T02.11-s1.02** Segment: **B** Completion Date: **August 8, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, MS, SH** Rain: **Yes**

Segment Length (ft): **3,746** Segment Location: **Bedrock channel west of Birdseye Road, downstream to the power line.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	**Downstream**	**1.00**	**0.00**	**No**	**Yes**
Ledge	**Downstream**	**1.00**	**0.00**	**No**	**Yes**

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**

	Score	STD	Historic
7.1 Channel Degradation	**18**	**None**	**No**
7.2 Channel Aggradation	**10**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**13**		**No**
Total Score	**54**		
Geomorphic Rating	**0.675**		

Channel Evolution Model **D**

Channel Evolution Stage **I**

Geomorphic Condition **Good**

Stream Sensitivity **Moderate**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**15**
6.2 Embeddedness	**11**
6.3 Velocity/Depth Patterns	**13**
6.4 Sediment Deposition	**8**
6.5 Channel Flow Status	**10**
6.6 Channel Alteration	**18**
6.7 Frequency of Riffles/Steps	**15**
6.8 Bank Stability	**Left: 8 Right: 8**
6.9 Bank Vegetation Protection	**Left: 9 Right: 9**
6.10 Riparian Vegetation Zone Width	**Left: 9 Right: 10**
Total Score	**143**
Habitat Rating	**0.715**

Habitat Stream Condition **Good**

Narrative:

Moderate aggradation. Potential for incision / widening moderated by bedrock control and well-developed forested buffers.

Stream: **Gully Brook** Reach # **T02.11-s1.04** Segment: **A** Completion Date: **August 4, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Rain: **Yes**

Segment Length (ft): **5,395** Segment Location: **From just downstream of Traverse Park to the downstream end of the reach close to**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken
Waterfall	**Upstream**	**12.00**	**10.00**	**Yes**	**Yes**
Waterfall	**Upstream**	**8.00**	**7.00**	**Yes**	**Yes**
Waterfall	**Mid-Segment**	**4.00**	**1.00**	**Yes**	**Yes**
Waterfall	**Mid-Segment**	**8.00**	**6.00**	**Yes**	**Yes**
Waterfall	**Mid-Segment**	**25.00**	**23.00**	**Yes**	**Yes**
Waterfall	**Downstream**	**6.00**	**4.00**	**No**	**Yes**
Waterfall	**Downstream**	**4.00**	**3.00**	**No**	**Yes**
Waterfall	**Downstream**	**5.00**	**4.00**	**No**	**Yes**
Waterfall	**Downstream**	**5.00**	**4.00**	**No**	**Yes**

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Other	**16.0**	**Yes**	**Yes**	**Yes**	**Yes**
	Problem	**Alignment**			
Bridge	**31.0**	**Yes**	**Yes**	**No**	**Yes**
	Problem	**None**			

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**

	Score	STD	Historic
7.1 Channel Degradation	**18**	**None**	**No**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**15**		**No**
7.4 Change in Planform	**14**		**No**
Total Score	**60**		
Geomorphic Rating	**0.75**		

Channel Evolution Model **D**

Channel Evolution Stage **I**

Geomorphic Condition **Good**

Stream Sensitivity **Very Low**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**15**
6.2 Embeddedness	**16**
6.3 Velocity/Depth Patterns	**18**
6.4 Sediment Deposition	**15**
6.5 Channel Flow Status	**15**
6.6 Channel Alteration	**18**
6.7 Frequency of Riffles/Steps	**18**
6.8 Bank Stability	**Left: 10 Right: 10**
6.9 Bank Vegetation Protection	**Left: 9 Right: 9**
6.10 Riparian Vegetation Zone Width	**Left: 10 Right: 10**
Total Score	**173**
Habitat Rating	**0.865**

Habitat Stream Condition **Referen**

Narrative:

Aggradation (minor). Channel is dominated by bedrock in the bed and banks.

Stream: **Gully Brook** Reach # **T02.11-s1.04** Segment: **B** Completion Date: **August 3, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Rain: **Yes**

Segment Length (ft): **1,442** Segment Location: **Segment west of and parallel to Birdseye Road through Traverse Park**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	**Upstream**	**1.00**	**0.00**	**No**	**Yes**

4.8 Channel Constrictions **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**5**	**C to F**	**Yes**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**10**		**No**
Total Score	**39**		
Geomorphic Rating	**0.4875**		

Channel Evolution Model **F**
Channel Evolution Stage **IV**
Geomorphic Condition **Fair**
Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**15**
6.2 Embeddedness	**16**
6.3 Velocity/Depth Patterns	**10**
6.4 Sediment Deposition	**10**
6.5 Channel Flow Status	**10**
6.6 Channel Alteration	**8**
6.7 Frequency of Riffles/Steps	**16**
6.8 Bank Stability	**Left: 9 Right: 9**
6.9 Bank Vegetation Protection	**Left: 8 Right: 8**
6.10 Riparian Vegetation Zone Width	**Left: 8 Right: 5**
Total Score	**132**
Habitat Rating	**0.66**

Habitat Stream Condition **Fair**

Narrative:

Aggradation & planform adjustment in response to hist. degradation resulting from channelization / floodplain encroachments. Active incision & widening moderated by coarseness of bed/banks; offset by aggradation and possible losing conditions.

Stream: **Gully Brook** | Reach # **T02.11-s1.04** | Segment: **C** | Completion Date: **August 3, 2006**

Organization: **Poultney/Mettowee NRCD** | Observers: **KLU, HS** | Rain: **Yes**

Segment Length (ft): **1,297** | Segment Location: **From Ira/Poultney town line at Birdseye Road Xg downstream to upstream end of**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	**Mid-Segment**	**1.00**	**0.00**	**No**	**Yes**
Ledge	**Mid-Segment**	**1.00**	**0.00**	**No**	**Yes**
Ledge	**Downstream**	**1.00**	**0.00**	**No**	**Yes**

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**12.0**	**Yes**	**No**	**Yes**	**Yes**

Problem **Deposition Above**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**18**	**None**	**No**
7.2 Channel Aggradation	**16**	**None**	**No**
7.3 Widening Channel	**16**		**No**
7.4 Change in Planform	**16**		**No**
Total Score	**66**		
Geomorphic Rating	**0.825**		

Channel Evolution Model **D**

Channel Evolution Stage **I**

Geomorphic Condition **Good**

Stream Sensitivity **Moderate**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**11**
6.2 Embeddedness	**13**
6.3 Velocity/Depth Patterns	**15**
6.4 Sediment Deposition	**13**
6.5 Channel Flow Status	**13**
6.6 Channel Alteration	**16**
6.7 Frequency of Riffles/Steps	**18**
6.8 Bank Stability	**Left: 10 Right: 9**
6.9 Bank Vegetation Protection	**Left: 9 Right: 9**
6.10 Riparian Vegetation Zone Width	**Left: 10 Right: 10**
Total Score	**156**
Habitat Rating	**0.78**

Habitat Stream Condition **Good**

Narrative:

Minor. Channel adjustments moderated by boulders and bedrock in bed and banks, as well as well-developed forested buffers.

Stream: **Gully Brook** Reach # **T02.11-s1.04** Segment: **D** Completion Date: **August 3, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Rain: **Yes**

Segment Length (ft): **995** Segment Location: **Approx 1000 feet of channel upstream of Ira / Poultney town line at Birdseye Road Xg**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	**Upstream**	**1.00**	**0.00**	**Yes**	**Yes**
Ledge	**Upstream**	**1.00**	**0.00**	**No**	**Yes**
Ledge	**Downstream**	**1.00**	**0.00**	**No**	**Yes**
Ledge	**Downstream**	**1.00**	**0.00**	**No**	**Yes**

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**7.00**	**Yes**	**Yes**	**Yes**	**Yes**

Problem **Deposition Above**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**

	Score	STD	Historic
7.1 Channel Degradation	**18**	**None**	**No**
7.2 Channel Aggradation	**15**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**13**		**No**
Total Score	**59**		
Geomorphic Rating	**0.7375**		

Channel Evolution Model **D**

Channel Evolution Stage **I**

Geomorphic Condition **Good**

Stream Sensitivity **Moderate**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	**11**
6.2 Embeddedness	**13**
6.3 Velocity/Depth Patterns	**15**
6.4 Sediment Deposition	**13**
6.5 Channel Flow Status	**13**
6.6 Channel Alteration	**16**
6.7 Frequency of Riffles/Steps	**18**
6.8 Bank Stability	**Left: 9 Right: 9**
6.9 Bank Vegetation Protection	**Left: 9 Right: 9**
6.10 Riparian Vegetation Zone Width	**Left: 10 Right: 9**
Total Score	**154**
Habitat Rating	**0.77**

Habitat Stream Condition **Good**

Narrative:

Minor widening / planform adjustment. Minimal historic channel alterations. Channel adjustments moderated by boulders and bedrock in bed and banks, as well as well -developed forested buffers.

Stream: **Castleton River** Reach # **T02.12** Segment: **0** Completion Date: **June 28, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, ES, SL** Rain: **Yes**

Segment Length (ft): **12,493** Segment Location: **From Route 4 in Ira township downstream to Traverse Farm at Gully Brook confluence.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Dam	**Downstream**	**0.00**	**0.00**	**Yes**	**Yes**

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	**43.4**	**Yes**	**Yes**	**No**	**Yes**
Problem	**Scour Below,Alignment**				
Bridge	**25.0**	**No**	**Yes**	**Yes**	**Yes**
Problem	**Deposition Above,Scour Below**				
Bridge	**19.0**	**Yes**	**No**	**No**	**Yes**
Problem	**None**				
Bridge	**43.0**	**Yes**	**No**	**No**	**Yes**
Problem	**Scour Below,Alignment**				
Culvert	**6.00**	**Yes**	**No**	**Yes**	**Yes**
Problem	**Scour Below**				
Old	**20.0**	**No**	**Yes**	**No**	**Yes**
Problem	**Alignment**				
Bridge	**0.00**	**Yes**	**No**	**No**	**Yes**
Problem	**Scour Below**				

Narrative:

None active

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**15**	**None**	**Yes**
7.2 Channel Aggradation	**18**	**None**	**No**
7.3 Widening Channel	**16**		**No**
7.4 Change in Planform	**15**		**No**
Total Score	**64**		
Geomorphic Rating	**0.8**		

Channel Evolution Model **F**

Channel Evolution Stage **I**

Geomorphic Condition **Good**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	**18**
6.2 Pool Substrate	**18**
6.3 Pool Variability	**18**
6.4 Sediment Deposition	**18**
6.5 Channel Flow Status	**18**
6.6 Channel Alteration	**13**
6.7 Channel Sinuosity	**18**
6.8 Bank Stability	**Left: 9 Right: 9**
6.9 Bank Vegetation Protection	**Left: 9 Right: 9**
6.10 Riparian Vegetation Zone Width	**Left: 9 Right: 2**
Total Score	**168**
Habitat Rating	**0.84**

Habitat Stream Condition **Good**

Project: Castleton River

Phase 2 Segment Summary

April 15, 2008 SGAT Version: 3

Stream: Castleton River | Reach # T02.01 | Segment: 0 | Completion Date: July 13, 2006

Organization: Poultney/Mettowee NRCD | Observers: KLU, HS | Why Not assessed: | Rain: Yes

Segment Length (ft): 3,626 | Segment Location: From Fair Haven WWTF downstream to confluence with Poultney River.

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **None**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	283	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	307

1.4 Adjacent Side	Left	Right
Hillside Slope	Steep	Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **220**

Width Determination **Estimated**

Confinement Type **Semi-confined**

Rock Gorge? **No**

Human-caused Change? **no**

Step 2. Stream Channel

2.1 Bankfull Width **83**

2.2 Max Depth (ft) **7.20**

2.3 Mean Depth (ft) **4.60**

2.4 Floodprone Width (ft) **215**

Notes:

Straightening inferred in vicinity of Route 4 highway crossing, installed prior to c.1972. Neck cutoff is pre-1950 based on review of historic topographic map.

Step 2. (Contued)

2.5 Aband. Floodpln **8.70** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **18.07**

2.7 Entrenchment Ratio **2.59**

2.8 Incision Ratio **1.21**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Not Applicable**

2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Bedrock	0%
Boulder	0%
Cobble	0%
Coarse Gravel	8%
Fine Gravel	45%
Sand	47%
Silt and smaller	0%

Silt/Clay Present? **Yes**

Detritus **2** %

Large Woody **3**

2.13 Average Largest Particle on

Bed **16.0** mm

Bar **5.0** mm

2.14 Stream Type

Stream Type: **C**

Bed Material: **Gravel**

Subclass Slope: **c**

Bed Form: **Dune-Ripple**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	Multiple	15.50
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Moderate**

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Cohesive	Cohesive
Lower		
Material Type	Clay	Clay
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	124	115
Erosion Height (ft)	8.00	16.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Deciduous	Deciduous

Bank Canopy	Left	Right
Canopy %	51-75	51-75

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	51-100
Sub-dominant	None	26-50
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Deciduous	Herbaceous
Sub-dominant	Herbaceous	Deciduous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Pasture
Sub-dominant	None	Forest
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **Minimal**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **1**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

4.6 Up/Down strm flow reg

(old) Upstrm Flow Reg **None**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	1	0
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
2	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
1	0	No

5.4 Stream Ford or Animal **Yes**

5.5 Straightening **Straightening**

Straightening Length: **452**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Phase 2 Segment Summary

April 15, 2008 SGAT Version: 3

Project: Castleton River
Stream: Castleton River — Reach # T02.02 — Segment: A — Completion Date: July 13, 2006
Organization: Poultney/Mettowee NRCD — Observers: KLU, HS, ES — Why Not assessed: — Rain: Yes
Segment Length (ft): 5,292 — Segment Location: From vicinity of Fair Haven WWTF d/s toward US Route 4.

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**
1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	353	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Very Steep	Very Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features
Valley Width (ft): **300**
Width Determination: **Estimated**
Confinement Type: **Semi-confined**
Rock Gorge?: **No**
Human-caused Change?: **no**

Step 2. Stream Channel

2.1 Bankfull Width: **98**
2.2 Max Depth (ft): **6.50**
2.3 Mean Depth (ft): **3.27**
2.4 Floodprone Width (ft): **250**

Notes:
WWTF outfall on RB near d/s end of segment. Old landfill (household rubbish) exposed in high bank failures along RB. Rip-rap length along RB at outfall is overstated; actual length = 10 feet; FIT would not accept L < 80 ft.

Step 2. (Contued)

2.5 Aband. Floodpln: **6.50** ft.
Human Elev Floodpln: **0.00** ft.
2.6 Width/Depth Ratio: **30.00**
2.7 Entrenchment Ratio: **2.55**
2.8 Incision Ratio: **1.00**
Human Elevated Inc Rat: **0.00**
2.9 Sinuosity: **Oxbows**
2.10 Riffles Type: **Not Applicable**
2.11 Riffle/Step Spacing (ft): **0**

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	0 %
Fine Gravel	3 %
Sand	97 %
Silt and smaller	0 %

Silt/Clay Present?: **Yes**
Detritus: **5** %
Large Woody: **56**

2.13 Average Largest Particle on

Bed	10.0	mm
Bar	5.0	mm

2.14 Stream Type
Stream Type: **C**
Bed Material: **Sand**
Subclass Slope: **c**
Bed Form: **Dune-Ripple**
Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	Multiple	26.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks
Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Clay	Clay
Consistency	Cohesive	Cohesive
Lower		
Material Type	Clay	Clay
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	2,256	1,869
Erosion Height (ft)	9.94	21.03
Revetmt. Type	None	Rip-Rap
Revetmt. Length (ft)	0	86

Near Bank Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Deciduous	Deciduous

Bank Canopy	Left	Right
Canopy %	51-75	51-75

Mid-Channel Canopy: **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Abundant**
4.2 Adjacent Wetlands: **Minimal**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **2**
4.5 Flow Regulation Type
Flow Regulation Use
Impoundments: **Small**
Impoundmt. Location: **Upstream**
4.6 Up/Down strm flow reg: **Up Stream**
(old) Upstrm Flow Reg: **Run-of-river**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	2	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	2	1

Diagonal	Delta	Island
0	3	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
2	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal: **No**
5.5 Straightening: **None**
Straightening Length: **0**
5.5 Dredging: **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River

Phase 2 Segment Summary

April 15, 2008 SGAT Version: 3

Stream: **Castleton River** Reach # **T02.02** Segment: **B** Completion Date: **July 13, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS, ES** Why Not assessed: Rain: **Yes**

Segment Length (ft): **6,938** Segment Location: **From Adams St Xg downstream to Fair Haven WWTF**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	599	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	1,132	446

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Extremely
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Silt/Clay	Silt/Clay

1.5 Valley Features

Valley Width (ft) **150**

Width Determination **Estimated**

Confinement Type **Narrowly**

Rock Gorge? **No**

Human-caused Change? **no**

Step 2. Stream Channel

2.1 Bankfull Width **110**

2.2 Max Depth (ft) **4.10**

2.3 Mean Depth (ft) **2.93**

2.4 Floodprone Width (ft) **122**

Notes:

Old landfill (cars, machinery) exposed along RB in d/s end of segment. Geologically incised reach. Three historic low-head dams in u/s reach constructed on bedrock falls. Limited encroachment by fill (slate) and development in upstream 500 feet; rest of

Step 2. (Contued)

2.5 Aband. Floodpln **4.10** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **37.44**

2.7 Entrenchment Ratio **1.11**

2.8 Incision Ratio **1.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Oxbows**

2.10 Riffles Type **Complete**

2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	3 %
Coarse Gravel	7 %
Fine Gravel	55 %
Sand	35 %
Silt and smaller	0 %

Silt/Clay Present? **Yes**

Detritus **15** %

Large Woody **112**

2.13 Average Largest Particle on

Bed **50.0** mm

Bar **5.0** mm

2.14 Stream Type

Stream Type: **B**

Bed Material: **Gravel**

Subclass Slope: **c**

Bed Form: **Riffle-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

B **4** **c** **Riffle-Pool**

3.3 old	Amount	Mean Height
Failures	Multiple	36.10
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Clay	Clay
Consistency	Cohesive	Cohesive
Lower		
Material Type	Clay	Clay
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	1,741	1,434
Erosion Height (ft)	23.33	33.55
Revetmt. Type	Rip-Rap	Multiple
Revetmt. Length (ft)	352	823

Near Bank Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Deciduous	Deciduous

Bank Canopy	Left	Right
Canopy %	51-75	51-75

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Abundant**

4.2 Adjacent Wetlands **Minimal**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **4**

4.5 Flow Regulation Type

Flow Regulation Use

Impoundments **Small**

Impoundmt. Location **Upstream**

4.6 Up/Down strm flow reg **Up Stream**

(old) Upstrm Flow Reg **Run-of-river**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	1	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	2	1
Diagonal	**Delta**	**Island**
0	0	1

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
2	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **None**

Straightening Length: **0**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: **Castleton River** — **Phase 2 Segment Summary** — — April 15, 2008 SGAT Version: 3

Stream: **Castleton River** — Reach # **T02.03** — Segment: **0** — Completion Date: **August 23, 2006**

Organization: **Poultney/Mettowee NRCD** — Observers: **KLU, HS, SH** — Why Not assessed: **impounded** — Rain: **Yes**

Segment Length (ft): **1,996** — Segment Location: **From Depot Street Xg downstream to Adams Street Xg.**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **None**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	517	1,014
height	0	0
Railroads	907	0
height	0	0
Improved Paths	0	0
height	0	0
Development	242	1,717

1.4 Adjacent Side	Left	Right
Hillside Slope	Very Steep	Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Always	Always
Texture	Bedrock	Bedrock

1.5 Valley Features

Valley Width (ft) **100**

Width Determination **Estimated**

Confinement Type **Narrowly**

Rock Gorge? **No**

Human-caused Change? **yes**

Step 2. Stream Channel

2.1 Bankfull Width **0**

2.2 Max Depth (ft) **0.00**

2.3 Mean Depth (ft) **0.00**

2.4 Floodprone Width (ft) **0**

Notes:

Reach is impounded by 3 historic run-of-river slate dams constructed on bedrock falls. Middle dam breached in 2004, exposing previous impounded upstream channel with bedrock controls. A long history of industrial, commercial and residential uses have

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **0.00**

2.7 Entrenchment Ratio **0.00**

2.8 Incision Ratio **0.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity

2.10 Riffles Type

2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Bedrock	0%
Boulder	0%
Cobble	0%
Coarse Gravel	0%
Fine Gravel	0%
Sand	0%
Silt and smaller	0%

Silt/Clay Present?

Detritus **0** %

Large Woody **0**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

Not Evaluated

2.14 Stream Type

Stream Type: **B**

Bed Material: **Bedrock**

Subclass Slope: **b**

Bed Form: **Step-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive
Lower		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	0	0
Erosion Height (ft)	0.00	0.00
Revetmt. Type	Multiple	Multiple
Revetmt. Length (ft)	1,013	1,064

Near Bank Veg. Type	Left	Right
Dominant	Bare	Bare
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	1-25	1-25

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	0-25	0-25
Sub-dominant	0-25	0-25
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Commercial	Residential
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **None**

4.2 Adjacent Wetlands **Minimal**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **Small Run of**

Flow Regulation Use **Other**

Impoundments **Small**

Impoundmt. Location **In Reach**

4.6 Up/Down strm flow reg **None**

(old) Upstrm Flow Reg **Run-of-river**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	3	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	2	0
Diagonal	**Delta**	**Island**
0	0	1

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
1	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **None**

Straightening Length: **0**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River

Phase 2 Segment Summary

April 15, 2008 SGAT Version: 3

Stream: **Castleton River** Reach # **T02.04** Segment: **0** Completion Date: **September 1, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, ES, SH, SL** Why Not assessed: Rain: **Yes**

Segment Length (ft): **3,389** Segment Location: **From the vicinity of the Clarendon-Pittsford Railroad crossing downstream to the River**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **None**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	979	340
height	0	0
Railroads	2,582	0
height	0	0
Improved Paths	0	0
height	0	0
Development	508	408

1.4 Adjacent Side	Left	Right
Hillside Slope	Steep	Flat
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **700**

Width Determination **Estimated**

Confinement Type **Broad**

Rock Gorge? **No**

Human-caused Change? **Yes**

Step 2. Stream Channel

2.1 Bankfull Width **0**

2.2 Max Depth (ft) **0.00**

2.3 Mean Depth (ft) **0.00**

2.4 Floodprone Width (ft) **0**

Notes:

Human-caused change in valley width by railroad, and by roads near d/s end of reach - reduces valley confinement ratio (from Very Broad to Broad) but reach still unconfined. Straightening possible historically in discrete locations along railroad and along roads at

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **0.00**

2.7 Entrenchment Ratio **0.00**

2.8 Incision Ratio **0.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity

2.10 Riffles Type **Not Applicable**

2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Bedrock	0%
Boulder	0%
Cobble	0%
Coarse Gravel	0%
Fine Gravel	2%
Sand	90%
Silt and smaller	8%

Silt/Clay Present? **Yes**

Detritus **0** %

Large Woody **20**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

2.14 Stream Type

Stream Type: **E**

Bed Material: **Sand**

Subclass Slope: **None**

Bed Form: **Dune-Ripple**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Moderate**

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Cohesive	Cohesive
Lower		
Material Type	Silt	Silt
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	66	76
Erosion Height (ft)	5.00	4.00
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	806	267

Near Bank Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Deciduous	Deciduous

Bank Canopy	Left	Right
Canopy %	26-50	26-50

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Abundant**

4.2 Adjacent Wetlands **Abundant**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **2**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

4.6 Up/Down strm flow reg **Down Stream**

(old) Upstrm Flow Reg **None**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	1	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	0	0
Diagonal	**Delta**	**Island**
0	0	1

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **253**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River | **Phase 2 Segment Summary** | | April 15, 2008 SGAT Version: 3

Stream: **Castleton River** Reach # **T02.05** Segment: **0** Completion Date: **September 1, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, ES, SH, SL** Why Not assessed: Rain: **Yes**

Segment Length (ft): **7,849** Segment Location: **From the confluence of Lake Bomoseen outlet channel downstream nearly to the Clarendon**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **None**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	3,461	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Steep	Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **1,000**

Width Determination **Estimated**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **Yes**

Step 2. Stream Channel

2.1 Bankfull Width **0**

2.2 Max Depth (ft) **0.00**

2.3 Mean Depth (ft) **0.00**

2.4 Floodprone Width (ft) **0**

Notes:

Human-caused change in valley width (1.5) is due to railroad, built historically, possibly in 1849 (Adams, 1870). Straightening (5.5) possible historically along railroad. Pasture along right and left corridors (3.3) is fallow. Cross section not measured, as reach was

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **0.00**

2.7 Entrenchment Ratio **0.00**

2.8 Incision Ratio **0.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Moderate**

2.10 Riffles Type **Not Applicable**

2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Bedrock	0%
Boulder	0%
Cobble	0%
Coarse Gravel	0%
Fine Gravel	1%
Sand	90%
Silt and smaller	9%

Silt/Clay Present? **Yes**

Detritus **5** %

Large Woody **104**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

2.14 Stream Type

Stream Type: **E**

Bed Material: **Sand**

Subclass Slope: **None**

Bed Form: **Dune-Ripple**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	One	25.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Moderate**

Bank Texture	Left	Right
Upper		
Material Type	Silt	Silt
Consistency	Cohesive	Cohesive
Lower		
Material Type	Silt	Silt
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	2,122	1,850
Erosion Height (ft)	3.80	3.51
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	52	407

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	51-75	51-75

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	0-25
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Shrubs/Saplin
Sub-dominant	Shrubs/Saplin	Pasture
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Abundant**

4.2 Adjacent Wetlands **Abundant**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **15**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

4.6 Up/Down strm flow reg **Down Stream**

(old) Upstrm Flow Reg **None**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
1	1	0
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
2	1	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **806**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River
Stream: Castleton River — Reach # T02.06 — Segment: 0
Organization: Poultney/Mettowee NRCD — Observers: KLU, ES, SH, SL — Why Not assessed: — Rain: Yes
Segment Length (ft): 5,302 — Segment Location: From wetlands upstream of the Blissville Road crossing downstream to the confluence of

Phase 2 Segment Summary

April 15, 2008 SGAT Version: 3
Completion Date: **September 1, 2005**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **None**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	475	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	213	101

1.4 Adjacent Side	Left	Right
Hillside Slope	Steep	Steep
Continuous w/	Never	Never
W/in 1 Bankfill	Never	Never
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **1,930**
Width Determination **Estimated**
Confinement Type **Very Broad**
Rock Gorge? **No**
Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **35**
2.2 Max Depth (ft) **2.45**
2.3 Mean Depth (ft) **1.60**
2.4 Floodprone Width (ft) **500**

Notes:

Minor encroachment along LB just downstream of Blissville Rd crossing. This was not counted as a human-caused change in valley width. Straightening (5.5) possible at Blissville Rd bridge crossing and along agricultural fields upstream of bridge. Beaver

Step 2. (Contued)

2.5 Aband. Floodpln **2.45** ft.
Human Elev Floodpln **0.00** ft.
2.6 Width/Depth Ratio **21.87**
2.7 Entrenchment Ratio **14.29**
2.8 Incision Ratio **1.00**
Human Elevated Inc Rat **0.00**
2.9 Sinuosity **Low**
2.10 Riffles Type **Not Applicable**
2.11 Riffle/Step Spacing (ft) **N/A**

2.12 Substrate Composition

Bedrock	0%
Boulder	0%
Cobble	0%
Coarse Gravel	5%
Fine Gravel	65%
Sand	30%
Silt and smaller	0%

Silt/Clay Present? **Yes**
Detritus **15** %
Large Woody **67**

2.13 Average Largest Particle on

Bed **50.0** mm
Bar **N/A** mm

2.14 Stream Type

Stream Type: **C**
Bed Material: **Gravel**
Subclass Slope: **None**
Bed Form: **Dune-Ripple**
Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive
Lower		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	1,972	1,047
Erosion Height (ft)	4.00	4.00
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	293	813

Near Bank Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Herbaceous	Herbaceous

Bank Canopy	Left	Right
Canopy %	1-25	1-25

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	26-50
Sub-dominant	26-50	>100
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Crop	Pasture
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Abundant**
4.2 Adjacent Wetlands **Abundant**
4.3 Flow Status **Moderate**
4.4 # of Debris Jams **7**
4.5 Flow Regulation Type **None**
Flow Regulation Use
Impoundments **None**
Impoundmt. Location
4.6 Up/Down strm flow reg
(old) Upstrm Flow Reg **None**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **2**
Affected Length (ft) **550**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
1	0	0
Diagonal	**Delta**	**Island**
0	0	1

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
2	1	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **No**
5.5 Straightening **Straightening**
Straightening Length: **423**
5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River | Phase 2 Segment Summary | | April 15, 2008 SGAT Version: 3

Stream: Castleton River | Reach # **T02.07** | Segment: **0** | Completion Date:

Organization: **Poultney/Mettowee NRCD** | Observers: **Kari Dolan, RMP** | Why Not assessed: **Other (to be explained in** | Rain:

Segment Length (ft): **0** | Segment Location:

QC Status - Staff: Provisional Cons

Provisional

Step 1. Valley and Floodplain

1.1 Segmentation

1.2 Alluvial Fan

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	**0**	**0**
height	**0**	**0**
Roads	**0**	**0**
height	**0**	**0**
Railroads	**0**	**0**
height	**0**	**0**
Improved Paths	**0**	**0**
height	**0**	**0**
Development	**0**	**0**

1.4 Adjacent Side	Left	Right
Hillside Slope		
Continuous w/		
W/in 1 Bankfill		
Texture		

1.5 Valley Features

Valley Width (ft) **0**

Width Determination

Confinement Type

Rock Gorge?

Human-caused Change?

Step 2. Stream Channel

2.1 Bankfull Width **0**

2.2 Max Depth (ft) **0.00**

2.3 Mean Depth (ft) **0.00**

2.4 Floodprone Width (ft) **0**

Notes:

KDolan, 02/18/08: I understand that is reach was not assessed; I placed the reach in the DMS in order to create provisional FEH

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **0.00**

2.7 Entrenchment Ratio **0.00**

2.8 Incision Ratio **0.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity

2.10 Riffles Type

2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Silt/Clay Present?

Detritus **0** %

Large Woody **0**

2.13 Average Largest Particle on

Bed **0.0**

Bar **0.0**

2.14 Stream Type

Stream Type: **C**

Bed Material: **Gravel**

Subclass Slope: **None**

Bed Form: **Riffle-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures		**0.00**
Gullies		**0.00**

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope

Bank Texture	Left	Right
Upper		
Material Type		
Consistency		
Lower		
Material Type		
Consistency		

Bank Erosion	Left	Right
Erosion Length (ft)	**0**	**0**
Erosion Height (ft)	**0.00**	**0.00**
Revetmt. Type		
Revetmt. Length (ft)	**0**	**0**

Near Bank Veg. Type	Left	Right
Dominant		
Sub-dominant		

Bank Canopy	Left	Right
Canopy %		
Mid-Channel Canopy		

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant		
Sub-dominant		
W less than 25	**0**	**0**

Buffer Veg. Type	Left	Right
Dominant		
Sub-dominant		

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant		
Sub-dominant		
Mass Failures	**0**	**0**
Height	**0**	**0**
Gullies	**0**	**0**
Height	**0**	**0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps

4.2 Adjacent Wetlands

4.3 Flow Status

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type

Flow Regulation Use

Impoundments

Impoundmt. Location

4.6 Up/Down strm flow reg

(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	**0**	Road Ditch	**0**
Other	**0**	Tile Drain	**0**
Overland Flow	**0**	Urb Strm Wtr Pipe	**0**

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	**0**	**0**
Diagonal	Delta	Island
0	**0**	**0**

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	**0**	**0**	**0**

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	**0**	

5.4 Stream Ford or Animal

5.5 Straightening

Straightening Length: **0**

5.5 Dredging

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: **Castleton River** | **Phase 2 Segment Summary** | April 15, 2008 SGAT Version: 3

Stream: **Castleton River** | Reach # **T02.08** | Segment: **0** | Completion Date:

Organization: **Poultney/Mettowee NRCD** | Observers: **Kari Dolan, RMP** | Why Not assessed: **Other (to be explained in** | Rain:

Segment Length (ft): **0** | Segment Location:

QC Status - Staff: Provisional Cons Provisional

Step 1. Valley and Floodplain

1.1 Segmentation

1.2 Alluvial Fan

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope		
Continuous w/		
W/in 1 Bankfill		
Texture		

1.5 Valley Features

Valley Width (ft) **0**

Width Determination

Confinement Type

Rock Gorge?

Human-caused Change?

Step 2. Stream Channel

2.1 Bankfull Width **0**

2.2 Max Depth (ft) **0.00**

2.3 Mean Depth (ft) **0.00**

2.4 Floodprone Width (ft) **0**

Notes:

KDolan, RMP, 2/18/08: not assessed; reason unknown; included adm. judgment in order to draw provisional FEH

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **0.00**

2.7 Entrenchment Ratio **0.00**

2.8 Incision Ratio **0.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity

2.10 Riffles Type

2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Silt/Clay Present?

Detritus **0** %

Large Woody **0**

2.13 Average Largest Particle on

Bed **0.0**

Bar **0.0**

2.14 Stream Type

Stream Type: **C**

Bed Material: **Gravel**

Subclass Slope: **None**

Bed Form: **Riffle-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures		0.00
Gullies		0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope

Bank Texture	Left	Right
Upper		
Material Type		
Consistency		
Lower		
Material Type		
Consistency		

Bank Erosion	Left	Right
Erosion Length (ft)	0	0
Erosion Height (ft)	0.00	0.00
Revetmt. Type		
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant		
Sub-dominant		

Bank Canopy	Left	Right
Canopy %		
Mid-Channel Canopy		

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant		
Sub-dominant		
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant		
Sub-dominant		

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant		
Sub-dominant		
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps

4.2 Adjacent Wetlands

4.3 Flow Status

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type

Flow Regulation Use

Impoundments

Impoundmt. Location

4.6 Up/Down strm flow reg

(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	0	0
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	

5.4 Stream Ford or Animal

5.5 Straightening

Straightening Length: **0**

5.5 Dredging

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: **Castleton River**
Stream: **Pond Hill Brook** Reach # **T02.08-s1.01** Segment: **A** Completion Date: **July 31, 2006**
Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Why Not assessed: Rain: **Yes**
Segment Length (ft): **513** Segment Location: **Downstream segment of the reach, from Route 4A (Main Street) Xg to confluence with the**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Planform and Scope**
1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	156	0
height	0	0
Roads	432	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	111	94

1.4 Adjacent Side	Left	Right
Hillside Slope	Hilly	Hilly
Continuous w/	Never	Never
W/in 1 Bankfill	Never	Never
Texture	Not Evalua	Not Evalua

1.5 Valley Features
Valley Width (ft) **150**
Width Determination **Estimated**
Confinement Type **Broad**
Rock Gorge? **No**
Human-caused Change? **yes**

Step 2. Stream Channel

2.1 Bankfull Width **16**
2.2 Max Depth (ft) **2.70**
2.3 Mean Depth (ft) **1.90**
2.4 Floodprone Width (ft) **250**

Notes:
Based on review of historic maps, this section of the reach appears to have been channelized some time after 1897 and before 1964, to follow Cemetery Drive and join the Castleton River at a point 800 feet upstream of its former confluence (see report for further

Step 2. (Contued)

2.5 Aband. Floodpln **3.70** ft.
Human Elev Floodpln **0.00** ft.
2.6 Width/Depth Ratio **8.42**
2.7 Entrenchment Ratio **15.63**
2.8 Incision Ratio **1.37**
Human Elevated Inc Rat **0.00**
2.9 Sinuosity **Low**
2.10 Riffles Type **Not Applicable**
2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Bedrock	0%
Boulder	0%
Cobble	0%
Coarse Gravel	0%
Fine Gravel	100%
Sand	0%
Silt and smaller	0%

Silt/Clay Present? **Yes**
Detritus **2** %
Large Woody **0**

2.13 Average Largest Particle on
Bed **0.0**
Bar **0.0**

Not Evaluated

2.14 Stream Type
Stream Type: **E**
Bed Material: **Gravel**
Subclass Slope: **c**
Bed Form: **Plane Bed**
Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks
Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive
Lower		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	0	0
Erosion Height (ft)	0.00	0.00
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	50	225

Near Bank Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Deciduous	Deciduous

Bank Canopy	Left	Right
Canopy %	1-25	1-25

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	0-25	0-25
Sub-dominant	0-25	0-25
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Deciduous	Herbaceous
Sub-dominant	Herbaceous	Deciduous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Residential	Residential
Sub-dominant	None	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **None**
4.2 Adjacent Wetlands **None**
4.3 Flow Status **Moderate**
4.4 # of Debris Jams **1**
4.5 Flow Regulation Type
Flow Regulation Use
Impoundments **Small**
Impoundmt. Location **Upstream**
4.6 Up/Down strm flow reg **Up Stream**
(old) Upstrm Flow Reg **Run-of-river**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**
Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	0	0
Diagonal	Delta	Island
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **No**
5.5 Straightening **Straightening**
Straightening Length: **427**
5.5 Dredging **Dredging**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River **Phase 2 Segment Summary** April 15, 2008 SGAT Version: 3

Stream: **Pond Hill Brook** Reach # **T02.08-s1.01** Segment: **B** Completion Date: **July 31, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Why Not assessed: Rain: **Yes**

Segment Length (ft): **927** Segment Location: **Segment northwest of Castleton State College campus downstream of bedrock gorge,**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	376	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Hilly	Hilly
Continuous w/	Sometimes	Never
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

- Valley Width (ft) **230**
- Width Determination **Estimated**
- Confinement Type **Very Broad**
- Rock Gorge? **No**
- Human-caused Change? **no**

Step 2. Stream Channel

- 2.1 Bankfull Width **18**
- 2.2 Max Depth (ft) **1.50**
- 2.3 Mean Depth (ft) **1.10**
- 2.4 Floodprone Width (ft) **85**

Notes:

Diversion of flow (4.7) from small impoundment behind low-head dam is directed to a right-bank constructed pond (c. 1970s - 1980s). Return flow via corrugated steel culvert approximately 400 ft downstream. Feature indexed as a

Step 2. (Contued)

- 2.5 Aband. Floodpln **1.70** ft.
- Human Elev Floodpln **0.00** ft.
- 2.6 Width/Depth Ratio **16.36**
- 2.7 Entrenchment Ratio **4.72**
- 2.8 Incision Ratio **1.13**
- Human Elevated Inc Rat **0.00**
- 2.9 Sinuosity **Moderate**
- 2.10 Riffles Type **Sedimented**
- 2.11 Riffle/Step Spacing (ft) **155**

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	3 %
Coarse Gravel	32 %
Fine Gravel	45 %
Sand	20 %
Silt and smaller	0 %

- Silt/Clay Present? **Yes**
- Detritus **5** %
- # Large Woody **2**

2.13 Average Largest Particle on

- Bed **0.0**
- Bar **0.0**

Not Evaluated

2.14 Stream Type

- Stream Type: **C**
- Bed Material: **Gravel**
- Subclass Slope: **c**
- Bed Form: **Riffle-Pool**
- Field Measured Slope:

2.15 Reference Stream Type (if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Moderate**

Bank Texture	Left	Right
Upper		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive
Lower		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	136	277
Erosion Height (ft)	1.00	1.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Deciduous	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	26-50	26-50

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	26-50
Sub-dominant	26-50	0-25
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Commercial	Residential
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

- 4.1 Springs / Seeps **Minimal**
- 4.2 Adjacent Wetlands **Minimal**
- 4.3 Flow Status **Moderate**
- 4.4 # of Debris Jams **5**
- 4.5 Flow Regulation Type **Small Bypass**
  - Flow Regulation Use **Other**
  - Impoundments **Small**
  - Impoundmt. Location **In Reach**
- 4.6 Up/Down strm flow reg **None**
  - (old) Upstrm Flow Reg **Diversion**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	1	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	3	0
Diagonal	**Delta**	**Island**
0	1	1

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
1	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
1	0	No

- 5.4 Stream Ford or Animal **No**
- 5.5 Straightening **None**
  - Straightening Length: **0**
- 5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Phase 2 Segment Summary

April 15, 2008 SGAT Version: 3

Project: **Castleton River**
Stream: **Pond Hill Brook** Reach # **T02.08-s1.01** Segment: **C** Completion Date: **July 31, 2006**
Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Why Not assessed: **bedrock gorge** Rain: **Yes**
Segment Length (ft): **677** Segment Location: **Bedrock gorge west of Castleton State College campus.**

QC Status - Staff: **Provisional** **Cons** **Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**
1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	283	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Extremely
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Always	Always
Texture	Bedrock	Bedrock

1.5 Valley Features
Valley Width (ft) **30**
Width Determination **Estimated**
Confinement Type **Narrowly**
Rock Gorge? **Yes**
Human-caused Change? **no**

Step 2. Stream Channel

2.1 Bankfull Width **0**
2.2 Max Depth (ft) **0.00**
2.3 Mean Depth (ft) **0.00**
2.4 Floodprone Width (ft) **0**

Notes:
Segment is bedrock gorge, therefore no RGA/ RHA or XS completed, as per protocols. Wooden footbridge spanning the gorge was not a constrictor since it is elevated well above the bankfull and flood prone elevations. VHD does not match

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.
Human Elev Floodpln **0.00** ft.
2.6 Width/Depth Ratio **0.00**
2.7 Entrenchment Ratio **0.00**
2.8 Incision Ratio **0.00**
Human Elevated Inc Rat **0.00**
2.9 Sinuosity
2.10 Riffles Type
2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Bedrock	100 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	0 %
Fine Gravel	0 %
Sand	0 %
Silt and smaller	0 %

Silt/Clay Present? **No**
Detritus **5** %
Large Woody **5**

2.13 Average Largest Particle on
Bed **N/A**
Bar **N/A**
Not Evaluated

2.14 Stream Type
Stream Type: **B**
Bed Material: **Bedrock**
Subclass Slope: **b**
Bed Form: **Cascade**
Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)
B **1** **b** **Cascade**

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks
Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive
Lower		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	0	0
Erosion Height (ft)	0.00	0.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Coniferous	Coniferous

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	51-100
Sub-dominant	None	26-50
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	Commercial
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**
4.2 Adjacent Wetlands **None**
4.3 Flow Status **Moderate**
4.4 # of Debris Jams **2**
4.5 Flow Regulation Type
Flow Regulation Use
Impoundments **Large**
Impoundmt. Location **Upstream**
4.6 Up/Down strm flow reg **Up Stream**
(old) Upstrm Flow Reg **Run-of-river**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	2	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**
Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
1	1	0
Diagonal	**Delta**	**Island**
1	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **No**
5.5 Straightening **None**
Straightening Length: **0**
5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River — **Phase 2 Segment Summary** — — April 15, 2008 SGAT Version: 3

Stream: **Pond Hill Brook** Reach # **T02.08-s1.01** Segment: **D** Completion Date: **July 31, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Why Not assessed: Rain: **Yes**

Segment Length (ft): **1,622** Segment Location: **From railroad crossing, south and west of athletic fields, through Castleton State Dam**

QC Status - Staff: **Provisional Cons Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **Other Reason**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	45	0
height	0	0
Roads	0	0
height	0	0
Railroads	479	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	42

1.4 Adjacent Side	Left	Right
Hillside Slope	Hilly	Hilly
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **300**

Width Determination **Estimated**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **yes**

Step 2. Stream Channel

2.1 Bankfull Width **14**

2.2 Max Depth (ft) **1.90**

2.3 Mean Depth (ft) **1.36**

2.4 Floodprone Width (ft) **400**

Notes:

Segment consists of a section of brook that was redirected around the athletic fields of Castleton State College to a former left-bank tributary channel. Actually, consists of 960 ft of C channel, 300 ft of B1-casc channel and 695 feet wetlands draining to impoundment

Step 2. (Contued)

2.5 Aband. Floodpln **1.90** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **9.93**

2.7 Entrenchment Ratio **29.63**

2.8 Incision Ratio **1.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Sedimented**

2.11 Riffle/Step Spacing (ft) **220**

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	30 %
Fine Gravel	55 %
Sand	15 %
Silt and smaller	0 %

Silt/Clay Present? **Yes**

Detritus **2** %

Large Woody **1**

2.13 Average Largest Particle on

Bed **0.0**

Bar **0.0**

Not Evaluated

2.14 Stream Type

Stream Type: **C**

Bed Material: **Gravel**

Subclass Slope: **c**

Bed Form: **Riffle-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Moderate**

Bank Texture	Left	Right
Upper		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive
Lower		
Material Type	Mix	Mix
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	73	72
Erosion Height (ft)	1.00	3.00
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	17	93

Near Bank Veg. Type	Left	Right
Dominant	Coniferous	Coniferous
Sub-dominant	Deciduous	Deciduous

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	0-25
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	Residential
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Abundant**

4.2 Adjacent Wetlands **Abundant**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **Large Run of**

Flow Regulation Use **Other**

Impoundments **Large**

Impoundmt. Location **In Reach**

4.6 Up/Down strm flow reg **None**

(old) Upstrm Flow Reg **Run-of-river**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	4	1
Diagonal	Delta	Island
2	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
2	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **750**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River — **Phase 2 Segment Summary** — April 15, 2008 SGAT Version: 3

Stream: Pond Hill Brook | Reach # T02.08-s1.01 | Segment: E | Completion Date: July 31, 2006

Organization: Poultney/Mettowee NRCD | Observers: KLU, HS | Why Not assessed: | Rain: Yes

Segment Length (ft): 1,711 | Segment Location: Upstream end of reach to railroad Xg.

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation: Channel Dimensions

1.2 Alluvial Fan: Yes

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	168	0
height	0	0
Improved Paths	0	0
height	0	0
Development	57	63

1.4 Adjacent Side	Left	Right
Hillside Slope	Hilly	Hilly
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft): 350
Width Determination: Estimated
Confinement Type: Very Broad
Rock Gorge?: No
Human-caused Change?: yes

Step 2. Stream Channel

2.1 Bankfull Width: 19
2.2 Max Depth (ft): 2.10
2.3 Mean Depth (ft): 1.55
2.4 Floodprone Width (ft): 500

Notes:

Human caused change in VW marked by railroad (LB) and Staso Road (RB), but not enough to cause significant change in valley confinement. Historic straightening inferred during construction of LB railroad in late 1800s (see report). Segment E coincident

Step 2. (Contued)

2.5 Aband. Floodpln: 2.10 ft.
Human Elev Floodpln: 0.00 ft.
2.6 Width/Depth Ratio: 11.94
2.7 Entrenchment Ratio: 27.03
2.8 Incision Ratio: 1.00
Human Elevated Inc Rat: 0.00
2.9 Sinuosity: Low
2.10 Riffles Type: Sedimented
2.11 Riffle/Step Spacing (ft): 200

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	5 %
Coarse Gravel	33 %
Fine Gravel	33 %
Sand	29 %
Silt and smaller	0 %

Silt/Clay Present?: Yes
Detritus: 5 %
Large Woody: 8

2.13 Average Largest Particle on

Bed	64.0	mm
Bar	60.0	mm

2.14 Stream Type

Stream Type: C
Bed Material: Gravel
Subclass Slope: c
Bed Form: Riffle-Pool
Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: Moderate

Bank Texture	Left	Right
Upper		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive
Lower		
Material Type	Mix	Mix
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	303	24
Erosion Height (ft)	4.09	3.65
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	39	39

Near Bank Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	26-50	26-50

Mid-Channel Canopy: Open

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	26-50	26-50
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Deciduous	Deciduous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Forest	Forest
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: Minimal
4.2 Adjacent Wetlands: Minimal
4.3 Flow Status: Moderate
4.4 # of Debris Jams: 8
4.5 Flow Regulation Type: None
Flow Regulation Use:
Impoundments: None
Impoundmt. Location:
4.6 Up/Down strm flow reg
(old) Upstrm Flow Reg: None

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams: 0
Affected Length (ft): 0

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
7	7	2
Diagonal	**Delta**	**Island**
7	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
3	0	0	1

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
1	0	No

5.4 Stream Ford or Animal: No
5.5 Straightening: Straightening
Straightening Length: 1,685
5.5 Dredging: None

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project:	Castleton River		**Phase 2 Segment Summary**	page 1 of 2	April 15, 2008 SGAT Version: 3
Stream:	**Pond Hill Brook**	Reach #	**T02.08-s1.02**	Segment: **0**	Completion Date: **July 31, 2006**
Organization:	**Poultney/Mettowee NRCD**	Observers:	**KLU, HS**	Why Not assessed:	Rain: **Yes**
Segment Length (ft):	**2,537**	Segment Location:	**Reach along the south side of Staso Road between slate quarry on left bank and transfer**		

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **None**

1.2 Alluvial Fan **Yes**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	**0**	**0**
height	**0**	**0**
Roads	**986**	**0**
height	**0**	**0**
Railroads	**1,101**	**0**
height	**0**	**0**
Improved Paths	**0**	**0**
height	**0**	**0**
Development	**1,126**	**95**

1.4 Adjacent Side	Left	Right
Hillside Slope	**Steep**	**Very Steep**
Continuous w/	**Never**	**Never**
W/in 1 Bankfill	**Sometimes**	**Sometimes**
Texture	**Other**	**Not Evalua**

1.5 Valley Features

Valley Width (ft)	**60**
Width Determination	**Estimated**
Confinement Type	**Semi-confined**
Rock Gorge?	**No**
Human-caused Change?	**yes**

Step 2. Stream Channel

2.1 Bankfull Width	**17**
2.2 Max Depth (ft)	**1.50**
2.3 Mean Depth (ft)	**0.91**
2.4 Floodprone Width (ft)	**22**

Notes:

Human caused change in VW marked by Staso Rd (RB), railroad (LB), quarry fill (LB), commercial and residential encroachments (RB). Natural alluvial fan setting reversed through historic dredging, channelization, armoring, and above encroachments.

Step 2. (Contued)

2.5 Aband. Floodpln	**9.30** ft.
Human Elev Floodpln	**0.00** ft.
2.6 Width/Depth Ratio	**18.68**
2.7 Entrenchment Ratio	**1.26**
2.8 Incision Ratio	**6.20**
Human Elevated Inc Rat	**0.00**
2.9 Sinuosity	**Low**
2.10 Riffles Type	**Complete**
2.11 Riffle/Step Spacing (ft)	**500**

2.12 Substrate Composition

Bedrock	**0** %
Boulder	**5** %
Cobble	**24** %
Coarse Gravel	**25** %
Fine Gravel	**19** %
Sand	**27** %
Silt and smaller	**0** %

Silt/Clay Present?	**Yes**
Detritus	**10** %
# Large Woody	**7**

2.13 Average Largest Particle on

Bed	**300.0**	**mm**
Bar	**90.0**	**mm**

2.14 Stream Type

Stream Type:	**F**
Bed Material:	**Gravel**
Subclass Slope:	**c**
Bed Form:	**Plane Bed**
Field Measured Slope:	

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	**One**	**12.00**
Gullies	**One**	**12.00**

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	**Mix**	**Mix**
Consistency	**Cohesive**	**Cohesive**
Lower		
Material Type	**Boulder/Cobbl**	**Boulder/Cobbl**
Consistency	**Cohesive**	**Cohesive**

Bank Erosion	Left	Right
Erosion Length (ft)	**189**	**340**
Erosion Height (ft)	**5.18**	**4.40**
Revetmt. Type	**Rip-Rap**	**Rip-Rap**
Revetmt. Length (ft)	**2,382**	**437**

Near Bank Veg. Type	Left	Right
Dominant	**Herbaceous**	**Herbaceous**
Sub-dominant	**Shrubs/Saplin**	**Shrubs/Saplin**

Bank Canopy	Left	Right
Canopy %	**51-75**	**51-75**
Mid-Channel Canopy	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**0-25**	**0-25**
Sub-dominant	**26-50**	**26-50**
W less than 25	**0**	**0**

Buffer Veg. Type	Left	Right
Dominant	**Deciduous**	**Deciduous**
Sub-dominant	**Shrubs/Saplin**	**Shrubs/Saplin**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Commercial**	**Commercial**
Sub-dominant	**Forest**	**Residential**
Mass Failures	**0**	**0**
Height	**0**	**0**
Gullies	**0**	**0**
Height	**12**	**12**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps	**Minimal**
4.2 Adjacent Wetlands	**None**
4.3 Flow Status	**Moderate**
4.4 # of Debris Jams	**6**
4.5 Flow Regulation Type	**Small Run of**
Flow Regulation Use	**Other**
Impoundments	**Small**
Impoundmt. Location	**In Reach**
4.6 Up/Down strm flow reg	**None**
(old) Upstrm Flow Reg	**Run-of-river**

4.7 StormwaterInputs

Field Ditch	**0**	Road Ditch	**0**
Other	**5**	Tile Drain	**0**
Overland Flow	**0**	Urb Strm Wtr Pipe	**0**

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
2	**5**	**6**
Diagonal	**Delta**	**Island**
1	**1**	**1**

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
3	**0**	**0**	**0**

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	**0**	**No**

5.4 Stream Ford or Animal	**No**
5.5 Straightening	**Straightening**
Straightening Length:	**2,411**
5.5 Dredging	**Dredging**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Pond Hill Brook** Reach # **T02.08-s1.03** Segment: **0** Completion Date: **July 26, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Why Not assessed: Rain: **Yes**

Segment Length (ft): **1,256** Segment Location: **Quarter mile of steep, forested bedrock channel upstream of Hadeka Stone Corporation.**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **None**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

	Length (ft) One	Both
Berms	111	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	14

1.4 Adjacent Side	Left	Right
Hillside Slope	Very Steep	Very Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Always	Always
Texture	Bedrock	Bedrock

1.5 Valley Features

- Valley Width (ft) **17**
- Width Determination **Measured**
- Confinement Type **Narrowly**
- Rock Gorge? **Yes**
- Human-caused Change? **no**

Step 2. Stream Channel

- 2.1 Bankfull Width **14**
- 2.2 Max Depth (ft) **2.40**
- 2.3 Mean Depth (ft) **1.30**
- 2.4 Floodprone Width (ft) **22**

Notes:

Bedrock bed and banks for all but upstream 150 feet (former reservoir or mill pond now sedimented in) and 200 ft near downstream end. Recorded depositional bars (St 5.1) were observed at these two ends of the reach. Left-bank berm of rubble in

Step 2. (Contued)

- 2.5 Aband. Floodpln **2.40** ft.
- Human Elev Floodpln **0.00** ft.
- 2.6 Width/Depth Ratio **10.38**
- 2.7 Entrenchment Ratio **1.59**
- 2.8 Incision Ratio **1.00**
- Human Elevated Inc Rat **0.00**
- 2.9 Sinuosity **Low**
- 2.10 Riffles Type **Not Applicable**
- 2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Bedrock	90 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	5 %
Fine Gravel	5 %
Sand	0 %
Silt and smaller	0 %

- Silt/Clay Present? **No**
- Detritus **2** %
- # Large Woody **8**

2.13 Average Largest Particle on

- Bed **N/A**
- Bar **N/A**

Not Evaluated

2.14 Stream Type

- Stream Type: **A**
- Bed Material: **Bedrock**
- Subclass Slope: **a**
- Bed Form: **Cascade**
- Field Measured Slope:

2.15 Reference Stream Type (if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive
Lower		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	0	0
Erosion Height (ft)	0.00	0.00
Revetmt. Type	Rip-Rap	None
Revetmt. Length (ft)	142	0

Near Bank Veg. Type	Left	Right
Dominant	Coniferous	Coniferous
Sub-dominant	None	None

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Coniferous	Coniferous
Sub-dominant	Deciduous	Deciduous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

- 4.1 Springs / Seeps **Minimal**
- 4.2 Adjacent Wetlands **None**
- 4.3 Flow Status **Moderate**
- 4.4 # of Debris Jams **5**
- 4.5 Flow Regulation Type **Small Run of**
- Flow Regulation Use **Other**
- Impoundments **Small**
- Impoundmt. Location **In Reach**
- 4.6 Up/Down strm flow reg **None**
- (old) Upstrm Flow Reg **Run-of-river**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

- 4.9 # of Beaver Dams **0**
- Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	1	3
Diagonal	Delta	Island
2	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
1	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
1	0	No

- 5.4 Stream Ford or Animal **No**
- 5.5 Straightening **None**
- Straightening Length: **0**
- 5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River | **Phase 2 Segment Summary** | page 1 of 2 | April 15, 2008 | SGAT Version: 3

Stream: **Pond Hill Brook** | Reach # **T02.08-s1.04** | Segment: **A** | Completion Date: **July 26, 2006**

Organization: **Poultney/Mettowee NRCD** | Observers: **KLU, HS** | Why Not assessed: **bedrock gorge** | Rain: **Yes**

Segment Length (ft): **384** | Segment Location: **Upstream end of bedrock gorge west of Pond Hill Road.**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

	Length (ft) One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Bedrock	Not Evalua

1.5 Valley Features

- Valley Width (ft) **35**
- Width Determination **Estimated**
- Confinement Type **Narrowly**
- Rock Gorge? **Yes**
- Human-caused Change? **no**

Step 2. Stream Channel

- 2.1 Bankfull Width **0**
- 2.2 Max Depth (ft) **0.00**
- 2.3 Mean Depth (ft) **0.00**
- 2.4 Floodprone Width (ft) **0**

Notes:

Short subreach of bedrock channel at downstream end of reach. Since bedrock "gorge", no RGA/RHA completed (by protocol). Former dam (breached) immediately downstream of this segment (in next reach). Segment A ends in a former mill

Step 2. (Contued)

- 2.5 Aband. Floodpln **0.00** ft.
- Human Elev Floodpln **0.00** ft.
- 2.6 Width/Depth Ratio **0.00**
- 2.7 Entrenchment Ratio **0.00**
- 2.8 Incision Ratio **0.00**
- Human Elevated Inc Rat **0.00**
- 2.9 Sinuosity
- 2.10 Riffles Type
- 2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Bedrock	0%
Boulder	0%
Cobble	0%
Coarse Gravel	0%
Fine Gravel	0%
Sand	0%
Silt and smaller	0%

- Silt/Clay Present? **No**
- Detritus **2** %
- # Large Woody **2**

2.13 Average Largest Particle on

- Bed **N/A**
- Bar **N/A**

Not Evaluated

2.14 Stream Type

- Stream Type:
- Bed Material:
- Subclass Slope:
- Bed Form:
- Field Measured Slope:

2.15 Reference Stream Type (if different from Phase 1)

B 1 a Cascade

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Moderate**

Bank Texture	Left	Right
Upper		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive
Lower		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	0	12
Erosion Height (ft)	0.00	3.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	51-100
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

- 4.1 Springs / Seeps **Minimal**
- 4.2 Adjacent Wetlands **Minimal**
- 4.3 Flow Status **Moderate**
- 4.4 # of Debris Jams **2**
- 4.5 Flow Regulation Type **None**
- Flow Regulation Use
- Impoundments **None**
- Impoundmt. Location
- 4.6 Up/Down strm flow reg
- (old) Upstrm Flow Reg **None**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

- 4.9 # of Beaver Dams **0**
- Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
2	1	1
Diagonal	Delta	Island
2	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

- 5.4 Stream Ford or Animal **No**
- 5.5 Straightening **None**
- Straightening Length: **0**
- 5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River | **Phase 2 Segment Summary** | April 15, 2008 SGAT Version: 3

Stream: **Pond Hill Brook** Reach # **T02.08-s1.04** Segment: **B** Completion Date: **July 26, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Why Not assessed: Rain: **Yes**

Segment Length (ft): **1,405** Segment Location: **Section of Pond Hill Brook which crosses Pond Hill Road at farm.**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	218	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	57

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Hilly
Continuous w/	Sometimes	Never
W/in 1 Bankfill	Sometimes	Never
Texture	Bedrock	Not Evalua

1.5 Valley Features

- Valley Width (ft) **200**
- Width Determination **Estimated**
- Confinement Type **Very Broad**
- Rock Gorge? **No**
- Human-caused Change? **yes**

Step 2. Stream Channel

2.1 Bankfull Width	23
2.2 Max Depth (ft)	0.95
2.3 Mean Depth (ft)	0.71
2.4 Floodprone Width (ft)	26

Notes:

While segment has lesser gradient than upstream segment, alluvial fan-like feature is not evident. Pond Hill Road crosses the stream valley at an oblique angle, reducing the valley width to some degree, but the encroachment does not lead to a substantial

Step 2. (Contued)

2.5 Aband. Floodpln	2.10 ft.
Human Elev Floodpln	0.00 ft.
2.6 Width/Depth Ratio	31.69
2.7 Entrenchment Ratio	1.13
2.8 Incision Ratio	2.21
Human Elevated Inc Rat	0.00
2.9 Sinuosity	Low
2.10 Riffles Type	Sedimented
2.11 Riffle/Step Spacing (ft)	150

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	19 %
Coarse Gravel	37 %
Fine Gravel	27 %
Sand	17 %
Silt and smaller	0 %

Silt/Clay Present? **Yes**

Detritus **5** %

Large Woody **13**

2.13 Average Largest Particle on

Bed	130.0	mm
Bar	115.0	mm

2.14 Stream Type

- Stream Type: **F**
- Bed Material: **Gravel**
- Subclass Slope: **b**
- Bed Form: **Riffle-Pool**
- Field Measured Slope:

2.15 Reference Stream Type (if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Moderate**

Bank Texture	Left	Right
Upper		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	37	0
Erosion Height (ft)	2.00	0.00
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	28	83

Near Bank Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Deciduous	Deciduous

Bank Canopy	Left	Right
Canopy %	1-25	1-25

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	0-25	0-25
Sub-dominant	>100	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Herbaceous	Herbaceous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Pasture	Pasture
Sub-dominant	Forest	Crop
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps	Minimal
4.2 Adjacent Wetlands	Minimal
4.3 Flow Status	Moderate
4.4 # of Debris Jams	7
4.5 Flow Regulation Type	None
Flow Regulation Use	
Impoundments	None
Impoundmt. Location	
4.6 Up/Down strm flow reg	
(old) Upstrm Flow Reg	None

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	1	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
1	12	3
Diagonal	**Delta**	**Island**
1	1	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
5	1	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
3	0	No

5.4 Stream Ford or Animal **Yes**

5.5 Straightening **Straightening**

Straightening Length: **731**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River

Phase 2 Segment Summary

April 15, 2008 SGAT Version: 3

Stream: **Pond Hill Brook** Reach # **T02.08-s1.04** Segment: **C** Completion Date: **July 26, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Why Not assessed: **bedrock gorge** Rain: **Yes**

Segment Length (ft): **636** Segment Location: **Downstream end of bedrock gorge east of Pond Hill Road.**

QC Status - Staff: **Provisional** Cons **Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Very Steep	Extremely
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Always	Always
Texture	Bedrock	Bedrock

1.5 Valley Features

Valley Width (ft) **20**

Width Determination **Estimated**

Confinement Type **Narrowly**

Rock Gorge? **Yes**

Human-caused Change? **no**

Step 2. Stream Channel

2.1 Bankfull Width **0**

2.2 Max Depth (ft) **0.00**

2.3 Mean Depth (ft) **0.00**

2.4 Floodprone Width (ft) **0**

Notes:

This segment is a subreach of steep gradient, narrowly-confined bedrock channel, consistent with upstream segment, T02.08-s1.05-A, - which exists due to a slightly misplaced Phase 1 reach break position. Evidence of direct livestock access to the

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **0.00**

2.7 Entrenchment Ratio **0.00**

2.8 Incision Ratio **0.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity

2.10 Riffles Type

2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Bedrock	100 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	0 %
Fine Gravel	0 %
Sand	0 %
Silt and smaller	0 %

Silt/Clay Present? **No**

Detritus **5** %

Large Woody **2**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

Not Evaluated

2.14 Stream Type

Stream Type:

Bed Material:

Subclass Slope:

Bed Form:

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

A 1 a Cascade

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Moderate**

Bank Texture	Left	Right
Upper		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive
Lower		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	0	0
Erosion Height (ft)	0.00	0.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Coniferous	Coniferous
Sub-dominant	None	None

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	>100
Sub-dominant	26-50	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Coniferous	Coniferous
Sub-dominant	Herbaceous	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Pasture	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **None**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **2**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

4.6 Up/Down strm flow reg

(old) Upstrm Flow Reg **None**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	1	0
Diagonal	**Delta**	**Island**
0	1	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **Yes**

5.5 Straightening **None**

Straightening Length: **0**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River

Stream: Pond Hill Brook

Organization: Poultney/Mettowee NRCD

Segment Length (ft): 1,687

Phase 2 Segment Summary

April 15, 2008 SGAT Version: 3

Reach # T02.08-s1.05 Segment: A Completion Date: July 25, 2006

Observers: KLU, HS Why Not assessed: bedrock gorge Rain: Yes

Segment Location: Bedrock channel along East side of Pond Hill Road.

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation Channel Dimensions

1.2 Alluvial Fan None

1.3 Corridor Encroachments

	Length (ft) One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Very Steep	Extremely
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Always	Always
Texture	Bedrock	Bedrock

1.5 Valley Features

- Valley Width (ft) 20
- Width Determination Measured
- Confinement Type Narrowly
- Rock Gorge? Yes
- Human-caused Change? no

Step 2. Stream Channel

- 2.1 Bankfull Width 8
- 2.2 Max Depth (ft) 0.85
- 2.3 Mean Depth (ft) 0.61
- 2.4 Floodprone Width (ft) 10

Notes:

Segment is a bedrock "gorge" - i.e., bedrock banks and bed, steep gradient, narrowly confined. Cross section data from Segment E applied to Step 2. Occasional step/pool bedform in addition to cascade. Animal crossing (5.4) is direct access to stream from

Step 2. (Contued)

- 2.5 Aband. Floodpln 0.85 ft.
- Human Elev Floodpln 0.00 ft.
- 2.6 Width/Depth Ratio 13.77
- 2.7 Entrenchment Ratio 1.17
- 2.8 Incision Ratio 1.00
- Human Elevated Inc Rat 0.00
- 2.9 Sinuosity Low
- 2.10 Riffles Type Complete
- 2.11 Riffle/Step Spacing (ft) 35

2.12 Substrate Composition

Bedrock	100 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	0 %
Fine Gravel	0 %
Sand	0 %
Silt and smaller	0 %

- Silt/Clay Present? No
- Detritus 2 %
- # Large Woody 3

2.13 Average Largest Particle on

- Bed N/A
- Bar N/A

Not Evaluated

2.14 Stream Type

- Stream Type: A
- Bed Material: Bedrock
- Subclass Slope: a
- Bed Form: Cascade
- Field Measured Slope:

2.15 Reference Stream Type (if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope Steep

Bank Texture	Left	Right
Upper		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive
Lower		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	0	49
Erosion Height (ft)	0.00	4.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Coniferous	Coniferous

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy Closed

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

- 4.1 Springs / Seeps None
- 4.2 Adjacent Wetlands None
- 4.3 Flow Status Moderate
- 4.4 # of Debris Jams 3
- 4.5 Flow Regulation Type None
- Flow Regulation Use
- Impoundments None
- Impoundmt. Location
- 4.6 Up/Down strm flow reg
- (old) Upstrm Flow Reg None

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

- 4.9 # of Beaver Dams 0
- Affected Length (ft) 0

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
1	0	1
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
2	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

- 5.4 Stream Ford or Animal Yes
- 5.5 Straightening None
- Straightening Length: 0
- 5.5 Dredging None

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River

Phase 2 Segment Summary

April 15, 2008 SGAT Version: 3

Stream: **Pond Hill Brook** Reach # **T02.08-s1.05** Segment: **B** Completion Date: **July 25, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Why Not assessed: Rain: **Yes**

Segment Length (ft): **1,034** Segment Location: **Segment downstream of pasture in scattered forest along Pond Hill Road.**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	70	0
height	0	0
Roads	328	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	88

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Extremely
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **25**

Width Determination **Measured**

Confinement Type **Narrowly**

Rock Gorge? **No**

Human-caused Change? **yes**

Step 2. Stream Channel

2.1 Bankfull Width **16**

2.2 Max Depth (ft) **1.00**

2.3 Mean Depth (ft) **0.71**

2.4 Floodprone Width (ft) **21**

Notes:

Straightening associated with culvert crossing. Actual planform now follows close to east side of Pond Hill Road downstream of the Xg - not reflected by VHD - therefore FIT locations / lengths are approximate. Animal crossing refers to low-intensity pasture

Step 2. (Contued)

2.5 Aband. Floodpln **1.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **22.54**

2.7 Entrenchment Ratio **1.31**

2.8 Incision Ratio **1.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Complete**

2.11 Riffle/Step Spacing (ft) **100**

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	100 %
Fine Gravel	0 %
Sand	0 %
Silt and smaller	0 %

Silt/Clay Present? **Yes**

Detritus **5** %

Large Woody **1**

2.13 Average Largest Particle on

Bed **0.0**

Bar **0.0**

Not Evaluated

2.14 Stream Type

Stream Type: **B**

Bed Material: **Gravel**

Subclass Slope: **b**

Bed Form: **Step-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

B 4 b Step-Pool

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Moderate**

Bank Texture	Left	Right
Upper		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive
Lower		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	90	173
Erosion Height (ft)	2.00	2.00
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	243	48

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Coniferous	Pasture

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	26-50
Sub-dominant	0-25	>100
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Pasture	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **None**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **2**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

4.6 Up/Down strm flow reg

(old) Upstrm Flow Reg **None**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	1	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
3	5	3
Diagonal	Delta	Island
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
6	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **Yes**

5.5 Straightening **Straightening**

Straightening Length: **403**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River
Stream: Pond Hill Brook | Reach # T02.08-s1.05
Organization: Poultney/Mettowee NRCD | Observers: KLU, HS
Segment Length (ft): 341 | Segment Location: Short bedrock-controlled section downstream of pasture, southwest of Pond Hill Rd.

Phase 2 Segment Summary

April 15, 2008 SGAT Version: 3
Segment: C | Completion Date: July 25, 2006
Why Not assessed: bedrock gorge | Rain: Yes

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation: Channel Dimensions
1.2 Alluvial Fan: None

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Extremely
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Bedrock	Bedrock

1.5 Valley Features
Valley Width (ft): 25
Width Determination: Estimated
Confinement Type: Semi-confined
Rock Gorge?: Yes
Human-caused Change?: no

Step 2. Stream Channel

2.1 Bankfull Width: 0
2.2 Max Depth (ft): 0.00
2.3 Mean Depth (ft): 0.00
2.4 Floodprone Width (ft): 0

Notes:
Segment is bedrock-controlled, steep gradient, narrowly- to semi-confined - i.e., "bedrock gorge". As per protocols, RGA, RHA not completed. Sensitivity of Very Low chosen. Stormwater input along RB is fine sediment and debris from nearby Pond Hill

Step 2. (Contued)

2.5 Aband. Floodpln: 0.00 ft.
Human Elev Floodpln: 0.00 ft.
2.6 Width/Depth Ratio: 0.00
2.7 Entrenchment Ratio: 0.00
2.8 Incision Ratio: 0.00
Human Elevated Inc Rat: 0.00
2.9 Sinuosity
2.10 Riffles Type
2.11 Riffle/Step Spacing (ft): 0

2.12 Substrate Composition

Bedrock	0%
Boulder	0%
Cobble	0%
Coarse Gravel	0%
Fine Gravel	0%
Sand	0%
Silt and smaller	0%

Silt/Clay Present?: No
Detritus: 0 %
Large Woody: 0

2.13 Average Largest Particle on
Bed: N/A
Bar: N/A

Not Evaluated

2.14 Stream Type
Stream Type:
Bed Material:
Subclass Slope:
Bed Form:
Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks
Typical Bank Slope: Steep

Bank Texture	Left	Right
Upper		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive
Lower		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	0	10
Erosion Height (ft)	0.00	3.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Herbaceous	Herbaceous

Bank Canopy	Left	Right
Canopy %	51-75	51-75

Mid-Channel Canopy: Open

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	26-50
Sub-dominant	26-50	0-25
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Coniferous	Coniferous
Sub-dominant	Herbaceous	Herbaceous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Pasture	Pasture
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: None
4.2 Adjacent Wetlands: None
4.3 Flow Status: Moderate
4.4 # of Debris Jams: 0
4.5 Flow Regulation Type: None
Flow Regulation Use
Impoundments: None
Impoundmt. Location
4.6 Up/Down strm flow reg
(old) Upstrm Flow Reg: None

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	1	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams: 0
Affected Length (ft): 0

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	0	1
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
1	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal: No
5.5 Straightening: None
Straightening Length: 0
5.5 Dredging: None

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River | **Phase 2 Segment Summary** | page 1 of 2 | April 15, 2008 | SGAT Version: 3

Stream: **Pond Hill Brook** | Reach # **T02.08-s1.05** | Segment: **D** | Completion Date: **July 25, 2006**

Organization: **Poultney/Mettowee NRCD** | Observers: **KLU, HS** | Why Not assessed: | Rain: **Yes**

Segment Length (ft): **827** | Segment Location: **Pasture segment southwest of Junction between Pond Hill Road and Pond Hill Ranch Rd.**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

	Length (ft) One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Very Steep	Steep
Continuous w/	Sometimes	Never
W/in 1 Bankfill	Sometimes	Never
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **50**

Width Determination **Measured**

Confinement Type **Semi-confined**

Rock Gorge? **No**

Human-caused Change? **no**

Step 2. Stream Channel

2.1 Bankfull Width **18**

2.2 Max Depth (ft) **1.25**

2.3 Mean Depth (ft) **0.49**

2.4 Floodprone Width (ft) **34**

Notes:

Dominant valley confinement is SC, occasionally NW. Segment does represent local reduction in gradient, but no major alluvial fan form is evident. Planform is more sinuous than VHD suggests. Stormwater input (fine sediment) at farm road crossing

Step 2. (Contued)

2.5 Aband. Floodpln **2.55** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **35.71**

2.7 Entrenchment Ratio **1.94**

2.8 Incision Ratio **2.04**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Moderate**

2.10 Riffles Type **Sedimented**

2.11 Riffle/Step Spacing (ft) **70**

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	14 %
Coarse Gravel	24 %
Fine Gravel	13 %
Sand	49 %
Silt and smaller	0 %

Silt/Clay Present? **Yes**

Detritus **2** %

Large Woody **1**

2.13 Average Largest Particle on

Bed **75.0** mm

Bar **40.0** mm

2.14 Stream Type

Stream Type: **B**

Bed Material: **Gravel**

Subclass Slope: **b**

Bed Form: **Riffle-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

C 4 b Riffle-Pool

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive
Lower		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	10	158
Erosion Height (ft)	2.00	2.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Pasture	Pasture
Sub-dominant	None	None

Bank Canopy	Left	Right
Canopy %	0	0

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	0-25	0-25
Sub-dominant	None	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Pasture	Pasture
Sub-dominant	None	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **Abundant**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **1**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

4.6 Up/Down strm flow reg

(old) Upstrm Flow Reg **None**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	1	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
2	3	1
Diagonal	**Delta**	**Island**
0	1	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
1	1	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	1	No

5.4 Stream Ford or Animal **Yes**

5.5 Straightening **Straightening**

Straightening Length: **408**

5.5 Dredging **Dredging**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River

Phase 2 Segment Summary

April 15, 2008 SGAT Version: 3

Stream: **Pond Hill Brook** Reach # **T02.08-s1.05** Segment: **E** Completion Date: **July 25, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Why Not assessed: **bedrock gorge** Rain: **Yes**

Segment Length (ft): **613** Segment Location: **Bedrock-controlled channel in hemlock forest along west side of Pond Hill Ranch Rd.**

QC Status - Staff: **Provisional Cons Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Extremely
Continuous w/	Always	Always
W/in 1 Bankfill	Always	Always
Texture	Bedrock	Bedrock

1.5 Valley Features

- Valley Width (ft) **12**
- Width Determination **Measured**
- Confinement Type **Narrowly**
- Rock Gorge? **Yes**
- Human-caused Change? **no**

Step 2. Stream Channel

- 2.1 Bankfull Width **8**
- 2.2 Max Depth (ft) **0.85**
- 2.3 Mean Depth (ft) **0.61**
- 2.4 Floodprone Width (ft) **10**

Notes:

Pond Hill Ranch Rd parallels the segment, but is located outside of the Phase 2 SCL-buffered corridor. Predominantly, bedrock is exposed in the channel bed and banks for a majority of the segment, long stretches of continuous ledge (not FIT'd) separated by

Step 2. (Contued)

- 2.5 Aband. Floodpln **0.85** ft.
- Human Elev Floodpln **0.00** ft.
- 2.6 Width/Depth Ratio **13.77**
- 2.7 Entrenchment Ratio **1.17**
- 2.8 Incision Ratio **1.00**
- Human Elevated Inc Rat **0.00**
- 2.9 Sinuosity **Low**
- 2.10 Riffles Type **Complete**
- 2.11 Riffle/Step Spacing (ft) **20**

2.12 Substrate Composition

Bedrock	100 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	0 %
Fine Gravel	0 %
Sand	0 %
Silt and smaller	0 %

- Silt/Clay Present? **No**
- Detritus **2** %
- # Large Woody **4**

2.13 Average Largest Particle on

- Bed **N/A**
- Bar **N/A**

Not Evaluated

2.14 Stream Type

- Stream Type: **A**
- Bed Material: **Bedrock**
- Subclass Slope: **a**
- Bed Form: **Cascade**
- Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	Multiple	10.67
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Moderate**

Bank Texture	Left	Right
Upper		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive
Lower		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	0	67
Erosion Height (ft)	0.00	2.12
Revetmt. Type	None	Multiple
Revetmt. Length (ft)	0	47

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	26-50
Sub-dominant	None	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

- 4.1 Springs / Seeps **None**
- 4.2 Adjacent Wetlands **None**
- 4.3 Flow Status **Moderate**
- 4.4 # of Debris Jams **3**
- 4.5 Flow Regulation Type **None**
- Flow Regulation Use
- Impoundments **None**
- Impoundmt. Location
- 4.6 Up/Down strm flow reg
- (old) Upstrm Flow Reg **None**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	5	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

- 4.9 # of Beaver Dams **0**
- Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
1	0	2

Diagonal	Delta	Island
0	1	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

- 5.4 Stream Ford or Animal **No**
- 5.5 Straightening **None**
- Straightening Length: **0**
- 5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River | **Phase 2 Segment Summary** | | April 15, 2008 SGAT Version: 3

Stream: **Pond Hill Brook** | Reach # **T02.08-s1.05** | Segment: **F** | Completion Date: **July 25, 2006**

Organization: **Poultney/Mettowee NRCD** | Observers: **KLU, HS** | Why Not assessed: | Rain: **Yes**

Segment Length (ft): **300** | Segment Location: **From upstream end of reach, along hay field to edge forest.**

QC Status - Staff: **Provisional Cons Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

	Length (ft) One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Steep	Very Steep
Continuous w/	Never	Never
W/in 1 Bankfill	Sometimes	Never
Texture	Not Evalua	Not Evalua

1.5 Valley Features

- Valley Width (ft) **130**
- Width Determination **Estimated**
- Confinement Type **Very Broad**
- Rock Gorge? **No**
- Human-caused Change? **no**

Step 2. Stream Channel

- 2.1 Bankfull Width **8**
- 2.2 Max Depth (ft) **0.80**
- 2.3 Mean Depth (ft) **0.57**
- 2.4 Floodprone Width (ft) **11**

Notes:

Stream bed actually dominated by silt; sand is finest substrate composition size available for classification in step 2.12. Segment appears historically dredged and straightened (ditched) to facilitate agricultural uses (currently hay) in RB corridor. Stormwater

Step 2. (Contued)

- 2.5 Aband. Floodpln **3.60** ft.
- Human Elev Floodpln **0.00** ft.
- 2.6 Width/Depth Ratio **14.04**
- 2.7 Entrenchment Ratio **1.38**
- 2.8 Incision Ratio **4.50**
- Human Elevated Inc Rat **0.00**
- 2.9 Sinuosity **Low**
- 2.10 Riffles Type **Complete**
- 2.11 Riffle/Step Spacing (ft) **80**

2.12 Substrate Composition

Bedrock	0%
Boulder	0%
Cobble	3%
Coarse Gravel	7%
Fine Gravel	20%
Sand	70%
Silt and smaller	0%

- Silt/Clay Present? **Yes**
- Detritus **5** %
- # Large Woody **0**

2.13 Average Largest Particle on

- Bed **0.0**
- Bar **0.0**

Not Evaluated

2.14 Stream Type

- Stream Type: **F**
- Bed Material: **Sand**
- Subclass Slope: **c**
- Bed Form: **Riffle-Pool**
- Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

C 5 c Riffle-Pool

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive
Lower		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	0	122
Erosion Height (ft)	0.00	3.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	None	None

Bank Canopy	Left	Right
Canopy %	26-50	0

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	0-25
Sub-dominant	None	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Herbaceous
Sub-dominant	Shrubs/Saplin	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Hay
Sub-dominant	None	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

- 4.1 Springs / Seeps **Minimal**
- 4.2 Adjacent Wetlands **Minimal**
- 4.3 Flow Status **Moderate**
- 4.4 # of Debris Jams **0**
- 4.5 Flow Regulation Type **None**
- Flow Regulation Use
- Impoundments **None**
- Impoundmt. Location
- 4.6 Up/Down strm flow reg
- (old) Upstrm Flow Reg **None**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	1	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

- 4.9 # of Beaver Dams **0**
- Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
1	2	0
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
1	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

- 5.4 Stream Ford or Animal **No**
- 5.5 Straightening **Straightening**
- Straightening Length: **268**
- 5.5 Dredging **Dredging**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River **Phase 2 Segment Summary** April 15, 2008 SGAT Version: 3

Stream: **Castleton River** Reach # **T02.09** Segment: **A** Completion Date: **August 11, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, ES, SL** Why Not assessed: Rain: **No**

Segment Length (ft): **3,190** Segment Location: **From former mills along LB below Mill Street crossing downstream nearly to Cemetery Lane**

QC Status - Staff: **Provisional Cons Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	374
height	0	0
Railroads	387	0
height	0	0
Improved Paths	0	0
height	0	0
Development	1,140	309

1.4 Adjacent Side	Left	Right
Hillside Slope	Steep	Hilly
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **450**

Width Determination **Estimated**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **Yes**

Step 2. Stream Channel

2.1 Bankfull Width	57
2.2 Max Depth (ft)	3.00
2.3 Mean Depth (ft)	2.40
2.4 Floodprone Width (ft)	450

Notes:

Updated in 2008 by SMRC relying on 2005 Phase 2 field observations. Segmented to capture difference in channel management histories, channel dimensions, degree of incision, and active adjustment processes. Human-caused change in valley width by

Step 2. (Contued)

2.5 Aband. Floodpln	3.00 ft.
Human Elev Floodpln	0.00 ft.
2.6 Width/Depth Ratio	23.75
2.7 Entrenchment Ratio	7.89
2.8 Incision Ratio	1.00
Human Elevated Inc Rat	0.00
2.9 Sinuosity	Moderate
2.10 Riffles Type	Complete
2.11 Riffle/Step Spacing (ft)	250

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	39 %
Coarse Gravel	7 %
Fine Gravel	48 %
Sand	6 %
Silt and smaller	0 %

Silt/Clay Present? **Yes**

Detritus **5** %

Large Woody **26**

2.13 Average Largest Particle on

Bed	120.0	mm
Bar	100.0	mm

2.14 Stream Type

Stream Type: **C**

Bed Material: **Gravel**

Subclass Slope: **None**

Bed Form: **Riffle-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Moderate**

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Gravel	Gravel
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	946	881
Erosion Height (ft)	2.91	3.12
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	97	435

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Herbaceous	Herbaceous

Bank Canopy	Left	Right
Canopy %	51-75	51-75

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	0-25	26-50
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Residential	Hay
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps	Abundant
4.2 Adjacent Wetlands	Abundant
4.3 Flow Status	Moderate
4.4 # of Debris Jams	6
4.5 Flow Regulation Type	
Flow Regulation Use	
Impoundments	Small
Impoundmt. Location	Upstream
4.6 Up/Down strm flow reg	Up Stream
(old) Upstrm Flow Reg	Run-of-river

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
1	3	1
Diagonal	**Delta**	**Island**
2	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
6	1	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
1	1	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **1,542**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River **Phase 2 Segment Summary** April 15, 2008 SGAT Version: 3

Stream: **Castleton River** Reach # **T02.09** Segment: **B** Completion Date: **August 11, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, ES, SL** Why Not assessed: **Other (to be explained in** Rain: **No**

Segment Length (ft): **2,045** Segment Location: **From railroad crossing above low-head dam downstream to area of former mills along LB**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	433	0
height	0	0
Roads	402	0
height	0	0
Railroads	792	0
height	0	0
Improved Paths	0	0
height	0	0
Development	716	239

1.4 Adjacent Side

	Left	Right
Hillside Slope	Steep	Hilly
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **450**

Width Determination **Estimated**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **Yes**

Step 2. Stream Channel

2.1 Bankfull Width **0**

2.2 Max Depth (ft) **0.00**

2.3 Mean Depth (ft) **0.00**

2.4 Floodprone Width (ft) **0**

Notes:

Updated in 2008 by SMRC, relying on 2005 Phase 2 field observations. Reach segmented to capture differences in channel management history, degree of floodplain connection, active adjustment processes and condition. Human-caused change in valley

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **0.00**

2.7 Entrenchment Ratio **0.00**

2.8 Incision Ratio **0.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity

2.10 Riffles Type

2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Silt/Clay Present? **Yes**

Detritus **5** %

Large Woody **4**

2.13 Average Largest Particle on

Bed **0.0**

Bar **0.0**

Not Evaluated

2.14 Stream Type

Stream Type: **F**

Bed Material: **Gravel**

Subclass Slope: **None**

Bed Form: **Plane Bed**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Gravel	Gravel
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	487	327
Erosion Height (ft)	5.71	4.23
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	1,232	749

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	51-75	51-75

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	26-50
Sub-dominant	0-25	51-100
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Hay
Sub-dominant	Industrial	Forest
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **Minimal**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **1**

4.5 Flow Regulation Type

Flow Regulation Use

Impoundments **Small**

Impoundmt. Location **In Reach**

4.6 Up/Down strm flow reg **None**

(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	2	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	2	1
Diagonal	**Delta**	**Island**
1	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
1	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
2	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **1,698**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River

Stream: North Breton Brook | Reach # T02.09-s1.01 | Segment: A | Completion Date: July 20, 2005

Organization: Poultney/Mettowee NRCD | Observers: KLU, SHPytlik | Why Not assessed: | Rain: Yes

Segment Length (ft): 2,745 | Segment Location: From Exit 5 ramp downstream to confluence of Castleton River main stem.

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	15	0
height	0	0
Railroads	1,606	0
height	0	0
Improved Paths	0	0
height	0	0
Development	748	708

1.4 Adjacent Side

	Left	Right
Hillside Slope	Steep	Flat
Continuous w/	Sometimes	Always
W/in 1 Bankfill	Sometimes	Always
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **150**

Width Determination **Estimated**

Confinement Type **Narrow**

Rock Gorge? **No**

Human-caused Change? **Yes**

Step 2. Stream Channel

2.1 Bankfull Width **0**

2.2 Max Depth (ft) **0.00**

2.3 Mean Depth (ft) **0.00**

2.4 Floodprone Width (ft) **0**

Notes:

Segment is a subreach (alluvial fan - reference D, modified reference C). Valley width (1.5) reduced along both left and right banks by Route 4 highway grading and box culverts in upstream end, and by railroad along left bank in downstream half. Fort

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **0.00**

2.7 Entrenchment Ratio **0.00**

2.8 Incision Ratio **0.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity

2.10 Riffles Type **Not Applicable**

2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Silt/Clay Present?

Detritus **0** %

Large Woody **0**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

2.14 Stream Type

Stream Type: **C**

Bed Material: **Gravel**

Subclass Slope: **None**

Bed Form: **Plane Bed**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

D 3 c Braided

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Moderate**

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Cohesive	Cohesive
Lower		
Material Type	Gravel	Gravel
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	184	489
Erosion Height (ft)	5.03	4.28
Revetmt. Type	Multiple	Hard Bank
Revetmt. Length (ft)	1,842	503

Near Bank Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Deciduous	Deciduous

Bank Canopy	Left	Right
Canopy %	26-50	26-50

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	0-25	0-25
Sub-dominant	None	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Mixed Trees	Mixed Trees

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Residential	Shrubs/Saplin
Sub-dominant	Commercial	Hay
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **Minimal**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **2**

4.5 Flow Regulation Type

Flow Regulation Use

Impoundments **Large**

Impoundmt. Location **Upstream**

4.6 Up/Down strm flow reg **Up Stream**

(old) Upstrm Flow Reg **Run-of-river**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	1	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
2	2	2
Diagonal	**Delta**	**Island**
2	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
1	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
1	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **2,745**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Phase 2 Segment Summary

April 15, 2008 SGAT Version: 3

Project: **Castleton River**
Stream: **North Breton Brook** Reach # **T02.09-s1.01** Segment: **B** Completion Date: **July 20, 2005**
Organization: **Poultney/Mettowee NRCD** Observers: **KLU, SHPytlik** Why Not assessed: Rain: **Yes**
Segment Length (ft): **1,762** Segment Location: **From Pelletier Dam downstream to Route 4 westbound Exit 5 off ramp.**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**
1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	1,402	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	86

1.4 Adjacent Side	Left	Right
Hillside Slope	Very Steep	Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features
Valley Width (ft) **400**
Width Determination **Estimated**
Confinement Type **Narrow**
Rock Gorge? **No**
Human-caused Change? **Yes**

Step 2. Stream Channel

2.1 Bankfull Width **38**
2.2 Max Depth (ft) **2.60**
2.3 Mean Depth (ft) **1.50**
2.4 Floodprone Width (ft) **61**

Notes:
Valley width reduced somewhat by East Hubbardton Rd along right corridor and old road along left bank. The remnant road grade encroaches somewhat on the channel and serves as a berm. This road surface is elevated above the flood-prone elevation,

Step 2. (Contued)

2.5 Aband. Floodpln **6.90** ft.
Human Elev Floodpln **6.90** ft.
2.6 Width/Depth Ratio **25.33**
2.7 Entrenchment Ratio **1.59**
2.8 Incision Ratio **2.65**
Human Elevated Inc Rat **2.65**
2.9 Sinuosity **Low**
2.10 Riffles Type **Not Applicable**
2.11 Riffle/Step Spacing (ft) **N/A**

2.12 Substrate Composition

Bedrock	0 %
Boulder	4 %
Cobble	49 %
Coarse Gravel	21 %
Fine Gravel	10 %
Sand	16 %
Silt and smaller	0 %

Silt/Clay Present? **No**
Detritus **10** %
Large Woody **8**

2.13 Average Largest Particle on
Bed **N/A**
Bar **N/A**

2.14 Stream Type
Stream Type: **F**
Bed Material: **Cobble**
Subclass Slope: **None**
Bed Form: **Plane Bed**
Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks
Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Gravel	Gravel
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	147	58
Erosion Height (ft)	5.00	2.00
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	57	253

Near Bank Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Deciduous	Deciduous

Bank Canopy	Left	Right
Canopy %	51-75	51-75

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	51-100
Sub-dominant	None	26-50
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Coniferous	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	Crop
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**
4.2 Adjacent Wetlands **None**
4.3 Flow Status **Moderate**
4.4 # of Debris Jams **2**
4.5 Flow Regulation Type
Flow Regulation Use
Impoundments **Large**
Impoundmt. Location **Upstream**
4.6 Up/Down strm flow reg **Up Stream**
(old) Upstrm Flow Reg **Run-of-river**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**
Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
1	1	1
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
2	0	No

5.4 Stream Ford or Animal **Yes**
5.5 Straightening **Straightening**
Straightening Length: **1,089**
5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River | **Phase 2 Segment Summary** | | April 15, 2008 | SGAT Version: 3

Stream: **North Breton Brook** Reach # **T02.09-s1.02** Segment: **A** Completion Date: **July 20, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, SHPytlik** Why Not assessed: **impounded** Rain: **Yes**

Segment Length (ft): **434** Segment Location: **Downstream end of reach comprised of wetlands (former mill pond) and small**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Flow Status**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	91	23

1.4 Adjacent Side	Left	Right
Hillside Slope	Hilly	Very Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Bedrock

1.5 Valley Features

Valley Width (ft) **400**

Width Determination **Estimated**

Confinement Type **Broad**

Rock Gorge? **No**

Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **0**

2.2 Max Depth (ft) **0.00**

2.3 Mean Depth (ft) **0.00**

2.4 Floodprone Width (ft) **0**

Notes:

Segment is comprised of wetlands (former mill pond) and impoundment above Pelletier Dam. Dam (this one or a predecessor) has been present in this general location since at least 1792. A grist mill and sawmill were present on Foot's mill lot in the late 1700s;

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **0.00**

2.7 Entrenchment Ratio **0.00**

2.8 Incision Ratio **0.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity

2.10 Riffles Type

2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	0 %
Fine Gravel	0 %
Sand	0 %
Silt and smaller	0 %

Silt/Clay Present?

Detritus **0** %

Large Woody **0**

2.13 Average Largest Particle on

Bed **0.0**

Bar **0.0**

2.14 Stream Type

Stream Type:

Bed Material:

Subclass Slope:

Bed Form:

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Moderate**

Bank Texture	Left	Right
Upper		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive
Lower		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	0	0
Erosion Height (ft)	0.00	0.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Coniferous

Bank Canopy	Left	Right
Canopy %	1-25	1-25

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	0-25	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	Shrubs/Saplin	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Forest
Sub-dominant	Residential	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Abundant**

4.2 Adjacent Wetlands **Abundant**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type

Flow Regulation Use

Impoundments **Large**

Impoundmt. Location **In Reach**

4.6 Up/Down strm flow reg **None**

(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **1**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	0	0
Diagonal	Delta	Island
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **None**

Straightening Length: **0**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River

Phase 2 Segment Summary

April 15, 2008 SGAT Version: 3

Stream: **North Breton Brook** Reach # **T02.09-s1.02** Segment: **B** Completion Date: **July 20, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, SHPytlik** Why Not assessed: Rain: **Yes**

Segment Length (ft): **3,530** Segment Location: **Segment flows parallel to and west of Hubbardton Rd and ends just upstream of**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Flow Status**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

	Length (ft) One	Both
Berms	0	0
height	0	0
Roads	1,322	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	54	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Hilly	Very Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Cobble	Bedrock

1.5 Valley Features

Valley Width (ft) **450**

Width Determination **Estimated**

Confinement Type **Broad**

Rock Gorge? **No**

Human-caused Change? **Yes**

Step 2. Stream Channel

2.1 Bankfull Width **54**

2.2 Max Depth (ft) **2.50**

2.3 Mean Depth (ft) **1.60**

2.4 Floodprone Width (ft) **614**

Notes:

Minor human-caused change in valley width by Hubbarton Road in upstream half of reach (LB). No significant change in valley confinement. Minor residential encroachment within LB corridor. Ford mid-segment to access RB fields from Hubbarton Road.

Step 2. (Contued)

2.5 Aband. Floodpln **2.80** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **33.75**

2.7 Entrenchment Ratio **11.37**

2.8 Incision Ratio **1.12**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Sedimented**

2.11 Riffle/Step Spacing (ft) **300**

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	13 %
Coarse Gravel	21 %
Fine Gravel	52 %
Sand	14 %
Silt and smaller	0 %

Silt/Clay Present? **Yes**

Detritus **5** %

Large Woody **60**

2.13 Average Largest Particle on

Bed **120.0** mm

Bar **120.0** mm

2.14 Stream Type

Stream Type: **C**

Bed Material: **Gravel**

Subclass Slope: **None**

Bed Form: **Riffle-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	One	20.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive
Lower		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	497	684
Erosion Height (ft)	1.59	2.02
Revetmt. Type	Rip-Rap	None
Revetmt. Length (ft)	49	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	>100
Sub-dominant	>100	0-25
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Herbaceous	Coniferous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Shrubs/Saplin	Pasture
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **Abundant**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **10**

4.5 Flow Regulation Type

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

4.6 Up/Down strm flow reg **Down Stream**

(old) Upstrm Flow Reg **Run-of-river**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	1	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
4	4	1
Diagonal	**Delta**	**Island**
1	0	1

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
2	1	1	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
1	0	No

5.4 Stream Ford or Animal **Yes**

5.5 Straightening **Straightening**

Straightening Length: **1,455**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River
Stream: North Breton Brook Reach # T02.09-s1.04 Segment: A Completion Date: August 2, 2005
Organization: Poultney/Mettowee NRCD Observers: KLU, SHPytlik Why Not assessed: Rain: Yes
Segment Length (ft): 827 Segment Location: Short remaining section at downstream-most end of reach below the bedrock gorge.

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**
1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Steep	Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features
Valley Width (ft) **130**
Width Determination **Estimated**
Confinement Type **Semi-confined**
Rock Gorge? **No**
Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **35**
2.2 Max Depth (ft) **1.50**
2.3 Mean Depth (ft) **0.80**
2.4 Floodprone Width (ft) **91**

Notes:
Short section of remaining channel downstream of the bedrock gorge to the confluence of Belgo Brook. Characteristics similar to Segment C; cross section data (Step 2) from Segm C applied to this very short segment. Small sediment delta at

Step 2. (Contued)

2.5 Aband. Floodpln **1.50** ft.
Human Elev Floodpln **0.00** ft.
2.6 Width/Depth Ratio **43.12**
2.7 Entrenchment Ratio **2.64**
2.8 Incision Ratio **1.00**
Human Elevated Inc Rat **0.00**
2.9 Sinuosity **Low**
2.10 Riffles Type **Sedimented**
2.11 Riffle/Step Spacing (ft) **250**

2.12 Substrate Composition

Bedrock	0%
Boulder	6%
Cobble	28%
Coarse Gravel	21%
Fine Gravel	18%
Sand	27%
Silt and smaller	0%

Silt/Clay Present? **Yes**
Detritus **2** %
Large Woody **2**

2.13 Average Largest Particle on
Bed **0.0**
Bar **0.0**
Not Evaluated

2.14 Stream Type
Stream Type: **C**
Bed Material: **Gravel**
Subclass Slope: **None**
Bed Form: **Riffle-Pool**
Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks
Typical Bank Slope **Moderate**

Bank Texture	Left	Right
Upper		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive
Lower		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	200	180
Erosion Height (ft)	2.00	2.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Coniferous	Coniferous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	51-100	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Coniferous	Coniferous
Sub-dominant	Deciduous	Deciduous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**
4.2 Adjacent Wetlands **Minimal**
4.3 Flow Status **Moderate**
4.4 # of Debris Jams **3**
4.5 Flow Regulation Type **None**
Flow Regulation Use
Impoundments **None**
Impoundmt. Location
4.6 Up/Down strm flow reg **None**
(old) Upstrm Flow Reg **None**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**
Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	0	0
Diagonal	Delta	Island
1	1	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	2

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **Yes**
5.5 Straightening **None**
Straightening Length: **0**
5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River | Phase 2 Segment Summary | | April 15, 2008 | SGAT Version: 3

Stream: **North Breton Brook** | Reach # **T02.09-s1.04** | Segment: **B** | Completion Date: **August 2, 2005**

Organization: **Poultney/Mettowee NRCD** | Observers: **KLU, SHPytlik** | Why Not assessed: | Rain: **Yes**

Segment Length (ft): **342** | Segment Location: **Short section of bedrock gorge near downstream end of reach.**

QC Status - Staff: **Provisional** **Cons** **Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **Subreach**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Steep	Steep
Continuous w/	Always	Always
W/in 1 Bankfill	Always	Always
Texture	Bedrock	Bedrock

1.5 Valley Features

Valley Width (ft) **50**

Width Determination **Measured**

Confinement Type **Narrowly**

Rock Gorge? **Yes**

Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **0**

2.2 Max Depth (ft) **0.00**

2.3 Mean Depth (ft) **0.00**

2.4 Floodprone Width (ft) **0**

Notes:

Short section of bedrock-cascade, bedrock step-pool channel with locally steeper gradient (2.9% estimated from topographic map).

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **0.00**

2.7 Entrenchment Ratio **0.00**

2.8 Incision Ratio **0.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Not Applicable**

2.11 Riffle/Step Spacing (ft) **N/A**

2.12 Substrate Composition

Silt/Clay Present?

Detritus **2** %

Large Woody **0**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

2.14 Stream Type

Stream Type: **B**

Bed Material: **Bedrock**

Subclass Slope: **None**

Bed Form: **Cascade**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

B **1** **Non Cascade**

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive
Lower		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	0	0
Erosion Height (ft)	0.00	0.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Coniferous	Coniferous
Sub-dominant	None	None

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Coniferous	Coniferous
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **None**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

4.6 Up/Down strm flow reg **None**

(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	0	0
Diagonal	Delta	Island
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **None**

Straightening Length: **0**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River

Phase 2 Segment Summary

April 15, 2008 SGAT Version: 3

Stream: North Breton Brook Reach # T02.09-s1.04 Segment: C Completion Date: August 2, 2005

Organization: Poultney/Mettowee NRCD Observers: KLU, SHPytlik Why Not assessed: Rain: Yes

Segment Length (ft): 2,960 Segment Location: West of Hubbarton Rd. 2960 ft downstream to bedrock gorge.

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Flat	Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **400**

Width Determination **Estimated**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **35**

2.2 Max Depth (ft) **1.50**

2.3 Mean Depth (ft) **0.80**

2.4 Floodprone Width (ft) **91**

Notes:

Relatively remote section flowing through forest and occasional wetlands. Channel-spanning bedrock offers vertical grade control near downstream end of segment. Sand and gravel quarry (limited activity) present to east of the channel near downstream end (outside

Step 2. (Contued)

2.5 Aband. Floodpln **1.50** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **43.12**

2.7 Entrenchment Ratio **2.64**

2.8 Incision Ratio **1.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Sedimented**

2.11 Riffle/Step Spacing (ft) **250**

2.12 Substrate Composition

Bedrock	0 %
Boulder	6 %
Cobble	28 %
Coarse Gravel	21 %
Fine Gravel	18 %
Sand	27 %
Silt and smaller	0 %

Silt/Clay Present? **Yes**

Detritus **2** %

Large Woody **44**

2.13 Average Largest Particle on

Bed	150.0	mm
Bar	N/A	mm

2.14 Stream Type

Stream Type: **C**

Bed Material: **Gravel**

Subclass Slope: **None**

Bed Form: **Riffle-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Moderate**

Bank Texture	Left	Right
Upper		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive
Lower		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	330	95
Erosion Height (ft)	1.17	2.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	51-100	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Abundant**

4.2 Adjacent Wetlands **Abundant**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **5**

4.5 Flow Regulation Type

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

4.6 Up/Down strm flow reg **None**

(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
2	2	2
Diagonal	**Delta**	**Island**
2	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **Yes**

5.5 Straightening **None**

Straightening Length: **0**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River — **Phase 2 Segment Summary** April 15, 2008 SGAT Version: 3

Stream: **North Breton Brook** Reach # **T02.09-s1.04** Segment: **D** Completion Date: **August 2, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, SHPytlik** Why Not assessed: Rain: **Yes**

Segment Length (ft): **1,566** Segment Location: **Channelized and bermed segment between agricultural fields west of Hubbarton Road.**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	626
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Hilly	Steep
Continuous w/	Never	Never
W/in 1 Bankfill	Never	Never
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **600**

Width Determination **Estimated**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **24**

2.2 Max Depth (ft) **2.00**

2.3 Mean Depth (ft) **1.40**

2.4 Floodprone Width (ft) **400**

Notes:

Channel appears straightened (historically, given age of trees along top of bank), then recently dredged (or windrowed) with spoils placed along LB and RB as berms. Very little vegetative growth on inside berm edge suggests recent timing, possibly within the

Step 2. (Contued)

2.5 Aband. Floodpln **2.00** ft.

Human Elev Floodpln **3.00** ft.

2.6 Width/Depth Ratio **17.14**

2.7 Entrenchment Ratio **16.67**

2.8 Incision Ratio **1.00**

Human Elevated Inc Rat **1.50**

2.9 Sinuosity **Low**

2.10 Riffles Type **Not Applicable**

2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Bedrock	0%
Boulder	0%
Cobble	2%
Coarse Gravel	8%
Fine Gravel	85%
Sand	5%
Silt and smaller	0%

Silt/Clay Present? **No**

Detritus **2** %

Large Woody **0**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

2.14 Stream Type

Stream Type: **C**

Bed Material: **Gravel**

Subclass Slope: **None**

Bed Form: **Plane Bed**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Moderate**

Bank Texture	Left	Right
Upper		
Material Type	Gravel	Gravel
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Gravel	Gravel
Consistency	Non-cohesive	Non-cohesive
Bank Erosion	Left	Right
Erosion Length (ft)	254	337
Erosion Height (ft)	3.00	3.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0
Near Bank Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin
Bank Canopy	Left	Right
Canopy %	51-75	51-75

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	51-100
Sub-dominant	26-50	26-50
W less than 25	0	0
Buffer Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Crop	Crop
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **Minimal**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

4.6 Up/Down strm flow reg **None**

(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
2	0	1
Diagonal	Delta	Island
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
1	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **Yes**

5.5 Straightening **With Windrowing**

Straightening Length: **1,239**

5.5 Dredging **Dredging**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: **Castleton River**
Stream: **North Breton Brook** Reach # **T02.09-s1.04** Segment: **E** Completion Date: **August 2, 2005**
Organization: **Poultney/Mettowee NRCD** Observers: **KLU, SHPytlik** Why Not assessed: Rain: **Yes**
Segment Length (ft): **1,014** Segment Location: **Upper sixth of the reach.**

QC Status - Staff: **Provisional** Cons **Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**
1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Very Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Gravel	Gravel

1.5 Valley Features
Valley Width (ft) **250**
Width Determination **Estimated**
Confinement Type **Broad**
Rock Gorge? **No**
Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **32**
2.2 Max Depth (ft) **1.50**
2.3 Mean Depth (ft) **0.80**
2.4 Floodprone Width (ft) **50**

Notes:
Channel segment pinned between bedrock-controlled valley wall along RB and corn fields along LB (beyond a minimal tree buffer). Channel is incised, resulting in stream type departure from C to F. The channel has lost connection with the

Step 2. (Contued)

2.5 Aband. Floodpln **3.30** ft.
Human Elev Floodpln **0.00** ft.
2.6 Width/Depth Ratio **39.75**
2.7 Entrenchment Ratio **1.57**
2.8 Incision Ratio **2.20**
Human Elevated Inc Rat **0.00**
2.9 Sinuosity **Low**
2.10 Riffles Type **Eroded**
2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Bedrock	0%
Boulder	1%
Cobble	13%
Coarse Gravel	34%
Fine Gravel	32%
Sand	20%
Silt and smaller	0%

Silt/Clay Present? **Yes**
Detritus **5** %
Large Woody **15**

2.13 Average Largest Particle on
Bed **100.0** mm
Bar **N/A** mm

2.14 Stream Type
Stream Type: **F**
Bed Material: **Gravel**
Subclass Slope: **None**
Bed Form: **Plane Bed**
Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks
Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Gravel	Gravel
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	527	251
Erosion Height (ft)	4.00	4.37
Revetmt. Type	Rip-Rap	None
Revetmt. Length (ft)	22	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Herbaceous	Herbaceous

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	>100
Sub-dominant	26-50	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Herbaceous	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Crop	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**
4.2 Adjacent Wetlands **Minimal**
4.3 Flow Status **Moderate**
4.4 # of Debris Jams **4**
4.5 Flow Regulation Type
Flow Regulation Use
Impoundments **None**
Impoundmt. Location
4.6 Up/Down strm flow reg **None**
(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**
Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	1	0
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
1	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **Yes**
5.5 Straightening **Straightening**
Straightening Length: **593**
5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

April 15, 2008 SGAT Version: 3

Project: **Castleton River**
Stream: **North Breton Brook** Reach # **T02.09-s1.05** Segment: **0** Completion Date: **August 2, 2005**
Organization: **Poultney/Mettowee NRCD** Observers: **KLU, SH** Why Not assessed: **wetland** Rain: **Yes**
Segment Length (ft): **3,458** Segment Location: **Wetlands-dominated reach west of and parallel to East Hubbardton Rd extending nearly**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **None**
1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Hilly	Hilly
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features
Valley Width (ft) **600**
Width Determination **Estimated**
Confinement Type **Very Broad**
Rock Gorge? **No**
Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **0**
2.2 Max Depth (ft) **0.00**
2.3 Mean Depth (ft) **0.00**
2.4 Floodprone Width (ft) **0**

Notes:
Reach dominated by wetlands and beaver impoundments. Cross section (2.0) not measured since channel did not exhibit standard fluvial form over a majority of the length. Straightening (5.5) possible in upper 1/6 and lower 1/6 of reach associated with

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.
Human Elev Floodpln **0.00** ft.
2.6 Width/Depth Ratio **0.00**
2.7 Entrenchment Ratio **0.00**
2.8 Incision Ratio **0.00**
Human Elevated Inc Rat **0.00**
2.9 Sinuosity
2.10 Riffles Type
2.11 Riffle/Step Spacing (ft) **0**
2.12 Substrate Composition

Silt/Clay Present?
Detritus **0** %
Large Woody **2**

2.13 Average Largest Particle on
Bed **0.0**
Bar **0.0**

2.14 Stream Type
Stream Type:
Bed Material:
Subclass Slope:
Bed Form:
Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks
Typical Bank Slope **Moderate**

Bank Texture	Left	Right
Upper		
Material Type		
Consistency		
Lower		
Material Type		
Consistency		
Bank Erosion	**Left**	**Right**
Erosion Length (ft)	279	306
Erosion Height (ft)	1.76	1.75
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	82	38
Near Bank Veg. Type	**Left**	**Right**
Dominant	Herbaceous	Herbaceous
Sub-dominant	Deciduous	Deciduous
Bank Canopy	**Left**	**Right**
Canopy %	51-75	76-100
Mid-Channel Canopy	Closed	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	>100
Sub-dominant	0-25	None
W less than 25	0	0
Buffer Veg. Type	**Left**	**Right**
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Hay	Forest
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Abundant**
4.2 Adjacent Wetlands **Abundant**
4.3 Flow Status **Moderate**
4.4 # of Debris Jams **1**
4.5 Flow Regulation Type **None**
Flow Regulation Use
Impoundments **None**
Impoundmt. Location
4.6 Up/Down strm flow reg **None**
(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **1**
Affected Length (ft) **200**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	0	0
Diagonal	**Delta**	**Island**
0	0	1

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
1	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **Yes**
5.5 Straightening **Straightening**
Straightening Length: **437**
5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River | Phase 2 Segment Summary | | April 15, 2008 SGAT Version: 3

Stream: Castleton River | Reach # T02.10 | Segment: 0 | Completion Date: August 11, 2005

Organization: Poultney/Mettowee NRCD | Observers: KLU, ES, SL | Why Not assessed: | Rain: No

Segment Length (ft): 2,626 | Segment Location: From the Route 4A crossing by Dumas to the second Route 4A crossing downstream of the

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation None

1.2 Alluvial Fan None

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	140	500
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	355	184

1.4 Adjacent Side	Left	Right
Hillside Slope	Very Steep	Hilly
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Always	Sometimes
Texture	Bedrock	Not Evalua

1.5 Valley Features

Valley Width (ft) 450

Width Determination Estimated

Confinement Type Broad

Rock Gorge? No

Human-caused Change? Yes

Step 2. Stream Channel

2.1 Bankfull Width 47

2.2 Max Depth (ft) 3.50

2.3 Mean Depth (ft) 2.60

2.4 Floodprone Width (ft) 200

Notes:

Human-caused change in valley width (1.5) refers to Route 4A (inside corridor) and the railroad (outside corridor). Bedrock exposed along LB provides lateral grade control. Channel-spanning bedrock vertical grade control (1.6) is located mid-reach, exposed in

Step 2. (Contued)

2.5 Aband. Floodpln 4.60 ft.

Human Elev Floodpln 0.00 ft.

2.6 Width/Depth Ratio 18.08

2.7 Entrenchment Ratio 4.26

2.8 Incision Ratio 1.31

Human Elevated Inc Rat 0.00

2.9 Sinuosity Low

2.10 Riffles Type Sedimented

2.11 Riffle/Step Spacing (ft) 150

2.12 Substrate Composition

Bedrock	0%
Boulder	5%
Cobble	25%
Coarse Gravel	42%
Fine Gravel	13%
Sand	15%
Silt and smaller	0%

Silt/Clay Present? Yes

Detritus 20 %

Large Woody 40

2.13 Average Largest Particle on

Bed	270.0	mm
Bar	N/A	mm

2.14 Stream Type

Stream Type: C

Bed Material: Gravel

Subclass Slope: None

Bed Form: Riffle-Pool

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	One	10.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope Steep

Bank Texture	Left	Right
Upper		
Material Type	Silt	Silt
Consistency	Cohesive	Cohesive
Lower		
Material Type	Silt	Silt
Consistency	Cohesive	Cohesive
Bank Erosion	Left	Right
Erosion Length (ft)	724	251
Erosion Height (ft)	2.00	2.00
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	402	216
Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin
Bank Canopy	Left	Right
Canopy %	76-100	76-100
Mid-Channel Canopy	Open	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	51-100
W less than 25	0	0
Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	Hay
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps Minimal

4.2 Adjacent Wetlands None

4.3 Flow Status Moderate

4.4 # of Debris Jams 7

4.5 Flow Regulation Type None

Flow Regulation Use

Impoundments None

Impoundmt. Location

4.6 Up/Down strm flow reg Down Stream

(old) Upstrm Flow Reg None

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams 0

Affected Length (ft) 0

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	1	0
Diagonal	**Delta**	**Island**
1	1	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
1	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
2	0	No

5.4 Stream Ford or Animal No

5.5 Straightening Straightening

Straightening Length: 996

5.5 Dredging None

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River

Phase 2 Segment Summary

April 15, 2008 SGAT Version: 3

Stream: Castleton River | Reach # T02.11 | Segment: A | Completion Date: June 30, 2005

Organization: Poultney/Mettowee NRCD | Observers: KLU, ES | Why Not assessed: | Rain: Yes

Segment Length (ft): 5,145 | Segment Location: From a point just downstream of Pond Hill Stables downstream to Rt. 4 A crossing

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	1,429	0
height	0	0
Roads	640	519
height	0	0
Railroads	994	0
height	0	0
Improved Paths	0	0
height	0	0
Development	171	86

1.4 Adjacent Side	Left	Right
Hillside Slope	Flat	Hilly
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

- Valley Width (ft) **400**
- Width Determination **Estimated**
- Confinement Type **Broad**
- Rock Gorge? **No**
- Human-caused Change? **Yes**

Step 2. Stream Channel

- 2.1 Bankfull Width **30**
- 2.2 Max Depth (ft) **3.70**
- 2.3 Mean Depth (ft) **2.90**
- 2.4 Floodprone Width (ft) **400**

Notes:

Valley width (1.5) encroached upon by railroad, trolley grade, roads. Trolley grade indexed as a berm. Berm (1.3) on LB constructed of hay. Bedform (2.14) riffle-pool or ripple-dune in short sections, but predominantly plane-bed. Pasture in right

Step 2. (Contued)

- 2.5 Aband. Floodpln **3.70** ft.
- Human Elev Floodpln **0.00** ft.
- 2.6 Width/Depth Ratio **10.34**
- 2.7 Entrenchment Ratio **13.33**
- 2.8 Incision Ratio **1.00**
- Human Elevated Inc Rat **0.00**
- 2.9 Sinuosity **Low**
- 2.10 Riffles Type **Not Applicable**
- 2.11 Riffle/Step Spacing (ft) **N/A**

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	32 %
Fine Gravel	36 %
Sand	32 %
Silt and smaller	0 %

- Silt/Clay Present? **Yes**
- Detritus **5** %
- # Large Woody **7**

2.13 Average Largest Particle on

Bed	60.0	mm
Bar	N/A	mm

2.14 Stream Type

- Stream Type: **C**
- Bed Material: **Gravel**
- Subclass Slope: **None**
- Bed Form: **Plane Bed**
- Field Measured Slope:

2.15 Reference Stream Type (if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	One	15.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Silt	Silt
Consistency	Cohesive	Cohesive
Lower		
Material Type	Gravel	Gravel
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	218	0
Erosion Height (ft)	3.00	0.00
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	1,372	1,367

Near Bank Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	1-25	1-25
Mid-Channel Canopy	Open	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	0-25	0-25
Sub-dominant	None	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Herbaceous	Herbaceous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Hay	Pasture
Sub-dominant	Crop	Hay
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

- 4.1 Springs / Seeps **Minimal**
- 4.2 Adjacent Wetlands **Minimal**
- 4.3 Flow Status **Moderate**
- 4.4 # of Debris Jams **0**
- 4.5 Flow Regulation Type **None**
- Flow Regulation Use
- Impoundments **None**
- Impoundmt. Location
- 4.6 Up/Down strm flow reg **None**
- (old) Upstrm Flow Reg **None**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	1	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

- 4.9 # of Beaver Dams **2**
- Affected Length (ft) **500**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
3	2	1
Diagonal	**Delta**	**Island**
2	1	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
1	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

- 5.4 Stream Ford or Animal **Yes**
- 5.5 Straightening **Straightening**
- Straightening Length: **4,564**
- 5.5 Dredging **Gravel Mining**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Castleton River** Reach # **T02.11** Segment: **B** Completion Date: **June 30, 2005**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, ES** Why Not assessed: Rain: **Yes**

Segment Length (ft): **5,876** Segment Location: **From Gully Brook confluence to just downstream of Pond Hill Stables**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	5,534	304
height	0	0
Roads	341	0
height	0	0
Railroads	1,753	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	258

1.4 Adjacent Side

	Left	Right
Hillside Slope	Flat	Flat
Continuous w/	Sometimes	Always
W/in 1 Bankfill	Sometimes	Always
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **500**

Width Determination **Estimated**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **Yes**

Step 2. Stream Channel

2.1 Bankfull Width	32
2.2 Max Depth (ft)	2.30
2.3 Mean Depth (ft)	1.40
2.4 Floodprone Width (ft)	500

Notes:

Change in valley width (1.5) caused by trolley grade & railroad, but confinement still Very Broad. Former trolley grade indexed as a berm. Cross section (2.0) measured 11/4/2006 by ES, SH. Bed form (2.14) was plane bed for brief sections in otherwise pool-

Step 2. (Contued)

2.5 Aband. Floodpln	3.00 ft.
Human Elev Floodpln	0.00 ft.
2.6 Width/Depth Ratio	22.86
2.7 Entrenchment Ratio	15.63
2.8 Incision Ratio	1.30
Human Elevated Inc Rat	0.00
2.9 Sinuosity	Low
2.10 Riffles Type	Sedimented
2.11 Riffle/Step Spacing (ft)	150

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	8 %
Coarse Gravel	38 %
Fine Gravel	16 %
Sand	38 %
Silt and smaller	0 %

Silt/Clay Present? **Yes**

Detritus **3** %

Large Woody **6**

2.13 Average Largest Particle on

Bed **0.0**

Bar **0.0**

2.14 Stream Type

Stream Type: **C**

Bed Material: **Gravel**

Subclass Slope: **None**

Bed Form: **Riffle-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Moderate**

Bank Texture	Left	Right
Upper		
Material Type		
Consistency		
Lower		
Material Type		
Consistency		

Bank Erosion	Left	Right
Erosion Length (ft)	226	549
Erosion Height (ft)	2.00	2.00
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	639	432

Near Bank Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Deciduous	Deciduous

Bank Canopy	Left	Right
Canopy %	26-50	26-50
Mid-Channel Canopy	Open	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	0-25	0-25
Sub-dominant	>100	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Hay	Hay
Sub-dominant	Pasture	Industrial
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps	Minimal
4.2 Adjacent Wetlands	Minimal
4.3 Flow Status	Moderate
4.4 # of Debris Jams	12
4.5 Flow Regulation Type	None
Flow Regulation Use	
Impoundments	None
Impoundmt. Location	
4.6 Up/Down strm flow reg	None
(old) Upstrm Flow Reg	None

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	1	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
3	3	3
Diagonal	**Delta**	**Island**
7	1	2

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
6	2	1	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
2	0	No

5.4 Stream Ford or Animal **Yes**

5.5 Straightening **Straightening**

Straightening Length: **5,867**

5.5 Dredging **Gravel Mining**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River | April 15, 2008 SGAT Version: 3

Phase 2 Segment Summary

Stream: Gully Brook | Reach # T02.11-s1.01 | Segment: 0 | Completion Date: August 8, 2006

Organization: Poultney/Mettowee NRCD | Observers: KLU, MS, SH | Why Not assessed: | Rain: Yes

Segment Length (ft): 1,346 | Segment Location: From Woodbury Road crossing downstream to confluence with Castleton River. Site of

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation None

1.2 Alluvial Fan Yes

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	1,308	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Steep	Hilly
Continuous w/	Never	Never
W/in 1 Bankfill	Never	Never
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) 1,100

Width Determination Estimated

Confinement Type Very Broad

Rock Gorge? No

Human-caused Change? Yes

Step 2. Stream Channel

2.1 Bankfull Width 43

2.2 Max Depth (ft) 1.77

2.3 Mean Depth (ft) 0.82

2.4 Floodprone Width (ft) 310

Notes:

Segment transitions from a brief alluvial fan setting near the head of the segment out into the broader Castleton River valley. Valley width is reduced by RB corridor encroachment of Birdseye Road, but not to the degree that valley confinement (Very

Step 2. (Contued)

2.5 Aband. Floodpln 1.77 ft.

Human Elev Floodpln 0.00 ft.

2.6 Width/Depth Ratio 52.93

2.7 Entrenchment Ratio 7.14

2.8 Incision Ratio 1.00

Human Elevated Inc Rat 0.00

2.9 Sinuosity Low

2.10 Riffles Type Eroded

2.11 Riffle/Step Spacing (ft) 0

2.12 Substrate Composition

Bedrock	0%
Boulder	5%
Cobble	16%
Coarse Gravel	31%
Fine Gravel	20%
Sand	28%
Silt and smaller	0%

Silt/Clay Present? Yes

Detritus 1 %

Large Woody 0

2.13 Average Largest Particle on

Bed	90.0	mm
Bar	N/A	mm

2.14 Stream Type

Stream Type: C

Bed Material: Gravel

Subclass Slope: c

Bed Form: Plane Bed

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope Moderate

Bank Texture	Left	Right
Upper		
Material Type	Gravel	Gravel
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Gravel	Gravel
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	0	0
Erosion Height (ft)	0.00	0.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy Closed

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	0-25
Sub-dominant	None	26-50
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Crop	Shrubs/Saplin
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps None

4.2 Adjacent Wetlands None

4.3 Flow Status Moderate

4.4 # of Debris Jams 1

4.5 Flow Regulation Type None

Flow Regulation Use

Impoundments None

Impoundmt. Location

4.6 Up/Down strm flow reg

(old) Upstrm Flow Reg None

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	1	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams 0

Affected Length (ft) 0

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	0	2
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
2	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal Yes

5.5 Straightening Straightening

Straightening Length: 1,337

5.5 Dredging Dredging, Gravel Mining, Gravel Mining

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Stream: **Gully Brook** Reach # **T02.11-s1.02** Segment: **A** Completion Date: **August 8, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, MS, SH** Why Not assessed: Rain: **Yes**

Segment Length (ft): **529** Segment Location: **From power line crossing downstream to Woodbury Road bridge crossing.**

QC Status - Staff: **Provisional Cons Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **Yes**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	200	274
height	0	0
Roads	385	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	410	0
height	0	0
Development	0	27

1.4 Adjacent Side	Left	Right
Hillside Slope	Hilly	Steep
Continuous w/	Never	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Cobble	Cobble

1.5 Valley Features

Valley Width (ft) **180**
Width Determination **Measured**
Confinement Type **Narrow**
Rock Gorge? **No**
Human-caused Change? **no**

Step 2. Stream Channel

2.1 Bankfull Width **36**
2.2 Max Depth (ft) **2.15**
2.3 Mean Depth (ft) **1.54**
2.4 Floodprone Width (ft) **45**

Notes:

Brief section of lesser gradient, unconfined valley setting, consistent with the head of an alluvial fan feature as the Gully Brook transitions out into the broader Castleton River valley. While Birdseye Road passes within the Ph2 SCL-buffered corridor, it is

Step 2. (Contued)

2.5 Aband. Floodpln **5.95** ft.
Human Elev Floodpln **0.00** ft.
2.6 Width/Depth Ratio **23.25**
2.7 Entrenchment Ratio **1.26**
2.8 Incision Ratio **2.77**
Human Elevated Inc Rat **0.00**
2.9 Sinuosity **Low**
2.10 Riffles Type **Eroded**
2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	0 %
Fine Gravel	0 %
Sand	0 %
Silt and smaller	0 %

Silt/Clay Present? **No**
Detritus **2** %
Large Woody **0**

2.13 Average Largest Particle on

Bed **0.0**
Bar **0.0**

Not Evaluated

2.14 Stream Type

Stream Type: **F**
Bed Material: **Gravel**
Subclass Slope: **c**
Bed Form: **Plane Bed**
Field Measured Slope:

2.15 Reference Stream Type
(if different from Phase 1)
D 4 c Braided

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	76	121
Erosion Height (ft)	4.00	3.00
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	28	28

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Coniferous	Coniferous

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	51-100
Sub-dominant	51-100	26-50
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Shrubs/Saplin	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**
4.2 Adjacent Wetlands **None**
4.3 Flow Status **Moderate**
4.4 # of Debris Jams **1**
4.5 Flow Regulation Type **None**
Flow Regulation Use
Impoundments **None**
Impoundmt. Location
4.6 Up/Down strm flow reg
(old) Upstrm Flow Reg **None**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**
Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
1	0	2
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
1	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **Yes**
5.5 Straightening **Straightening**
Straightening Length: **494**
5.5 Dredging **Dredging**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River | **Phase 2 Segment Summary** page 1 of 2 | April 15, 2008 SGAT Version: 3

Stream: **Gully Brook** Reach # **T02.11-s1.02** Segment: **B** Completion Date: **August 8, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, MS, SH** Why Not assessed: Rain: **Yes**

Segment Length (ft): **3,746** Segment Location: **Bedrock channel west of Birdseye Road, downstream to the power line.**

QC Status - Staff: Provisional **Cons** **Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **Planform and Scope**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	57	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	74	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Very Steep	Extremely
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Always	Always
Texture	Bedrock	Bedrock

1.5 Valley Features

Valley Width (ft) **30**

Width Determination **Estimated**

Confinement Type **Narrowly**

Rock Gorge? **Yes**

Human-caused Change? **no**

Step 2. Stream Channel

2.1 Bankfull Width **25**

2.2 Max Depth (ft) **2.00**

2.3 Mean Depth (ft) **1.18**

2.4 Floodprone Width (ft) **38**

Notes:

Birdseye Road along RB encroaches within Ph2 SCL-buffered corridor, but is elevated well above FPW stage; no significant change in valley confinement. Dominantly a cobble step/pool channel with occasional bedrock-cascade, boulder-cascade, and gravel

Step 2. (Contued)

2.5 Aband. Floodpln **2.00** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **21.44**

2.7 Entrenchment Ratio **1.49**

2.8 Incision Ratio **1.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Complete**

2.11 Riffle/Step Spacing (ft) **200**

2.12 Substrate Composition

Bedrock	9 %
Boulder	14 %
Cobble	26 %
Coarse Gravel	17 %
Fine Gravel	16 %
Sand	18 %
Silt and smaller	0 %

Silt/Clay Present? **No**

Detritus **5** %

Large Woody **35**

2.13 Average Largest Particle on

Bed	250.0	mm
Bar	200.0	mm

2.14 Stream Type

Stream Type: **B**

Bed Material: **Gravel**

Subclass Slope: **b**

Bed Form: **Step-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	226	142
Erosion Height (ft)	2.84	3.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Coniferous	Coniferous
Sub-dominant	Deciduous	Deciduous

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Coniferous	Coniferous
Sub-dominant	Deciduous	Deciduous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **None**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **7**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

4.6 Up/Down strm flow reg

(old) Upstrm Flow Reg **None**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
1	8	15
Diagonal	**Delta**	**Island**
0	3	1

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
4	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	Yes

5.4 Stream Ford or Animal **No**

5.5 Straightening **None**

Straightening Length: **0**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River | Phase 2 Segment Summary | | April 15, 2008 | SGAT Version: 3

Stream: Gully Brook | Reach # T02.11-s1.04 | Segment: A | Completion Date: August 4, 2006

Organization: Poultney/Mettowee NRCD | Observers: KLU, HS | Why Not assessed: | Rain: Yes

Segment Length (ft): 5,395 | Segment Location: From just downstream of Traverse Park to the downstream end of the reach close to the

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Planform and Scope**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	73

1.4 Adjacent Side	Left	Right
Hillside Slope	Very Steep	Very Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Bedrock	Bedrock

1.5 Valley Features

Valley Width (ft) **36**

Width Determination **Measured**

Confinement Type **Narrowly**

Rock Gorge? **Yes**

Human-caused Change? **no**

Step 2. Stream Channel

2.1 Bankfull Width	21
2.2 Max Depth (ft)	1.80
2.3 Mean Depth (ft)	1.30
2.4 Floodprone Width (ft)	36

Notes:

Historic dam (now breached) and drinking water reservoir (now by-passed by the channel) located mid-segment (see report for more details). Overall, segment is steep-gradient, narrowly-confined, step/poo, bedrock channel, with brief sections of

Step 2. (Contued)

2.5 Aband. Floodpln	1.80 ft.
Human Elev Floodpln	0.00 ft.
2.6 Width/Depth Ratio	16.31
2.7 Entrenchment Ratio	1.67
2.8 Incision Ratio	1.00
Human Elevated Inc Rat	0.00
2.9 Sinuosity	Low
2.10 Riffles Type	Complete
2.11 Riffle/Step Spacing (ft)	100

2.12 Substrate Composition

Bedrock	52 %
Boulder	11 %
Cobble	10 %
Coarse Gravel	12 %
Fine Gravel	10 %
Sand	5 %
Silt and smaller	0 %

Silt/Clay Present? **No**

Detritus **2** %

Large Woody **35**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

Not Evaluated

2.14 Stream Type

Stream Type: **B**

Bed Material: **Bedrock**

Subclass Slope: **b**

Bed Form: **Step-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	Multiple	6.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Moderate**

Bank Texture	Left	Right
Upper		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive
Lower		
Material Type	Bedrock	Bedrock
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	70	33
Erosion Height (ft)	2.00	2.54
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Coniferous	Coniferous
Sub-dominant	None	None

Bank Canopy	Left	Right
Canopy %	76-100	76-100

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Coniferous	Coniferous
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps	Minimal
4.2 Adjacent Wetlands	None
4.3 Flow Status	Moderate
4.4 # of Debris Jams	7
4.5 Flow Regulation Type	None
Flow Regulation Use	
Impoundments	None
Impoundmt. Location	
4.6 Up/Down strm flow reg	
(old) Upstrm Flow Reg	None

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
5	4	8
Diagonal	**Delta**	**Island**
1	3	1

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
4	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	Yes

5.4 Stream Ford or Animal **Yes**

5.5 Straightening **None**

Straightening Length: **0**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River

Phase 2 Segment Summary

April 15, 2008 SGAT Version: 3

Stream: **Gully Brook** Reach # **T02.11-s1.04** Segment: **B** Completion Date: **August 3, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Why Not assessed: Rain: **Yes**

Segment Length (ft): **1,442** Segment Location: **Segment west of and parallel to Birdseye Road through Traverse Park**

QC Status - Staff: Passed Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **Yes**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	558	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Hilly	Hilly
Continuous w/	Never	Never
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

- Valley Width (ft) **100**
- Width Determination **Estimated**
- Confinement Type **Broad**
- Rock Gorge? **No**
- Human-caused Change? **yes**

Step 2. Stream Channel

- 2.1 Bankfull Width **14**
- 2.2 Max Depth (ft) **1.00**
- 2.3 Mean Depth (ft) **0.70**
- 2.4 Floodprone Width (ft) **16**

Notes:

Encroachments in the segment include Birdseye Road along the RB corridor, and hay field uses along LB corridor. Historic straightening inferred from linear planform along Birdseye Road. Presence of the road has reduced natural valley width from Very

Step 2. (Contued)

- 2.5 Aband. Floodpln **2.30** ft.
- Human Elev Floodpln **0.00** ft.
- 2.6 Width/Depth Ratio **20.00**
- 2.7 Entrenchment Ratio **1.17**
- 2.8 Incision Ratio **2.30**
- Human Elevated Inc Rat **0.00**
- 2.9 Sinuosity **Low**
- 2.10 Riffles Type **Sedimented**
- 2.11 Riffle/Step Spacing (ft) **80**

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	0 %
Fine Gravel	0 %
Sand	0 %
Silt and smaller	0 %

- Silt/Clay Present? **No**
- Detritus **10** %
- # Large Woody **15**

2.13 Average Largest Particle on

- Bed **210.0** mm
- Bar **190.0** mm

2.14 Stream Type

- Stream Type: **F**
- Bed Material: **Cobble**
- Subclass Slope: **b**
- Bed Form: **Step-Pool**
- Field Measured Slope:

2.15 Reference Stream Type (if different from Phase 1)

C 3 b Step-Pool

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	24	69
Erosion Height (ft)	3.00	1.46
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Deciduous	Deciduous

Bank Canopy	Left	Right
Canopy %	51-75	51-75

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	26-50
Sub-dominant	>100	>100
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Hay	Shrubs/Saplin
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

- 4.1 Springs / Seeps **Minimal**
- 4.2 Adjacent Wetlands **None**
- 4.3 Flow Status **Moderate**
- 4.4 # of Debris Jams **6**
- 4.5 Flow Regulation Type **None**
- Flow Regulation Use
- Impoundments **None**
- Impoundmt. Location
- 4.6 Up/Down strm flow reg
- (old) Upstrm Flow Reg **None**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	1	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

- 4.9 # of Beaver Dams **0**
- Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
3	5	2
Diagonal	**Delta**	**Island**
3	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
2	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
2	0	No

- 5.4 Stream Ford or Animal **Yes**
- 5.5 Straightening **Straightening**
- Straightening Length: **456**
- 5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Phase 2 Segment Summary

April 15, 2008 SGAT Version: 3

Project:	Castleton River		
Stream:	Gully Brook	Reach #	T02.11-s1.04
Segment:	C	Completion Date:	August 3, 2006
Organization:	Poultney/Mettowee NRCD	Observers:	KLU, HS
Why Not assessed:		Rain:	Yes
Segment Length (ft):	1,297	Segment Location:	From Ira/Poultney town line at Birdseye Road Xg downstream to upstream end of fields at

QC Status - Staff: Passed Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	33	26

1.4 Adjacent Side	Left	Right
Hillside Slope	Steep	Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft)	40
Width Determination	Estimated
Confinement Type	Semi-confined
Rock Gorge?	No
Human-caused Change?	no

Step 2. Stream Channel

2.1 Bankfull Width	14
2.2 Max Depth (ft)	1.10
2.3 Mean Depth (ft)	0.69
2.4 Floodprone Width (ft)	39

Notes:

Frequent occurrences of bedrock in bed and banks in otherwise cobble-dominated step/pool channel (with occasional riffle/pool form). Segment is transitional between steeper (>4 %) slopes further upstream and a broader valley of lesser gradient (2 to 4%)

Step 2. (Contued)

2.5 Aband. Floodpln	1.20 ft.
Human Elev Floodpln	0.00 ft.
2.6 Width/Depth Ratio	20.58
2.7 Entrenchment Ratio	2.75
2.8 Incision Ratio	1.09
Human Elevated Inc Rat	0.00
2.9 Sinuosity	Moderate
2.10 Riffles Type	Complete
2.11 Riffle/Step Spacing (ft)	90

2.12 Substrate Composition

Bedrock	2%
Boulder	8%
Cobble	42%
Coarse Gravel	19%
Fine Gravel	22%
Sand	7%
Silt and smaller	0%

Silt/Clay Present?	No
Detritus	10 %
# Large Woody	9

2.13 Average Largest Particle on

Bed	250.0	mm
Bar	170.0	mm

2.14 Stream Type

Stream Type:	C
Bed Material:	Cobble
Subclass Slope:	b
Bed Form:	Step-Pool
Field Measured Slope:	

2.15 Reference Stream Type (if different from Phase 1)

C 3 b Step-Pool

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Moderate**

Bank Texture	Left	Right
Upper		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive
Lower		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	0	21
Erosion Height (ft)	0.00	1.00
Revetmt. Type	Hard Bank	Hard Bank
Revetmt. Length (ft)	15	16

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Coniferous	Coniferous

Bank Canopy	Left	Right
Canopy %	76-100	76-100
Mid-Channel Canopy	Closed	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Coniferous	Coniferous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps	Minimal
4.2 Adjacent Wetlands	Minimal
4.3 Flow Status	Moderate
4.4 # of Debris Jams	6
4.5 Flow Regulation Type	None
Flow Regulation Use	
Impoundments	None
Impoundmt. Location	
4.6 Up/Down strm flow reg	
(old) Upstrm Flow Reg	None

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams	0
Affected Length (ft)	0

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	4	6
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
2	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal	No
5.5 Straightening	Straightening
Straightening Length:	45
5.5 Dredging	None

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River | **Phase 2 Segment Summary** | | April 15, 2008 SGAT Version: 3

Stream: **Gully Brook** Reach # **T02.11-s1.04** Segment: **D** Completion Date: **August 3, 2006**

Organization: **Poultney/Mettowee NRCD** Observers: **KLU, HS** Why Not assessed: Rain: **Yes**

Segment Length (ft): **995** Segment Location: **Approx 1000 feet of channel upstream of Ira / Poultney town line at Birdseye Road Xg**

QC Status - Staff: Passed Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Planform and Scope**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

	Length (ft) One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	35	16

1.4 Adjacent Side

	Left	Right
Hillside Slope	Very Steep	Very Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Bedrock	Boulder

1.5 Valley Features

Valley Width (ft) **20**

Width Determination **Estimated**

Confinement Type **Narrowly**

Rock Gorge? **No**

Human-caused Change? **no**

Step 2. Stream Channel

2.1 Bankfull Width **13**

2.2 Max Depth (ft) **0.75**

2.3 Mean Depth (ft) **0.56**

2.4 Floodprone Width (ft) **17**

Notes:

Encroachment by clearing (logging landing?) on RB, and timber bridge crossing for gravel recreational road. Frequent exposures of bedrock in bed and banks in otherwise cobble -dominated channel. Occasional cascade in otherwise step/pool dominated bed form.

Step 2. (Contued)

2.5 Aband. Floodpln **0.75** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **22.32**

2.7 Entrenchment Ratio **1.36**

2.8 Incision Ratio **1.00**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Complete**

2.11 Riffle/Step Spacing (ft) **30**

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	0 %
Fine Gravel	0 %
Sand	0 %
Silt and smaller	0 %

Silt/Clay Present? **No**

Detritus **10** %

Large Woody **11**

2.13 Average Largest Particle on

Bed **250.0** mm

Bar **170.0** mm

2.14 Stream Type

Stream Type: **B**

Bed Material: **Cobble**

Subclass Slope: **a**

Bed Form: **Step-Pool**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive
Lower		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive
Bank Erosion	**Left**	**Right**
Erosion Length (ft)	68	0
Erosion Height (ft)	4.74	0.00
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	27	17
Near Bank Veg. Type	**Left**	**Right**
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin
Bank Canopy	**Left**	**Right**
Canopy %	76-100	76-100
Mid-Channel Canopy	Closed	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	None
W less than 25	0	0
Buffer Veg. Type	**Left**	**Right**
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **Minimal**

4.3 Flow Status **Moderate**

4.4 # of Debris Jams **5**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

4.6 Up/Down strm flow reg

(old) Upstrm Flow Reg **None**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **0**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
2	1	2
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
3	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No

5.4 Stream Ford or Animal **Yes**

5.5 Straightening **Straightening**

Straightening Length: **48**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: Castleton River | **Phase 2 Segment Summary** | April 15, 2008 SGAT Version: 3

Stream: **Castleton River** | Reach # **T02.12** | Segment: **0** | Completion Date: **June 28, 2005**

Organization: **Poultney/Mettowee NRCD** | Observers: **KLU, ES, SL** | Why Not assessed: | Rain: **Yes**

Segment Length (ft): **12,493** | Segment Location: **From Route 4 in Ira township downstream to Traverse Farm at Gully Brook confluence.**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **None**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	4,023	684
height	0	0
Roads	2,898	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	52	462

1.4 Adjacent Side	Left	Right
Hillside Slope	Flat	Flat
Continuous w/	Sometimes	Never
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Silt/Clay	Silt/Clay

1.5 Valley Features

- Valley Width (ft) **780**
- Width Determination **Estimated**
- Confinement Type **Very Broad**
- Rock Gorge? **No**
- Human-caused Change? **Yes**

Step 2. Stream Channel

- 2.1 Bankfull Width **0**
- 2.2 Max Depth (ft) **0.00**
- 2.3 Mean Depth (ft) **0.00**
- 2.4 Floodprone Width (ft) **0**

Notes:

Valley width (1.5) reduced by railroad, trolley grade, and roads, but valley confinement still "Very Broad". Trolley grade FIT'd as "berm". Culvert is present along logging road (former ski area access); however, flow in Castleton River at this point is highly braided and

Step 2. (Contued)

- 2.5 Aband. Floodpln **0.00** ft.
- Human Elev Floodpln **0.00** ft.
- 2.6 Width/Depth Ratio **0.00**
- 2.7 Entrenchment Ratio **0.00**
- 2.8 Incision Ratio **0.00**
- Human Elevated Inc Rat **0.00**
- 2.9 Sinuosity
- 2.10 Riffles Type
- 2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Bedrock	0%
Boulder	0%
Cobble	0%
Coarse Gravel	0%
Fine Gravel	5%
Sand	90%
Silt and smaller	5%

- Silt/Clay Present? **Yes**
- Detritus **0** %
- # Large Woody **0**

2.13 Average Largest Particle on

- Bed **N/A**
- Bar **N/A**

2.14 Stream Type

- Stream Type: **E**
- Bed Material: **Gravel**
- Subclass Slope: **None**
- Bed Form: **Dune-Ripple**
- Field Measured Slope:

2.15 Reference Stream Type (if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Silt	Silt
Consistency	Cohesive	Cohesive
Lower		
Material Type	Silt	Silt
Consistency	Cohesive	Cohesive
Bank Erosion	**Left**	**Right**
Erosion Length (ft)	59	197
Erosion Height (ft)	2.00	1.23
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	260	226
Near Bank Veg. Type	**Left**	**Right**
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin
Bank Canopy	**Left**	**Right**
Canopy %	1-25	1-25
Mid-Channel Canopy	Open	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	0-25
Sub-dominant	26-50	>100
W less than 25	0	0
Buffer Veg. Type	**Left**	**Right**
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Herbaceous	Herbaceous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Pasture	Pasture
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

- 4.1 Springs / Seeps **Abundant**
- 4.2 Adjacent Wetlands **Abundant**
- 4.3 Flow Status **Moderate**
- 4.4 # of Debris Jams **8**
- 4.5 Flow Regulation Type **None**
- Flow Regulation Use
- Impoundments **None**
- Impoundmt. Location
- 4.6 Up/Down strm flow reg **None**
- (old) Upstrm Flow Reg **None**

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	3	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **2**

Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
0	2	0
Diagonal	**Delta**	**Island**
0	1	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
2	0	No

- 5.4 Stream Ford or Animal **Yes**
- 5.5 Straightening **Straightening**
- Straightening Length: **3,264**
- 5.5 Dredging **Dredging**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

APPENDIX C

Quality Assurance Documentation

MEMORANDUM

TO: Kristen Underwood, SMRC

FR: Shannon Pytlik, VT ANR River Management

DATE: March 21, 2007

RE: **Castleton River Phase 2 2006 QA Report**

Hi Kristen – Great job as usual! I just have a few minor comments that I would appreciate some response to.

Thanks,
Shannon

South Mountain Research & Consulting Services (SMRC) appreciates the opportunity to clarify data limitations, enhance data accuracy, and maximize the utility of the Castleton River Phase 2 data set (2006 reaches). This response to VT River Management Section QA Review Comments has been completed by Kristen L. Underwood, PG of SMRC (comments are in blue text following each step below). Where applicable, corrections made to original field data sheets (Field Notes, RGA, RHA) as a result of this QA review have been made in red. Applicable updates have been made to the Phase 1 and Phase 2 data in the VTDEC Data Management System (DMS) and to the summary report which accompanies this data.

General Comments:

Cross Sections
In general the cross sections do not go far enough into the valley to characterize the relationship of the river to its floodplain and valley floor. I am having a hard time deciphering your cross section code. I don't know what you are referring to by "LP", "TBIS".
Generally, I do have cross section measurements that extend beyond the left pin and right pin areas (these are recorded on the field data sheets, which I realize that you did not have a copy of at the time of your QA review). In the past, I have tended not to include the floodplain / valley wall measurements in the cross section spreadsheet, since they tend to "dwarf" the cross section profile itself, and it is hard to see the detail of the bankfull channel features (e.g., benches).

LP = Left Pin; TBIS = Top of Break in Slope.

I noticed that reaches that are segmented only have one cross section in the spreadsheet. The spreadsheets are designed to accommodate up to 4 segments. The following reaches have multiple segments, yet only one cross section in the spreadsheet:

- T02.08-S1.01
- T02.08-S1.04
- T02.08-S1.05
- T02.11-S1.02 – has 3 Xsections and 2 segments?

- T02.11-S1.04

Segmentation in the above reaches relied on abbreviated cross sections completed within the reach. These are cross section sites which typically captured only bankfull, edge-water, thalweg, and flood prone width points – to track the degree of floodplain connection and entrenchment ratio. They were typically recorded on the Waypoint / Photo Log (which I realize that you did not have a copy of at the time of your QA review).

The data should only be entered into the Pebble Count spreadsheet if you use all of the size categories. We did an analysis where we entered all size classes of pebbles for a reach and then determined and entered the Phase 2 generalized categories. The data results were NOT the same. For example, the roughness came out different. We have the table in the Phase 2 excel spreadsheet for those consultants that do a more detailed pebble count and plan to use the data to complete a more detailed hydraulic analysis. I will be adding this detail to the spreadsheet for next year so people don't enter the data and use the inaccurate numbers.

Thank you for this clarification. I was under the understanding the pebble count data were required to be entered into the Pebble Count spreadsheet – even if pebble counts were performed to the Phase 2 standard where itemizing to the detailed size classification is not required. I relied on the pebble count data only for determination of the dominant substrate size (D50). I did not use the channel roughness values or discharge estimates (which rely on the pebble count data) in the determination of bankfull elevation. Instead, I relied on bankfull features identified in the field (e.g., benches) to determine bankfull elevation. Noted bankfull width, max depth and cross sectional area (which are not dependent on the pebble count data) were also reviewed in comparison to Regional Hydraulic Geometry Estimates – mindful of where active channel adjustments (e.g., widening) might lead to channel dimensions that diverged from predicted values.

Channel Evolution Model

You seem to use the CEM of D a lot. Why do you think this is so applicable to the Castleton River? You even use it on some reaches that are incised which seems inconsistent to me. I would appreciate more documentation in the report for the justification for the selected CEM.

As I read the description of D-stage versus F-stage channel evolution provided in Appendix C of the protocols, it seems that some degree of incision is not inconsistent with a D-stage CEM. As stated, "the difference between F and D-stage channel evolution processes is the degree of channel incision." (page C-3). Generally speaking, I feel that the D-stage CEM is more applicable than the F-stage CEM for many tributary reaches and some main stem reaches of the Castleton River, given the frequency of bedrock vertical and lateral grade controls. Often, incision is constrained by exposed or shallow bedrock. Comments specific to assignment of the D-stage CEM under each applicable reach/segment are provided below.

Also, I would like to offer the following general comments on assignment of CEM and CES.

<u>General Comments</u>

SMRC has assigned channel evolution model (CEM) and channel evolution stage (CES) because it is a requirement of completing the protocols. However, speaking generally, SMRC would like to note the high uncertainty and subjectivity inherent in assigning both CEM and CES to segments based on the results of Phase 2 assessments from one date. Inferring a possible evolution of channel adjustments based on one discrete and limited set of observations and measurements from one snapshot in time, with limited knowledge of the historic channel and watershed stressors, is at best theoretical. A trend cannot be definitively assigned on the basis of one set of data.

A channel evolution model can begin to characterize a theory of the possible sequence of channel adjustments in response to a known or inferred stressor(s). However, lateral and vertical adjustments in river systems are much more complex than a single CEM can express. Vertical and lateral grade controls to channel adjustment often exist, soils of highly variable erodibility and cohesive strength can be present along the corridor in the stream bed and banks, vertical layering of lithologies can exist, variable riparian vegetation conditions may exist, all of which constrain channel adjustments in response to a given stressor to varying degrees. In addition, the majority of rivers have experienced multiple stressors (of varying types, magnitude, duration, and periodicity) to multiple locations (of varying extent), especially over recent centuries of human habitation. Channel adjustments in response to these multiple stressors are translated upstream and downstream (as constrained by the various boundary conditions). Process lag times, threshold relationships, and cumulative effects (Jacobson et al., 2001) operating over broader spatial and temporal scales determine how the system responses to stressors will overlap and manifest themselves in a specific channel morphology at a specific watershed location at a given time. In other words, the present condition and dimensions of a given segment are the manifestation of these dynamic channel adjustment processes in response to variable stressors, integrated over time and space.

Administrative Judgment
It appears as if you used the "Administrative Judgment" fields for reaches that you did not assess. I don't think this should be used because the implications to FEH. If you do use it you should always fill in who are in the entity

I appreciate this point and I agree. The content in the Administrative Judgment fields (for reaches not assessed) was apparently resident in the database prior to my adding data from these 2005 and 2006 reaches. I do not know who entered this data.

Sub Class Slope
You don't need to enter a sub class slope if it is the same as the stream type. For example if you have an A stream type you don't need an "a" as a sub class slope. In this situation the sub class slope should be none. I can see the Phase 1 assessor incorrectly had the sub class slope in their data, but it should be revised for those reaches where we have Phase 2 data.

There has been a recent change made to the DMS, whereby a QC flag is raised if any Phase 2 Step 2 fields are left blank – including this subclass slope field. For this reason, I have been entering the subclass slope even when it may be perceived as redundant (i.e., same as the stream type classification).

Castleton River

<u>T2.01</u>
In the report you refer to the incision as "historic or recent". We reserve historic for post glacial incision and would refer to this as recent incision.

Thank you for the opportunity to discuss the topic of "historic" versus "recent", as I still have some confusion on this point. I also share your concern and struggled with these terms "ancient" and "historic" and "recent". I agree it is important to be consistent. Perhaps this QC review dialogue, and others like it, can help to define a more standardized set of definitions and terminology to insert in the VTANR protocols.

The only references to these terms that I have been able to find in the current version of the protocols (March 2006) are on page 73 under Section 7.0 on Rapid Geomorphic Assessment and on page 25 under Section 2.5 on Recently Abandoned Floodplain. Section 7.0 defines "historic" as occurring "in the past", and does not seem to identify a time scale to distinguish "recent" versus "existing" versus "historic". Section 2.5 defines "recent" versus "historic" in the context of an incising (incised) channel based on dimensions, suggesting that "high abandoned terraces … more than 3 times the bankfull maximum depth" are historic (or pre-date historic). Better clarification in the protocols would be helpful.

I appreciate the clarification you provide under comments for reach T2.02 below – namely, that "recent" refers to the past 200 years and "historic" refers to anything before that. I have some concern with this definition for two main reasons. First, it seems to be inconsistent with the statement on page 73 regarding when to check the "historic" box next to each channel adjustment process under the RGA. Based on the explanation given on page 73, I would check "historic" for any process that is not active (current). Therefore, both "recent" adjustments (occurring within the last 200 years) and "historic" adjustments (occurring earlier than the last 200 years, but after glacial retreat) would seem to require that the "historic" box be checked. This explanation on page 73 is what led me to characterize adjustments occurring in the last few 100 years as "historic". Secondly, (this is a picky point, but) the Castleton River assessment (and other projects in Vermont) have identified channel manipulations by humans that have occurred more than 200 years before present. (Dams 3 and 2 on reach T2.03 were constructed in the 1780s). So, perhaps a clarification that "historic" applies to adjustments occurring in the last 250 years or 300 years would be helpful.

In the report under the summaries for reaches T2.01 and T2.02, I attempted to characterize the timescale for the observed degree of vertical separation of the channel from high abandoned terraces which form the series of plateaus upon which the village of Fair Haven is developed. As discussed in the geology section of the Phase 2 report (Section 2.2) and in the text under each reach, it is inferred that incision resulting in the current entrenched position of the channel below this plateau occurred over several thousand years ago (post-glacial). Following your definition provided above, this timescale would be defined as "historic"; I have edited the report text, accordingly.

Phase 1 dominant bed material is sand and Phase 2 is gravel. Do you have some reason for thinking the reference is different than the existing?
The Phase 2 bed substrate composition (Step 2.12) was derived from a pebble count completed at a single cross section location. The D50 was on the cusp between sand and gravel categories; 47% of the counted "pebbles" were sand or smaller. The Phase 1 bed substrate composition describes the overall reach-wide, reference condition. Observations of bed form (dominantly ripple-dune, but occasionally riffle/pool) and sediment substrates suggested a D50 slightly smaller in size than was measured at the one discrete cross section site. The cross section was measured downstream of the Route 4 highway crossing, local to some right-bank high-bank erosion exposing sands overlying silts and approximately 500 feet downstream of some left-bank high-bank erosion exposing sands and gravels. It is possible that these localized areas of streambank erosion have resulted in slightly coarser bed materials at the cross section site, than are reflected elsewhere in the reach.

Why did you use the D stage CEM? If the stream has incised (therefore has the potential to incise) you should use the F stage CEM.

At present, the channel in reach T02.01 is not exhibiting major adjustments – it was rated in "Good" condition (score of 0.775). Projecting forward in time, from this quasi-equilibrium condition, to anticipate a model of channel evolution in response to some as yet undefined stressor(s), is purely speculation. (See also SMRC general comments under *Channel Evolution Model* above, regarding uncertainty and subjectivity involved in assigning CEM and CES). Since protocols require assignment of a CEM/CES, in SMRC's estimation, a D-stage CEM more adequately describes the potential channel evolution model for reach T02.01 than an F-stage CEM.

An F-stage CEM according to protocols (Appendix C, page C1) applies to "unconfined, low gradient valleys" or "moderately entrenched, semi-confined …streams"… " under the assumption that the stream has a bed and banks that are sufficiently erodible so that they can be shaped by the stream over" time. It seems that an incision ratio of 2.0 or greater is implied under Stage II of the description of F-stage CEM – meaning that stressor-induced incision would result in complete entrenchment of the channel relative to its present floodplain. Currently, the floodplain available to the Castleton River in reach T02.01 is relatively narrow (a Semi-Confined channel confinement was noted, two to four times the channel width). It is true, as you mention, that reach T02.01 has undergone incision in the past (post-glacial). Abandoned terraces from this post-glacial incision are present within 6 to 16 feet above the channel thalweg (at a vertical distance of one to more than two times the maximum depth). Thus, future incision might be expected that would result in an incision ratio greater than 2.0 (measured relative to the current floodplain). However, it is theorized that historic (post-glacial) incision occurred under far more intense hydrologic and sediment regimes. It is theorized that climate was much wetter and colder, and the degree of vegetation on the landscape soon after deglaciation would have been absent to very minimal. Also, the sediments that the river originally incised into were the sands and fine gravels of the inferred delta deposits. It could be argued that the current river channel does not have the same potential to incise under the current climate and hydrologic and sediment regimes. Based on observation of sediment profiles exposed in high-bank erosion in the reach, sediments through which the Castleton River is presently flowing are dominated by lacustrine silts and silty-clays – more cohesive in nature than the overlying sands and gravels. In addition, channel-spanning bedrock is exposed mid-reach. These factors suggested that if incision were to be induced by a future stressor or stressors (e.g., channelization, increased hydrologic loading), it would be moderated (under the current climate regimes) by the cohesive nature of these sediments and presence of channel-spanning bedrock.

A D-stage CEM applies to "unconfined, low …gradient valleys" where the degree of degradation may be limited "because its bed is significantly more resistant to erosion than its banks". These channels tend to exhibit excessive widening, aggradation and planform adjustments rather than degradation in response to stressors. It seems that an incision ratio less than 2.0 is implied under the description of D-stage CEM (i.e., see description of Stage IIb in Appendix C of protocols). Given this description, and the above-noted considerations, a D-stage CEM was selected for reach T02.01.

As stated in the Phase 2 report, "A measured incision ratio of 1.2 suggests a minor degree of historic or recent incision. The cross section was completed near the Route 4 crossing and some degree of localized incision may be associated with straightening in vicinity of the crossing. It is also possible that bankfull elevation was underestimated. Negligible signs of active incision (e.g., headcuts, undercut banks) or active widening were noted." Therefore, a CES of "I" was chosen.

T2.02

General Intro - I am concerned about your use of ancient and historic. We call "recent" the past 200 years and "historic" anything before that. This is just a matter of opinion and not wrong by any means, but it would be nice to be consistent so people don't get confused.

Please see discussion under T02.01.

For both T02.01 & T02.02 you selected the CEM D stage I. I question whether this is appropriate to use given the setting. Typically, the D CEM is only selected if the stream cannot incise for some reason. Given that neither of these have any grade controls and the bed material is primarily gravel I think there is potential for incision. Please let me know what your reasoning was for selecting the D stage.

Please see responses under reach T02.01 above.

Also, T02.01 had an occurrence of channel-spanning bedrock and Segment B of reach T02.02 had an occurrence of grade control. It may have been channel-spanning varved clays; however, due to turbidity and the speed of the current on the kayak assessment date, it was not possible to rule out bedrock. Please note that due to a "glitch" in the DMS, these FIT'd occurrences of grade control were not properly uploading to the DMS at the time that you were conducting the QA review of data. This glitch appears to have been resolved in the meantime, and these grade controls now appear in the DMS under these reaches.

While the bed materials in reaches T02.01 and T02.02 were dominated by fine gravels and sands, the native sediments through which the channel is flowing appear to be dominated by cohesive silts and silty-clays of lacustrine origin, based on observation of sediment profiles in the high banks. These cohesive silts and silty-clays would theoretically be more erosion-resistant than sands and gravels, and may serve to moderate channel incision.

In SMRC's estimation, a D-stage CEM more adequately describes the potential channel evolution model for reach T02.02 than an F-stage CEM. Signs of active incision in reach T02.02 were not observed. Instead, the dominant adjustment process was planform adjustment, accompanied by minor to moderate widening and aggradation. Historic incision in this reach is theorized to have occurred in the 1000s of years following glacial retreat, induced by base-level lowering in the Champlain Valley. Abandoned terraces from this post-glacial incision are present within 80 feet above the channel thalweg (at a vertical distance of more than twelve times the maximum depth). Based on this occurrence, future incision might be expected that would result in an incision ratio greater than 2.0 (F-stage CEM) measured relative to the current floodplain. However, it is theorized that historic (post-glacial) incision occurred under far more intense hydrologic and sediment regimes. It is theorized that climate was much wetter and colder, and the degree of vegetation on the landscape soon after deglaciation would have been absent to very minimal. Also, the sediments that the river originally incised into were the more erodible sands and fine gravels of the inferred delta deposits. Erodibility is also defined on the basis of the hydrologic regime. It could be argued that the current river channel does not have the same potential to incise under the current climate and hydrologic and sediment regimes – and lateral adjustments may dominate over incision (i.e., D-stage CEM). Based on observation of sediment profiles exposed in high-bank erosion in the reach, sediments through which the Castleton River is presently flowing are dominated by lacustrine silts and silty-clays – more cohesive in nature than the overlying sands and gravels. In addition, grade controls are exposed mid-reach. These factors suggest that if incision were to be induced by a future stressor or stressors (e.g., channelization, increased hydrologic loading), it would be moderated (under the current climate regimes) by the cohesive nature of these sediments and presence of grade controls, both within the reach and in upstream and downstream reaches.

T2.02 A
Why is the RGA not filled in for this segment?
This was a simple oversight. Thank you for catching it. RGA data are now filled in.

Cross section does not extend far enough into the valley. It does not include the floodprone area. See response to general comment re: Cross Sections.

T2.02B
Phase 1 has a grade control listed, yet Phase 2 has none. Should the one in Phase 1 be removed?
Segment B of reach T02.02 had an occurrence of grade control. It may have been channel-spanning varved clays; however, due to turbidity and the speed of the current on the kayak assessment date, it was not possible to rule out bedrock. Please note that due to a "glitch" in the DMS, FIT'd occurrences of grade control were not properly uploading to the DMS at the time that you were conducting the QA review of data. This glitch appears to have been resolved in the meantime, and these grade controls now appear in the DMS.

What is the constriction of "other"? Slate walls maybe?
Yes, slate walls and fill material.

T2.03
I understand why the RGA was not completed; I don't understand why you entered a CEM, Condition and sensitivity? Seems like it may have been an "administrative judgment", yet not all of the fields are filled in?
Per Section 7.0, pages 71 and 72 of the protocols, this reach would qualify as a reach impounded by a dams as well as a reach controlled by bedrock. In each of these settings, protocols instruct the user to forgo Steps 7.1 through 7.4 (RGA), Step 7.5 (Adjustment Process/ CEM), and Step 7.6 (Condition).

For impounded reaches, protocols instruct one to use the reference stream type as the basis for the sensitivity. Reach, T02.03 would be classified as a bedrock channel in absence of the dams. For bedrock-controlled channels, protocols instruct to assign a sensitivity of "Low".

Accordingly, I have removed the CEM, and Condition ratings from Step 7, but left the "Low" sensitivity.

What is the "other" 5 foot wide channel constriction?
This is the breached opening in Dam #2 (Structural Slate Dam).

Pond Hill Brook

T02.08-S1.05 F

Why do you have a sub-class slope of b for a reach with a slope of 1%? I would think it was just a C by reference?
The sub-class slope of "b" under the Subreach Reference Stream Type for segment F was incorrect – a simple data-entry error. I have corrected the DMS and the report text.

What do you mean by "historic" incision? If it was post glacial and not related to our current hydrologic regime, than the terrace would not be counted as the recently abandoned floodplain.
Signs of active incision were not observed in Segment F. The incision suggested by a measured incision ratio of 4.5 is expected to have occurred in the past as a result of channelization and ditching to facilitate the use of adjacent floodplain as a hay field. It is inferred that such channelization/ditching would have occurred within the last 200 years. By the definition of "recent" and "historic" that you have provided under reach T02.02 comments, this would be classified as "recent" incision. However, following instructions provided in the protocols (page 73, March 2006 version), I checked the "historic" box next to incision on the RGA, "to indicate that while the channel is not actively or currently undergoing the adjustment process, the adjustment did occur in the past."

Since the channel incision is inferred to have occurred within the last 200 years, it was appropriate to count the terrace as the recently abandoned floodplain.

Do you have the cross section in an excel spreadsheet? I know you can only enter up to four segments in one spreadsheet, but I would still like the data if you have it.
The cross section site was an abbreviated cross section recorded on the Waypoint / Photo Log (which I realize that you did not have a copy of at the time of your QA review).

I don't understand why you used the D CEM on a stream with incision?
As I read the description of D-stage versus F-stage channel evolution provided in Appendix C of the protocols, it seems that some degree of incision is not inconsistent with a D-stage CEM. As stated, "the difference between F and D-stage channel evolution processes is the degree of channel incision." (page C-3).

In SMRC's estimation, neither of the two available CEM choices in Appendix C of the protocols appears to adequately describe this segment.

An F-stage CEM according to protocols (Appendix C, page C1) applies to "unconfined, low gradient valleys" … " under the assumption that the stream has a bed and banks that are sufficiently erodible so that they can be shaped by the stream over" time. It seems that an incision ratio of 2.0 or greater is implied under the description of F-stage CEM (i.e., Stage II). While Segment T02.08-s1.05-F has a measured "incision" ratio of 4.5, this ratio appears to be the result of bed-lowering and/or floodplain elevation increases associated with channelization / ditching and plowing, rather than (or in addition to) active incision processes. Segment T02.08-s1.05-F arguably has limited stream power (due to a small drainage area, and relatively low slope) to shape its bed and banks. Exposed soils (till) appeared relatively cohesive. And channel-spanning bedrock provides vertical grade control.

A D-stage CEM applies to "unconfined, low …gradient valleys" where the degree of degradation may be limited "because its bed is significantly more resistant to erosion than its banks". These channels tend to exhibit excessive widening, aggradation and planform adjustments rather than degradation. It seems that an incision ratio less than 2.0 is implied under the description of D-stage CEM (i.e., Stage IIb). True, T02.08-s1.05-F appears to have a incision ratio in excess of

2.0. However, its banks are apparently resistant to widening, aggradation and planform adjustments, as these processes do not appear to be excessive in the reach. An "incision" ratio of 4.5 would not exactly be consistent with the description under Stage IIb which identifies incision to be moderate or limited by the cohesiveness of boundary materials.

Since assignment of a CEM and CES is a requirement of the protocols, SMRC has chosen D-stage CEM, Stage IIb CES, with an associated stream type departure from C to F. However, the above comments would serve to qualify this assignment.

T02.08-S1.05 E

Do you have the cross section in an excel spreadsheet? I know you can only enter up to four segments in one spreadsheet, but I would still like the data if you have it.
The cross section site was an abbreviated cross section recorded on the Waypoint / Photo Log (which I realize that you did not have a copy of at the time of your QA review).

T02.08-S1.05 D

Where in the cross section is the RAF? What do the "LP", "TBIS" refer to in the cross section? LP = Left Pin; TBIS = Top of Break in Slope.
Upon review of this segment and its cross section, SMRC determined that the incision ratio is greater than originally identified. The RAF is at the right pin. An incision ratio of 2.05 is now applicable. The appropriate parameters in Step 2.0 of the DMS were revised. Also, the segment was evaluated as a reference Unconfined channel (rather than as a confined), which has undergone a Stream Type Departure (Cb to B). Step 7 was revised in the DMS. Accordingly, the segment sensitivity was changed to "Extreme".

Why did you use the D CEM when the stream is incised?
As I read the description of D-stage versus F-stage channel evolution provided in Appendix C of the protocols, it seems that some degree of incision is not inconsistent with a D-stage CEM. As stated, "the difference between F and D-stage channel evolution processes is the degree of channel incision." (page C-3). The measured incision ratio was originally 1.16. – a D-stage CEM would be consistent with this value (in absence of active incision). Now that the cross section interpretation has been revised, and the incision ratio has been revised to 2.05, I agree that an F-stage CEM would be more appropriate.

Bedrock is shallow beneath the segment. Channel-spanning bedrock (classified as "ledge" by protocols) is exposed in three separate locations near the upstream and downstream ends of the segment. Thus, the potential for further incision is interpreted as being limited.

T02.08-S1.05 C

What was the cross section used for? Why do you have the RGA, CEM, condition and stream type filled in? Segment C is a brief section of steep-gradient bedrock-controlled channel. Bedrock ("ledge", by protocols) is exposed in the channel for a majority of the length, with locally steeper sections of cascade bedform over bedrock waterfalls. SMRC did not fill in the RGA or condition. I only filled in the stream type, CEM/CES and the sensitivity. The stream type and CEM/CES were completed in an effort to be thorough, and I felt that observations from the reach were sufficient to support these estimations. I have removed the CEM/CES and stream type entries in the DMS. Assignment of a "Low" sensitivity to "bedrock gorge" is prescribed by protocols (page 72, March 2006 version). I have changed the sensitivity from "Very Low" to "Low" in the DMS.

T02.08-S1.05 B

Why isn't the cross section in the spreadsheet?

The cross section site was an abbreviated cross section recorded on the Waypoint / Photo Log (which I realize that you did not have a copy of at the time of your QA review).

T02.08 S1.04 B

Interesting use of "repairs". We usually use something like "post flood channel work". Repairs sound beneficial and necessary. I was using "repairs" in reference to the road and culvert. I have added text to the report that might help to clarify this word choice.

T02.08 S1.04 A

Why does T02.08-S1.03 have the RGA filled in and not this segment?

That was an inconsistency on my part. I understand that following protocols (March 2006 version), "if your segment is confined within a bedrock gorge, you should forego the completion of Steps 7.1 through 7.6 and assess the segment or reach as having a "Low" sensitivity". I can remove the RGA from Segment T02.08-s1.03, if you wish.

I have removed the CEM/CES and stream type entries in the DMS under segment T02.08-s1.04-A (and T02.08-s1.04-C). Assignment of a "Low" sensitivity to "bedrock gorge" is prescribed by protocols (page 72, March 2006 version). I have changed the sensitivity from "Very Low" to "Low" in the DMS.

T02.08-S1.03

None

T02.08-S1.02

Your cross section does not show the floodplain that was abandoned as a terrace. Can you add this? How wide was the floodplain that is not lost to the stream. Actually, the submitted cross section does have the floodplain that was abandoned as a terrace. The RTOB (Right Top of Bank) point at Distance = 24.8 ft and Elevation = 104 represents the southern edge of the abandoned terrace. The ground surface stays fairly level from this RTOB point to the north of the river until you reach the Staso Road. The LTOB point at Distance = -11.4 and Elevation = 104.8 is the old railroad grade (now abandoned). The ground slopes downward slightly beyond this rail grade to the south. The floodplain available to the channel is 21.5 feet wide at the Flood Prone Width Elevation (estimated 10- to 50-year storm). A slightly wider floodplain would be available to this entrenched channel at higher flood magnitudes.

T02.08-S1.01 E

I don't have a cross section for this segment. The pictures in the report look like the segment has a very high bank on the left bank. Is the right bank the one with the ample floodplain access?

The cross section site was an abbreviated cross section recorded on the Waypoint / Photo Log (which I realize that you did not have a copy of at the time of your QA review).

The picture in the report is taken at the upstream 100 feet of the reach - essentially at the reach break. As stated in the report, "The grade of the railroad spur is coincident with the left bank in the upper 100 feet of the segment, but gradually "pulls away" from the channel to a distance of greater than 100 feet with distance downstream." At this one discrete point, yes, there is limited floodplain access along the right bank. The majority of the segment had ample floodplain access (on alternating left and right banks). An entrenchment of 27 and an incision ratio of 1.0

were measured at the cross section completed in the downstream half of the segment, which is characteristic of the segment as a whole.

T02.08-S1.01 D
Why isn't the cross section in the spreadsheet?
Page 69, two periods at the end of the first paragraph.
The cross section site was an abbreviated cross section recorded on the Waypoint / Photo Log (which I realize that you did not have a copy of at the time of your QA review).

T02.08-S1.01 C
Why isn't the cross section in the spreadsheet?
The cross section site was an abbreviated cross section recorded on the Waypoint / Photo Log (which I realize that you did not have a copy of at the time of your QA review).

T02.08-S1.01 B
Why isn't the cross section in the spreadsheet?
If the stream is incised than why did you select the D CEM?
The cross section site was an abbreviated cross section recorded on the Waypoint / Photo Log (which I realize that you did not have a copy of at the time of your QA review).

As I read the description of D-stage versus F-stage channel evolution provided in Appendix C of the protocols, it seems that some degree of incision is not inconsistent with a D-stage CEM. As stated, "the difference between F and D-stage channel evolution processes is the degree of channel incision." (page C-3). The measured incision ratio was 1.13. No signs of active incision were observed; the noted very minor degree of incision is probably historic, or may represent a slight underestimation of the bankfull elevation. Assignment of a D-stage CEM would be consistent with the noted conditions in the segment.

While there were no bedrock grade controls observed in Segment B, I made the assumption that bedrock was shallow beneath the segment and would serve to limit vertical adjustments in response to a future stressor, given the close proximity of bedrock (gorge) in upstream Segment C. I can also see that if the thickness of sediments overlying bedrock in Segment B is sufficiently large, the channel could incise (in response to some future stressor(s)) to a degree that the incision ratio would exceed 2.0. In that case, the F-stage CEM model would be more appropriate to describe the channel evolution.

In absence of soil boring information or geophysical surveys that could allow us to map the depth of bedrock beneath Segment B, assignment of a D-stage or F-stage CEM model is purely speculative. (See also SMRC general comments under *Channel Evolution Model* above, regarding uncertainty and subjectivity involved in assigning CEM and CES).

The more important element of the CEM and CES assignment is the fact that, at present, Segment B appears to be in relatively stable condition (condition score = 0.81). Channel adjustments are minor and suggestive of dynamic equilibrium – Stage I of channel evolution.

T02.08-S1.01 A
If the stream is incised than why did you select the D CEM?
As I read the description of D-stage versus F-stage channel evolution provided in Appendix C of the protocols, it seems that some degree of incision is not inconsistent with a D-stage CEM. As stated, "the difference between F and D-stage channel evolution processes is the degree of channel incision." (page C-3).

As indicated in the report, "The measured incision ratio (1.4) is in part due to elevation of the floodplain local to the channel - by road bed material of Cemetery Drive (along right bank) and by a shallow berm (along left bank)." And "Degradation appears historic in nature, based on the absence of features which would indicate active incision." There may have been some measure of channel incision in the past in response to significant channelization. However, vertical adjustments were apparently moderated – perhaps due to cohesive sediments surrounding the channel, perhaps due to armoring of the bed, perhaps due to the local fixed base levels (of the downstream culvert at the confluence with Castleton River, and the upstream bedrock gorge). Lateral adjustments have been moderated also by channel armoring and road embankments, and the shallow berm.

Since the channel has not lost connection to its floodplain, a D-stage CEM was selected. Stage IIb CES was selected, as the noted segment conditions seem to most closely match this stage as described in Appendix C of the protocols.

If the features you measured are not indicative of incision than they should not be used to determine the recently abandoned floodplain elevation, which does indicate incision.
I am not sure I understand this comment. Are you saying that the RAF should not be measured at the berm (or at an encroaching road embankment), but instead skip over or through those features to the nearby floodplain? If so, this method would be different than the method I have used in other watersheds (where my methods were QA-approved by other RMS staff – perhaps my interpretation of RAF at a berm was not clear to the RMS staff in those cases?). Greater clarification of this point in the protocols would be helpful. As I review the section on Recently Abandoned Floodplain and measurement of Incision Ratio in the protocols (March 2006 version), there is no discussion of this.

I can see that if the sole purpose of the IR is to measure active or historic incision, ignoring an adjacent berm or road in the identification of the RAF would be appropriate. In doing so, though, we would miss capturing the degree of entrenchment of the channel caused by these encroaching structures, particularly if they were not high enough in elevation to influence the measurement of FPW and therefore the ER.

In this particular case (T2.08-s1.01-A), the segment and floodplain have been so disturbed that it is difficult to ascertain what the RAF is, and whether the current degree of vertical separation of the thalweg from the surrounding features has been influenced by historic incision versus fill (berm, road base, residential development), and in what proportions.

If the RAF determination should ignore the berm, SMRC would need to repeat the cross section to discern the corrected RAF and IR.

Gully Brook

T02.11-S1.04 C
Why the D CEM with incision?
Some degree of incision is not inconsistent with a D-stage CEM. As stated, "the difference between F and D-stage channel evolution processes is the degree of channel incision." (page C-3). The incision ratio is 1.09; incision is historic (based on the absence of features that would indicate active incision). At this very small ratio, it is also possible that the bankfull elevation was slightly underestimated.

Bedrock is expected to be at shallow depths throughout the segment, based on close proximity of bedrock gorges, and exposure of channel-spanning bedrock at three separate sections within the segment, as well as lateral bedrock controls. Therefore, it is expected that vertical adjustments would be moderated in the event of an incision-inducing stressor. Therefore, a D-stage CEM was chosen.

T02.11-S1.02 A & T02.11-S1.01

You call T2.11-S1.02A a STD from D to F. Would the reference for T02.11-S1.01 be a D? Should it be changed?

Within these sections, the Gully Brook is emerging from a narrowly-confined, bedrock-controlled valley and flowing out onto the much broader Castleton River floodplain. The channel gradient decreases substantially (from 3.2% in T2.11-s1.02-B to 1.5% in Segment A and ultimately to 1.3% in T2.11-s1.01). The sediment transport capacity of the Gully Brook drops significantly. Topographic contours at this slope transition suggest an alluvial fan feature. This alluvial fan probably formed under earlier post-glacial environments (thousands of years before present) when sediment deposition was more active. At segment S1.02-A, these alluvial fan deposits probably overlie glacial terminal moraine deposits near the southern valley wall of the Castleton River. Farther to the north (downstream) near the center of the Castleton River valley alluvial fan deposits are probably interlayered with recent Castleton River alluvial sediments to cover post-glacial lacustrine silt and clay deposits (Stewart & MacClintock, 1966).

It is theorized that climate was much wetter and colder, and the degree of vegetation on the landscape soon after deglaciation would have been absent to very minimal. It is theorized that flow rates and sediment loads would have been much higher in the Gully Brook in post-glacial times, than they are today. A braided channel (D stream type) might be expected as the reference stream type in this valley setting under these more intense hydrologic and sediment regimes.

Under current, less instense, sediment and flow regimes, a classically-define, braided, D reference stream type may not be appropriate at this location. However, within Segment S1.02-A, evidence of multiple flood chutes outside of the managed (historically dredged, straightened, bermed) channel suggested a natural tendency for a multi-thread channel in this location upstream of and in direct vicinity of the Woodbury Road crossing. For this reason, I selected a D reference stream type for this segment. Also, this segment seems to be located at the point of most intense slope reduction (and therefore most intense decrease in sediment transport capacity). With distance downstream, a single-thread, meandering, and laterally adjusting reference stream type of C seems more appropriate under present sediment and hydrologic regimes. Since we do not have available to us a record of channel dimensions, profile, and planform of the Gully Brook from 250 years ago (pre-human-disturbance), assignment of the reference stream type is somewhat subjective. I could support either a C or D reference stream type for T02.11-S1.01.

MEMORANDUM

TO: Kristen Underwood, SMRC

FR: Shannon Pytlik, VT ANR River Management

DATE: **April 1, 2008**

RE: **Castleton River Phase 2 2007 Update QA Report**

QA response comments noted in blue text below – K. Underwood, SMRC, 11 April 2008

I noticed you did the indexing for this project in SGAT V4.53. It would have been a good idea to update the project to V4.56 so you have the full FIT functionality. It looks like you didn't index inadequate buffers for example, which would have been an option with the updated SGAT version. We may have discussed this some time along the way, but I don't recall. V4.56 was released in Spring of 2007 so it would have been available for use on this project.

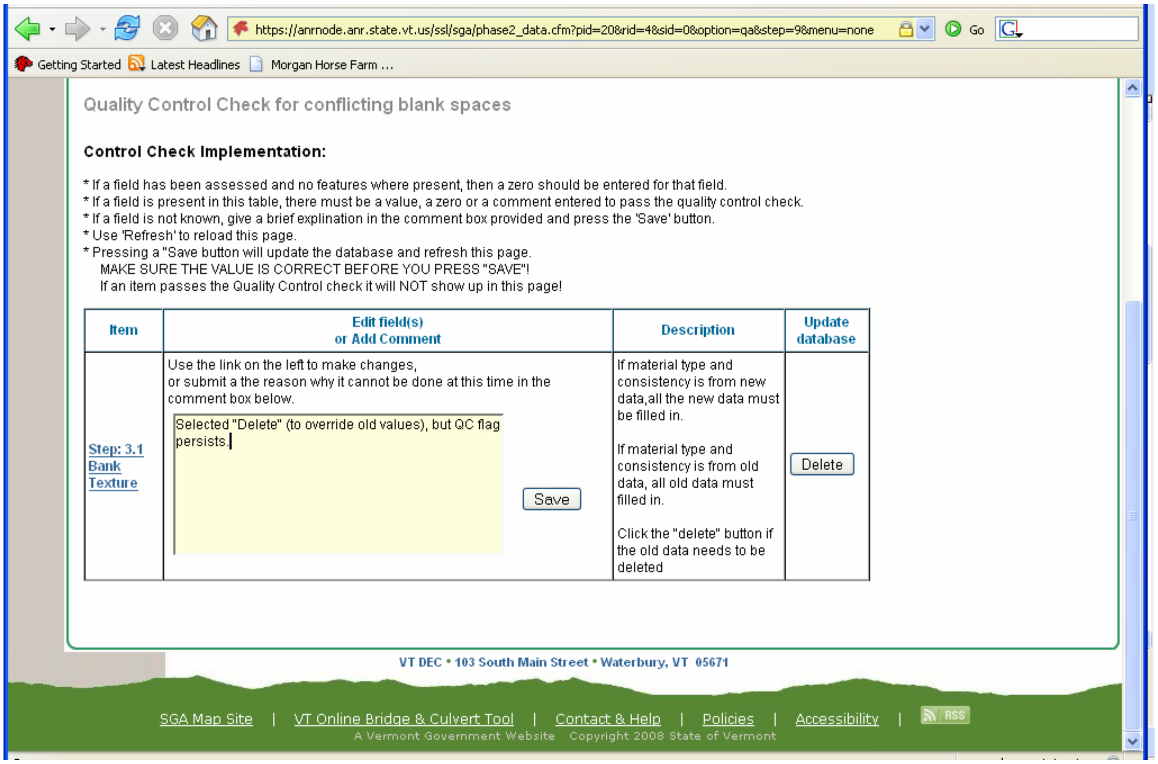
Unfortunately, the FIT indexing had already been done in March of 2007 (in the then current version of SGAT, v.4.53). The cost estimate / budget for updating these 2005 reaches was predicated on the assumption that I would be simply uploading the existing FIT files and finalizing the manual DMS updates. At this point, these 2005 reaches are now at an equal status (with respect to FIT/SGAT) to the 2006 reaches (which were also indexed using SGAT v.4.53 in the Winter of 2007).

Te spreadsheets are also the older version and not in the most updated version. These were released in Spring of 2007.
I only became aware of this newer spreadsheet in April of 2008, after I had already uploaded the Castleton cross sections for review. Cross sections for the 2006 reaches are also in this older version of the spreadsheet.

T02.04
Can bank texture be filled it? I believe it was silty? CEM blank, should this be none?
Blank CEM was an oversight; I have added the CEM (F-stage) to the DMS.

Bank texture data shows up in the DMS in the data entry mode under the fields labeled "old data". I have transferred it to the new database fields so that it is populated to the Phase 2 segment summary report. I thought that I had done so before, and am wondering if many of these reaches may have ended up with blank cells under bank texture (Step 3.1), due to the way in which the QC check X.1 was resolved (see below). I had chosen to delete the old bank texture data – and perhaps this caused the new bank data to be deleted?

I've just repeated this process and the new bank data appear to be present in the DMS now.



T2.05
Can bank texture be filled it? Typo in seg location
Yes, see comment re: bank texture under T2.04.
Fixed the typo under Segment Location.

T2.06
Can bank texture be filled it?
Yes, see comment re: bank texture under T2.04.

T02.09-S1.01 B
The cross section has a valley width of 400' and the DMS indicates 200'. Was the cross section not in a representative location for the valley width?
I inadvertently missed entering the updated valley width of 400' under Step 1.5 in the DMS; the DMS has been corrected.

T2.09-S1.02 B
I would have scored Planform a little higher. I reserve Poor for the worst case scenarios and with a Fair, Poor, Good, etc I would have put it in mid-Fair.
I can agree with a Fair rating for Planform. I have changed the DMS and relevant sections of the text. The revised, overall RGA condition score remains in the "Fair" quadrant.

T02.09-S1.04
The new cross section spreadsheet resolves this issue with needing to have different segments identified by the cross section than what is in the spreadsheet.

T02.09-S1.04 D
Looks like the right bank buffer width is minimal but this may be that the stream is in the wrong location n the vhd. Wow this reach sounds fairly hammered……
Yes, the VHD is significantly offset from the actual channel position. The reach maps in the Appendix to the Phase 2 report show the GPS'd location of the berm and erosion features (immediately surrounding the actual channel position) to be located in the middle of the strip of trees between crop fields. The channel also shows up pretty well on the 2003 NAIP images.

T02.10
Bank texture blank?
see comment re: bank texture under T2.04

T02.11
Bank texture blank?
see comment re: bank texture under T2.04

T02.11 B
Dredging noted as historic in notes, there has been active dredging in recent years including at and just downstream of the GB confluence. It's clear after reviewing these reaches for QA that this reach needs some attention. There is also now a head cut, a new avulsion and additional channel alerations that I am sure you have heard about. Just an FYI – not expecting you to add that data in after the fact.
The description field of the FIT point file notes that dredging in the area of the Gully Brook confluence is both historic and recent (2006). (Perhaps some dredging occurred in 2007 also). I have now updated the notes (Step 5) for reaches T2.12 and T2.11-B to identify this more recent dredging activity.

T02.12

Bank texture?
see comment re: bank texture under T2.04

What is the dam noted as a grade control?
The VTDEC Dam Inventory (Emergency_Other_DAMS) identifies a dam in the direct vicinity of the culvert crossing by the former ski area access road crossing. I have added a note to this effect to Step 5 Comments field of the DMS.

Is this reach more of a wetland or a stream? I always thought of it as a wetland but I have not walked it.
It is wetland-dominated.

APPENDIX D

Assignment of VTrans Structure Numbers to Bridges and Culverts

A total of 18 bridge, arch and culvert crossing structures were encountered during Phase 2 assessments in the Castleton River watershed in 2006. Structure spans, clearance and width measurements were conducted at each structure. A full Bridge & Culvert Assessment was completed at 11 of the structures, following Appendix G (April, 2005) of the VTANR geomorphic assessment protocols. Of the other 7 structures, one was a simple wooden footbridge, not associated with any transportation corridor; therefore a full assessment was not completed at this structure. Six of the other 7 structures were on major roads in the town of Fair Haven; B&C assessments had been completed at these structures in 2005 by the Rutland Regional Planning Commission. SMRC relied on the RRPC assessment results for these six structures.

A listing of all the crossing structures encountered is provided in Table D-1; field map numbers in this table correspond to sequential numbers assigned specific to this Phase 2 SGA project. A shape file provided on the Project CD references this field map number and provides the location of each crossing structure. Span information was entered into Step 4.8 (Constrictions) of the Phase 2 database of the VTANR web-based Data Management System (DMS) under the appropriate reach records. The Bridge and Culvert Assessment information has been entered into the structures database in the VTANR web-based DMS ("Castleton Town" project). A standard B&C Assessment report for each of the structure printed from the DMS is provided in Appendix E of this Phase 2 Stream Geomorphic Assessment Report.

Determine VTrans Structure Number

To enable data entry into the structures database of the DMS, a unique VTrans Structure Number must be entered for each bridge or culvert structure. Of the twelve structures assessed by SMRC, three already had a VTrans Structure Number assigned. For each of the remaining structures, a unique VTrans Structure Number was assigned during this project. The assignment of the VTrans Structure Number followed guidance provided in the Addendum to Appendix G of the VTANR geomorphic assessment protocols (April, 2005). Methods are summarized below.

Review Existing Resources

For each crossing structure, the following ArcView™ shape files were reviewed to determine whether or not a VTrans Structure Number had already been assigned.

> **VTrans Structure Number**
> TransStructures_TRANSTRUC
> VT Bridges and Culverts – transportation structures available from the Vermont Center for Geographic Information (www.vcgi.org). Post date: 9 November 2005
>
> Consisting of four separate tables:
>
> 1) BC_LocalInventoryTable,
> 2) BC_VTransInventoryTable_Primary,
> 3) BC_VTransInventoryTable_Secondary, and
> 4) BC_VTransInventoryTable_Other.

The three structures with existing VTrans Structure Numbers were contained in either the "LocalInventoryTable" or the "VTransInventoryTable_Primary".

Table D-1. Identification of crossing structures encountered during Phase 2 assessments with an indication of which structures were assessed by Appendix G of VTANR Protocols (*N/A = Not Available*).

Field Map #	**Reach**	Segment	Road	Route [a]	Town	Structure Type	Bridge-Length or Culvert-Diam.(ft)	Bridge & Culvert Assessment? [b]
16	T02.01	N/A	US Route 4	US-4	Fair Haven	Bridge	260	RRPC
17	T02.01	N/A	US Route 4	US-4	Fair Haven	Bridge	260	RRPC
12	T02.03	N/A	River Street	TH 8	Fair Haven	Bridge	50	RRPC
13	T02.03	N/A	Depot Street	TH 45	Fair Haven	Bridge	64	RRPC
14	T02.03	N/A	Main Street	TH 1	Fair Haven	Bridge	52	RRPC
15	T02.03	N/A	Adams Street	TH 50	Fair Haven	Bridge	52	RRPC
10	T02.08-s1.01	A	Route 4A (Main St)	TH 1	Castleton	Bridge	11	SMRC, RRPC
11	T02.08-s1.01	A	railroad	N/A	Castleton	Culvert	6	SMRC, RRPC
18	T02.08-s1.01	C	foot path	N/A	Castleton	Footbridge	30	No
9	T02.08-s1.01	D	railroad	N/A	Castleton	Culvert	4	SMRC
8	T02.08-s1.01	E	South Street	TH 4	Castleton	Arch	11.5	SMRC, RRPC
7	T02.08-s1.02	N/A	driveway Hadeka	Class 8	Castleton	Culvert	7.4	SMRC
6	T02.08-s1.04	B	Pond Hill Road	TH 44	Castleton	Culvert	5.9	SMRC
5	T02.08-s1.05	B	Pond Hill Road	TH 44	Castleton	Culvert	5.7	SMRC
4	T02.11-s1.02	A	Woodbury Rd	Class 8	Castleton	Bridge	37	SMRC
3	T02.11-s1.04	A	logging road	N/A	Poultney	Bridge	31	SMRC
2	T02.11-s1.04	C	Birdseye Rd	TH 29	Poultney	Bridge	12	SMRC
1	T02.11-s1.04	D	gravel road	N/A	Ira	Bridge	7	SMRC

Notes:

a US = United States Highway; TH = Town Highway; Class 8 = road (AOT Class 8) is present in *TransRoad_RDS* coverage, but no route number provided; N/A = Not Available - road/path is not present in TransRoad_RDS coverage.

b RRPC = Rutland Regional Planning Commission completed B&C assessment in 2005.
SMRC = South Mountain Research & Consulting completed B&C assessment in 2006.
SMRC, RRPC = South Mountain Research & Consulting updated 2005 RRPC B&C assessment in 2006.

Stream Geomorphic Assessment

VT DEC

Bridge Summary Report

General Information

Structure ID	200020003E11072	**Local Structure ID**	---
VTrans ID	700007023611013		
Assessment Date	05/17/2005	**Observers**	E. Swift, S. Schild
Town	Fair Haven		
Location	US route 4 east bound		
Latitude	43.59	**Longitude**	-73.28
Road Name	EAST BOUND US HWY	**Road Type**	Paved
Stream Name	Castleton River		
Channel width	48 ft. (Measured)	**High flow stage**	No

Bridge/Arch Information

Material	Prestressed Concrete	**Number of bridge piers/arches**	2
Bridge Width	50 ft.	**Skewed to roadway?**	No
Bridge Clearance	40 ft.		
Bridge/Arch Span	260 ft.		

Geomorphic Information

Floodplain filled by roadway approaches	Partially
Structure is located at significant break in valley slope	No
Obstructions at the opening of the structure	---
Steep riffle present immediately upstream of structure	No
If channel avulses, stream will	Unsure
Estimated distance avulsion would follow road	--- ft.
Angle of stream flow approaching structure	Sharp bend
Pool present immediately downstream of structure	No
Downstream bank heights are substantially higher than upstream bank heights	No
Stepped footers	No

More Geomorphic Information

	Upstream	Downstream	In Structure
Dominant Bed Material	Sand	Cobble	Sand
Bedrock Present	No	No	No
Type of Sediment Deposits	---	---	---
Elevation of sediment deposits greater than 1/2 bankfull	No	No	No
Bank Erosion	High	High	
Hard Bank Armoring	Intact	None	
Stream bed scour causing undermining around or under structure	---	---	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)	---	---	

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Herbaceous/Grass	Shrub/Sapling	
Dominant Vegetation Type - Right	Herbaceous/Grass	Shrub/Sapling	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

Vegetation Band - Left	Yes	No
Vegetation Band - Right	Yes	No

Assignment of VTrans Structure Number to remaining structures

As per the Addendum to Appendix G of the VTANR protocols pertaining to Bridge & Culvert Assessments, the assignment of a VTrans Structure Number is based upon the structure size, type, and location. Refer to the Addendum for more details. Table D-2 provides a summary of the component elements of the VTrans Structure Number assigned to each structure.

VTrans Structure Number = <STRUCTYPE><ROUTE#><NUM><CTCODE><SYSFLAG>

<STRUCTYPE>

Under this project, the span measured at each structure was used to determine the <STRUCTYPE> value. For culverts, the span equates to the "culvert width" parameter noted on the B&C assessment form. The span value was used to categorize whether the structure was a Long, Short, or Ultra Short structure, as defined in the table below. The span, together with the identification of the structure as either a Town, State or Private structure, defined the value (code) assigned under <STRUCTYPE>.

Code	Structure Type	Description
10	Town Long	>= 20 feet
20	State Long	>= 20 feet
30	State Short	< 20 feet >= 6 feet
40	Town Short	< 20 feet >= 6 feet
50	State Ultra Short	< 6 feet
60	Town Ultra Short	< 6 feet
70	Other	e.g., private bridges, culverts

<ROUTE#>

The route number of the road crossing the bridge or culvert structure was determined from a review of the attribute data for VTrans road center line shape file (*TransRoad_RDS* obtained from www.vcgi.org on 3 June 2006; post date 24 October 2005). A majority of the structures encountered in this project were private crossings on farm roads, driveways, railroads, or recreational paths, and no corresponding state or town route number was available. A value of "0000" was entered as the <ROUTE#> element for these structures.

<NUM>

Typically, the number assigned under this category is an approximate 911 address for the structure, determined from review of the E911 sites data overlain on the VTrans road network. However, since a majority of the structures for which VTrans structure numbers needed to be assigned were private crossings on farm roads, driveways, or recreational paths, and no corresponding road network coverage was available, a 911-type address could not be readily developed. Therefore, the value substituted for the <NUM> component, was the Field Map # prefixed by the appropriate number of zeros to bring the total number of digits to four.

<CTCODE>

From a review of the attribute data for VTrans road center line shape file (TransRoad_RDS), the VTrans County/Town code for the watershed towns are as follows:

Castleton	1015	Poultney	1085
Ira	1045		

<SYSFLAG>

The system flag denotes whether the structure is a town system structure (1), a state system structure (2), or a private system structure (3). For this project, it was assumed that a state system structure is one located on a state highway, and a town system structure is one located on a town highway (as depicted on the town highway maps for watershed towns. A private system structure was assumed to be one located on a private driveway, private road, path or railroad.

APPENDIX E

Bridge & Culvert Assessment Reports

Stream Geomorphic Assessment VT DEC

Bridge Summary Report

General Information

Structure ID	200020003W11072	**Local Structure ID**	---
VTrans ID	700007022511013		
Assessment Date	05/17/2005	**Observers**	Ethan Swift, Steve Schild
Town	Fair Haven		
Location	US Route 4 westbound lane		
Latitude	43.59	**Longitude**	-73.29
Road Name	WEST BOUND US HWY	**Road Type**	Paved
Stream Name	Castleton River		
Channel width	48 ft. (Measured)	**High flow stage**	No

Bridge/Arch Information

Material	Prestressed Concrete	**Number of bridge piers/arches**	2
Bridge Width	50 ft.	**Skewed to roadway?**	No
Bridge Clearance	40 ft.		
Bridge/Arch Span	260 ft.		

Geomorphic Information

Floodplain filled by roadway approaches	Partially
Structure is located at significant break in valley slope	No
Obstructions at the opening of the structure	---
Steep riffle present immediately upstream of structure	No
If channel avulses, stream will	Unsure
Estimated distance avulsion would follow road	--- ft.
Angle of stream flow approaching structure	Sharp bend
Pool present immediately downstream of structure	No
Downstream bank heights are substantially higher than upstream bank heights	No
Stepped footers	No

More Geomorphic Information

	Upstream	Downstream	In Structure
Dominant Bed Material	Sand	Cobble	Sand
Bedrock Present	No	No	No
Type of Sediment Deposits	---	---	---
Elevation of sediment deposits greater than 1/2 bankfull	No	No	No
Bank Erosion	High	High	
Hard Bank Armoring	Intact	None	
Stream bed scour causing undermining around or under structure	---	---	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)	---	---	

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Herbaceous/Grass	Shrub/Sapling	
Dominant Vegetation Type - Right	Herbaceous/Grass	Shrub/Sapling	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

Vegetation Band - Left	Yes	No
Vegetation Band - Right	Yes	No

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	---	---	---

Other Information

Spatial location data collected with GPS?	No	**Photos taken?**	Yes
Comments	mass failure site upstream		

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	---	---	---

Other Information

Spatial location data collected with GPS?	No	**Photos taken?**	Yes
Comments	---		

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Stream Geomorphic Assessment VT DEC

Bridge Summary Report

General Information

Structure ID	101107000411071	**Local Structure ID**	---
VTrans ID	700007021711013		
Assessment Date	05/17/2005	**Observers**	E. Swift, S. Schild
Town	Fair Haven		
Location	shirt factory dam		
Latitude	43.59	**Longitude**	-73.27
Road Name	ADAMS ST	**Road Type**	Paved
Stream Name	Castleton River		
Channel width	32 ft. (Measured)	**High flow stage**	No

Bridge/Arch Information

Material	Masonary (arches) & Slabs	**Number of bridge piers/arches**	0
Bridge Width	12 ft.	**Skewed to roadway?**	No
Bridge Clearance	25 ft.		
Bridge/Arch Span	52 ft.		

Geomorphic Information

Floodplain filled by roadway approaches	Entirely
Structure is located at significant break in valley slope	Yes
Obstructions at the opening of the structure	---
Steep riffle present immediately upstream of structure	Yes
If channel avulses, stream will	Unsure
Estimated distance avulsion would follow road	--- ft.
Angle of stream flow approaching structure	Mild bend
Pool present immediately downstream of structure	Yes
Downstream bank heights are substantially higher than upstream bank heights	Yes
Stepped footers	Yes

More Geomorphic Information

	Upstream	Downstream	In Structure
Dominant Bed Material	Bedrock	Bedrock	Bedrock
Bedrock Present	Yes	Yes	Yes
Type of Sediment Deposits	---	---	---
Elevation of sediment deposits greater than 1/2 bankfull	No	No	No
Bank Erosion	Low	High	
Hard Bank Armoring	Intact	Failing	
Stream bed scour causing undermining around or under structure	---	---	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)	---	---	

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Shrub/Sapling	Road Embankment	
Dominant Vegetation Type - Right	Shrub/Sapling	Road Embankment	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

	Upstream	Downstream
Vegetation Band - Left	No	No
Vegetation Band - Right	No	Yes

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	---	---	---

Other Information

Spatial location data collected with GPS?	No	**Photos taken?**	Yes
Comments	---		

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Stream Geomorphic Assessment VT DEC

Bridge Summary Report

General Information

Structure ID	20014200011072	**Local Structure ID**	---
VTrans ID			
Assessment Date	05/17/2005	**Observers**	E. Swift, S. Schild
Town	Fair Haven		
Location	structural slate dam		
Latitude	---	**Longitude**	---
Road Name	S MAIN ST	**Road Type**	Paved
Stream Name	Castleton River		
Channel width	25 ft. (Measured)	**High flow stage**	No

Bridge/Arch Information

Material	Concrete	**Number of bridge piers/arches**	0
Bridge Width	27 ft.	**Skewed to roadway?**	No
Bridge Clearance	15 ft.		
Bridge/Arch Span	52 ft.		

Geomorphic Information

Floodplain filled by roadway approaches	Entirely
Structure is located at significant break in valley slope	Yes
Obstructions at the opening of the structure	---
Steep riffle present immediately upstream of structure	Yes
If channel avulses, stream will	Cross road
Estimated distance avulsion would follow road	--- ft.
Angle of stream flow approaching structure	Channelized Straight
Pool present immediately downstream of structure	Yes
Downstream bank heights are substantially higher than upstream bank heights	No
Stepped footers	No

More Geomorphic Information

	Upstream	Downstream	In Structure
Dominant Bed Material	Cobble	Boulder	Boulder
Bedrock Present	Yes	Yes	Yes
Type of Sediment Deposits	---	---	---
Elevation of sediment deposits greater than 1/2 bankfull	No	No	No
Bank Erosion	None	Low	
Hard Bank Armoring	None	Intact	
Stream bed scour causing undermining around or under structure	---	---	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)	---	---	

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Road Embankment	Road Embankment	
Dominant Vegetation Type - Right	Road Embankment	Road Embankment	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

	Upstream	Downstream	In Structure
Vegetation Band - Left	No	No	
Vegetation Band - Right	No	No	

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	---	---	---

Other Information

Spatial location data collected with GPS?	No	**Photos taken?**	Yes
Comments	---		

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Bridge Summary Report

General Information

Structure ID	101107000211071	**Local Structure ID**	---
VTrans ID	700007021611013		
Assessment Date	05/17/2005	**Observers**	E. Swift, S. Schild
Town	Fair Haven		
Location	water street bridge		
Latitude	43.59	**Longitude**	-73.26
Road Name	WATER STREET	**Road Type**	Paved
Stream Name	Castleton River		
Channel width	32 ft. (Measured)	**High flow stage**	No

Bridge/Arch Information

Material	Concrete	**Number of bridge piers/arches**	0
Bridge Width	20 ft.	**Skewed to roadway?**	No
Bridge Clearance	18 ft.		
Bridge/Arch Span	64 ft.		

Geomorphic Information

Floodplain filled by roadway approaches	Entirely
Structure is located at significant break in valley slope	Yes
Obstructions at the opening of the structure	---
Steep riffle present immediately upstream of structure	No
If channel avulses, stream will	Cross road
Estimated distance avulsion would follow road	--- ft.
Angle of stream flow approaching structure	Sharp bend
Pool present immediately downstream of structure	Yes
Downstream bank heights are substantially higher than upstream bank heights	Yes
Stepped footers	No

More Geomorphic Information

	Upstream	Downstream	In Structure
Dominant Bed Material	Boulder	Boulder	Boulder
Bedrock Present	No	Yes	No
Type of Sediment Deposits	---	---	---
Elevation of sediment deposits greater than 1/2 bankfull	No	No	No
Bank Erosion	None	Low	
Hard Bank Armoring	Intact	Failing	
Stream bed scour causing undermining around or under structure	---	---	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)	---	---	

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Road Embankment	Road Embankment	
Dominant Vegetation Type - Right	Road Embankment	Shrub/Sapling	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

	Upstream	Downstream
Vegetation Band - Left	No	No
Vegetation Band - Right	No	No

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	---	---	---

Other Information

Spatial location data collected with GPS?	No	**Photos taken?**	Yes
Comments	---		

Stream Geomorphic Assessment

VT DEC

Bridge Summary Report

General Information

Structure ID	101107000111071	**Local Structure ID**	---
VTrans ID	700007021511013		
Assessment Date	05/17/2005	**Observers**	E. Swift, S. Schild
Town	Fair Haven		
Location	---		
Latitude	43.59	**Longitude**	-73.26
Road Name	RIVER ST	**Road Type**	Paved
Stream Name	Castleton River		
Channel width	38 ft. (Measured)	**High flow stage**	No

Bridge/Arch Information

Material	Prestressed Concrete	**Number of bridge piers/arches**	0
Bridge Width	30 ft.	**Skewed to roadway?**	No
Bridge Clearance	8 ft.		
Bridge/Arch Span	50 ft.		

Geomorphic Information

Floodplain filled by roadway approaches	Entirely
Structure is located at significant break in valley slope	Yes
Obstructions at the opening of the structure	---
Steep riffle present immediately upstream of structure	No
If channel avulses, stream will	Cross road
Estimated distance avulsion would follow road	--- ft.
Angle of stream flow approaching structure	Sharp bend
Pool present immediately downstream of structure	Yes
Downstream bank heights are substantially higher than upstream bank heights	Yes
Stepped footers	No

More Geomorphic Information

	Upstream	Downstream	In Structure
Dominant Bed Material	Cobble	Boulder	Cobble
Bedrock Present	No	No	No
Type of Sediment Deposits	---	---	---
Elevation of sediment deposits greater than 1/2 bankfull	No	No	No
Bank Erosion	Low	Low	
Hard Bank Armoring	Failing	Failing	
Stream bed scour causing undermining around or under structure	---	---	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)	---	---	

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Road Embankment	Shrub/Sapling	
Dominant Vegetation Type - Right	Herbaceous/Grass	Herbaceous/Grass	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

Vegetation Band - Left	No	No	
Vegetation Band - Right	No	No	

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	---	---	---

Other Information

Spatial location data collected with GPS?	No	**Photos taken?**	Yes
Comments	---		

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Stream Geomorphic Assessment

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Culvert Summary Report

General Information

Structure ID	700000001110153	**Local Structure ID**	---
VTrans ID			
Assessment Date	07/31/2006	**Observers**	KU/SMRC, HS/PMWP
Town	Castleton		
Location	railroad crossing near junction of Cemetery Drive and Savage Rd.		
Latitude	---	**Longitude**	---
Road Name	railroad	**Road Type**	Railroad
Stream Name	Pond Hill Brook		
Channel width	20 ft. (Curve)	**High flow stage**	No

Culvert Information

Material	Steel Corrugated	**Number of culverts**	1
Culvert Length	42 ft.	**Skewed to roadway?**	No
Culvert Height	4 ft. (0.3 ft.)	**Culvert Overflow Pipe**	No
Culvert Width	6 ft. (0.5 ft.)		

Geomorphic Information

Floodplain filled by roadway approaches	Entirely
Structure is located at significant break in valley slope	Yes
Obstructions at the opening of the structure	---
Culvert slope as compared with channel slope is significantly	Lower
Steep riffle present immediately upstream of structure	No
If channel avulses, stream will	Unsure
Estimated distance avulsion would follow road	--- ft.
Angle of stream flow approaching structure	Channelized Straight
Culvert outlet invert	Cascade
Outlet drop (invert to water surface)	0.4 ft.
Water depth in culvert (at outlet)	0.3 ft.
Pool present immediately downstream of structure	No
Downstream bank heights are substantially higher than upstream bank heights	No

More Geomorphic Information

	Upstream	Downstream	In Structure
Dominant Bed Material	Cobble	Boulder	Unknown
Bedrock Present	No	No	
Material Present throughout			No
Type of Sediment Deposits	---	---	---
Elevation of sediment deposits greater than 1/2 bankfull	No	No	No
Bank Erosion	None	None	
Hard Bank Armoring	Intact	Intact	
Stream bed scour causing undermining around or under structure	---	---	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)	---	---	

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Herbaceous/Grass	Road Embankment	
Dominant Vegetation Type - Right	Road Embankment	Road Embankment	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

Vegetation Band - Left	No	No
Vegetation Band - Right	No	No

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	---	---	---

Other Information

Spatial location data collected with GPS?	No	**Photos taken?**	Yes
Comments	Appears to be same structure RRPC labelled VTrans structure # 00051103001711031		

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Stream Geomorphic Assessment VT DEC

Culvert Summary Report

General Information

Structure ID	700000000910153	**Local Structure ID**	---
VTrans ID			
Assessment Date	07/31/2006	**Observers**	KU/SMRC, HS/PMWP
Town	Castleton		
Location	Crossing of former RR (now greenway) 1120 ft SW of South St. crossing		
Latitude	43.60	**Longitude**	-73.18
Road Name	greenway (railroad)	**Road Type**	Trail
Stream Name	Pond Hill Brook		
Channel width	20 ft. (Curve)	**High flow stage**	No

Culvert Information

Material	Concrete	**Number of culverts**	2
Culvert Length	38 ft.	**Skewed to roadway?**	No
Culvert Height	5 ft. (0.4 ft.)	**Culvert Overflow Pipe**	No
Culvert Width	4 ft. (0.3 ft.)		

Geomorphic Information

Floodplain filled by roadway approaches	Entirely
Structure is located at significant break in valley slope	No
Obstructions at the opening of the structure	---
Culvert slope as compared with channel slope is significantly	Same
Steep riffle present immediately upstream of structure	No
If channel avulses, stream will	Unsure
Estimated distance avulsion would follow road	--- ft.
Angle of stream flow approaching structure	Sharp Bend
Culvert outlet invert	At Grade
Outlet drop (invert to water surface)	0.0 ft.
Water depth in culvert (at outlet)	1.5 ft.
Pool present immediately downstream of structure	Yes
Downstream bank heights are substantially higher than upstream bank heights	No

More Geomorphic Information

	Upstream	Downstream	In Structure
Dominant Bed Material	Gravel	Sand	Unknown
Bedrock Present	No	No	
Material Present throughout			No
Type of Sediment Deposits	---	---	---
Elevation of sediment deposits greater than 1/2 bankfull	No	No	No
Bank Erosion	Low	Low	
Hard Bank Armoring	Intact	Intact	
Stream bed scour causing undermining around or under structure	---	---	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)	---	---	

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Shrub/Sapling	Road Embankment	
Dominant Vegetation Type - Right	Shrub/Sapling	Deciduous Forest	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

Vegetation Band - Left	Yes	No
Vegetation Band - Right	Yes	No

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	---	---	---

Other Information

Spatial location data collected with GPS?	Yes	**Photos taken?**	Yes
Comments	Trail is 'greenway' on old railroad bed for Delaware and Hudson RR. Site of double culvert crossing, but southern culvert is blocked at inlet and not conveying flow. Culvert is partially filled by fine sediment.		

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Table D-2. Derivation of VTrans Structure Numbers

Field Map #	Reach	Segment	Road	Route [a]	Town	Structure Type	Bridge-Length or Culvert-Diam.(ft)	Bridge & Culvert Assessment? [b]	Existing VTrans Structure Number [c]	STRUCTYPE	ROUTE#	NUM	CTCODE	SYSFLAG	Assigned VTrans Number
										Derivation of Vtrans Structure Number as per Addendum to Appendix G.					
16	T02.01	N/A	US Route 4	US-4	Fair Haven	Bridge	260	RRPC	200020003E11072						
17	T02.01	N/A	US Route 4	US-4	Fair Haven	Bridge	260	RRPC	200020003W11072						
12	T02.03	N/A	River Street	TH 8	Fair Haven	Bridge	50	RRPC	101107000111071						
13	T02.03	N/A	Depot Street	TH 45	Fair Haven	Bridge	64	RRPC	101107000211071						
14	T02.03	N/A	Main Street	TH 1	Fair Haven	Bridge	52	RRPC	200142000111072						
15	T02.03	N/A	Adams Street	TH 50	Fair Haven	Bridge	52	RRPC	101107000411071						
10	T02.08-s1.01	A	Route 4A (Main St)	TH 1	Castleton	Bridge	11	SMRC, RRPC	300142000511031						
11	T02.08-s1.01	A	railroad	N/A	Castleton	Culvert	6	SMRC, RRPC		70	0000	0011	1015	3	700000001110153
18	T02.08-s1.01	C	foot path	N/A	Castleton	Footbridge	30	No		70	0000	0018	1015	3	700000001810153
9	T02.08-s1.01	D	railroad	N/A	Castleton	Culvert	4	SMRC		70	0000	0009	1015	3	700000000910153
8	T02.08-s1.01	E	South Street	TH 4	Castleton	Arch	11.5	SMRC, RRPC	401103002911031						
7	T02.08-s1.02	N/A	driveway Hadeka	Class 8	Castleton	Culvert	7.4	SMRC		70	0000	0007	1015	3	700000000710153
6	T02.08-s1.04	B	Pond Hill Road	TH 44	Castleton	Culvert	5.9	SMRC	*See Note d*	60	0044	0006	1015	1	600044000610151
5	T02.08-s1.05	B	Pond Hill Road	TH 44	Castleton	Culvert	5.7	SMRC	*See Note e*	60	0044	0005	1015	1	600044000510151
4	T02.11-s1.02	A	Woodbury Rd	Class 8	Castleton	Bridge	37	SMRC		70	0000	0004	1015	3	700000000410153
3	T02.11-s1.04	A	logging road	N/A	Poultney	Bridge	31	SMRC		70	0000	0003	1085	3	700000000310853
2	T02.11-s1.04	C	Birdseye Rd	TH 29	Poultney	Bridge	12	SMRC	401117003611171						
1	T02.11-s1.04	D	gravel road	N/A	Ira	Bridge	7	SMRC		70	0000	0001	1045	3	700000000110453

Notes:

a US = United States Highway; TH = Town Highway; Class 8 = road (AOT Class 8) is present in *TransRoad_RDS* coverage, but no route number provided; N/A = Not Available - road/path is not present in TransRoad_RDS coverage.

b RRPC = Rutland Regional Planning Commission completed B&C assessment in 2005.
SMRC = South Mountain Research & Consulting completed B&C assessment in 2006.
SMRC, RRPC = South Mountain Research & Consulting updated 2005 RRPC B&C assessment in 2006.

c Source of Vtrans Structure Number is "*TransStructures_TRANSTRUC*" shape file obtained from VCGI (www.vcgi.org), post date: 9 Nov 2005.

d This structure may possibly be the culvert assessed in 2005 by RRPC and labelled as Vtrans Struct No. 00441103001311031; unable to confirm with available location information in the RRPC record.

e This structure may possibly be the culvert assessed in 2005 by RRPC and labelled as Vtrans Struct No. 00051103001711031; unable to confirm with available location information in the RRPC record.

Stream Geomorphic Assessment

VT DEC

Culvert Summary Report

General Information

Structure ID	700000000710153	**Local Structure ID**	---
VTrans ID			
Assessment Date	07/26/2006	**Observers**	KU/SMRC, HS/PMWP
Town	Castleton		
Location	100 ft SW of jct with Staso Rd		
Latitude	---	**Longitude**	---
Road Name	driveway	**Road Type**	Gravel
Stream Name	Pond Hill Brook		
Channel width	17 ft. (Curve)	**High flow stage**	No

Culvert Information

Material	Steel Corrugated	**Number of culverts**	1
Culvert Length	25 ft.	**Skewed to roadway?**	No
Culvert Height	6 ft. (0.5 ft.)	**Culvert Overflow Pipe**	No
Culvert Width	7 ft. (0.6 ft.)		

Geomorphic Information

Floodplain filled by roadway approaches	Entirely
Structure is located at significant break in valley slope	Yes
Obstructions at the opening of the structure	---
Culvert slope as compared with channel slope is significantly	Lower
Steep riffle present immediately upstream of structure	Yes
If channel avulses, stream will	Cross Road
Estimated distance avulsion would follow road	--- ft.
Angle of stream flow approaching structure	Channelized Straight
Culvert outlet invert	Cascade
Outlet drop (invert to water surface)	0.3 ft.
Water depth in culvert (at outlet)	0.3 ft.
Pool present immediately downstream of structure	Yes
Downstream bank heights are substantially higher than upstream bank heights	No

More Geomorphic Information

	Upstream	Downstream	In Structure
Dominant Bed Material	Boulder	Cobble	None
Bedrock Present	No	No	
Material Present throughout			No
Type of Sediment Deposits	---	---	---
Elevation of sediment deposits greater than 1/2 bankfull	No	No	No
Bank Erosion	None	None	
Hard Bank Armoring	Intact	Intact	
Stream bed scour causing undermining around or under structure	---	---	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)	---	---	

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Road Embankment	Shrub/Sapling	
Dominant Vegetation Type - Right	Shrub/Sapling	Shrub/Sapling	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

Vegetation Band - Left	No	No
Vegetation Band - Right	No	No

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	---	---	---

Other Information

Spatial location data collected with GPS?	No	**Photos taken?**	Yes
Comments	Driveway for Hadeka Stone Corporation. Large scour pool at d/s end. Located approx 125 ft d/s of Waypoint 468 from Phase 2 project.		

Stream Geomorphic Assessment VT DEC

Culvert Summary Report

General Information

Structure ID	600044000610151	**Local Structure ID**	---
VTrans ID			
Assessment Date	07/25/2006	**Observers**	KU/SMRC, HS/PMWP
Town	Castleton		
Location	1775 feet SW of junction with Applesauce Hill Rd		
Latitude	43.59	**Longitude**	-73.16
Road Name	POND HILL RD	**Road Type**	Gravel
Stream Name	Pond Hill Brook		
Channel width	12 ft. (Curve)	**High flow stage**	No

Culvert Information

Material	Steel Corrugated	**Number of culverts**	1
Culvert Length	27 ft.	**Skewed to roadway?**	Yes
Culvert Height	5 ft. (0.4 ft.)	**Culvert Overflow Pipe**	No
Culvert Width	6 ft. (0.5 ft.)		

Geomorphic Information

Floodplain filled by roadway approaches	Partially
Structure is located at significant break in valley slope	Yes
Obstructions at the opening of the structure	---
Culvert slope as compared with channel slope is significantly	Lower
Steep riffle present immediately upstream of structure	Yes
If channel avulses, stream will	Cross Road
Estimated distance avulsion would follow road	--- ft.
Angle of stream flow approaching structure	Channelized Straight
Culvert outlet invert	Cascade
Outlet drop (invert to water surface)	0.3 ft.
Water depth in culvert (at outlet)	0.1 ft.
Pool present immediately downstream of structure	No
Downstream bank heights are substantially higher than upstream bank heights	No

More Geomorphic Information

	Upstream	Downstream	In Structure
Dominant Bed Material	Cobble	Cobble	Unknown
Bedrock Present	No	No	
Material Present throughout			No
Type of Sediment Deposits	---	---	---
Elevation of sediment deposits greater than 1/2 bankfull	No	No	No
Bank Erosion	None	None	
Hard Bank Armoring	Intact	Failing	
Stream bed scour causing undermining around or under structure	---	---	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)	---	---	

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Herbaceous/Grass	Herbaceous/Grass	
Dominant Vegetation Type - Right	Herbaceous/Grass	Herbaceous/Grass	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

Vegetation Band - Left	No	No
Vegetation Band - Right	No	No

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	---	---	---

Other Information

Spatial location data collected with GPS?	Yes	**Photos taken?**	Yes
Comments	This may be culvert assessed by RRPC and labelled with VTrans Structure # 000441103001311031		

Stream Geomorphic Assessment

VT DEC

Culvert Summary Report

General Information

Structure ID	600044000510151	**Local Structure ID**	---
VTrans ID			
Assessment Date	07/25/2006	**Observers**	KU/SMRC, HS/PMWP
Town	Castleton		
Location	90 ft north of Poultney/Castleton town line		
Latitude	43.59	**Longitude**	-73.16
Road Name	POND HILL RD	**Road Type**	Gravel
Stream Name	Pond Hill Brook		
Channel width	11 ft. (Curve)	**High flow stage**	No

Culvert Information

Material	Steel Corrugated	**Number of culverts**	1
Culvert Length	27 ft.	**Skewed to roadway?**	Yes
Culvert Height	4 ft. (0.3 ft.)	**Culvert Overflow Pipe**	No
Culvert Width	6 ft. (0.5 ft.)		

Geomorphic Information

Floodplain filled by roadway approaches	Entirely
Structure is located at significant break in valley slope	No
Obstructions at the opening of the structure	---
Culvert slope as compared with channel slope is significantly	Lower
Steep riffle present immediately upstream of structure	Yes
If channel avulses, stream will	Follow Road
Estimated distance avulsion would follow road	100 ft.
Angle of stream flow approaching structure	Mild Bend
Culvert outlet invert	Free Fall
Outlet drop (invert to water surface)	1.4 ft.
Water depth in culvert (at outlet)	0.2 ft.
Pool present immediately downstream of structure	Yes
Downstream bank heights are substantially higher than upstream bank heights	No

More Geomorphic Information

	Upstream	Downstream	In Structure
Dominant Bed Material	Cobble	Cobble	Unknown
Bedrock Present	No	No	
Material Present throughout			No
Type of Sediment Deposits	---	---	---
Elevation of sediment deposits greater than 1/2 bankfull	No	No	No
Bank Erosion	None	None	
Hard Bank Armoring	Intact	Intact	
Stream bed scour causing undermining around or under structure	---	---	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)	---	---	

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Deciduous Forest	Road Embankment	
Dominant Vegetation Type - Right	Road Embankment	Deciduous Forest	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

Vegetation Band - Left	Yes	No
Vegetation Band - Right	No	Yes

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	---	---	---

Other Information

Spatial location data collected with GPS?	Yes	**Photos taken?**	Yes
Comments	This may possibly be culvert assessed by RRPC and labelled with VTrans Structure # 00051103001711031		

Stream Geomorphic Assessment VT DEC

Bridge Summary Report

General Information

Structure ID	700000000410153	**Local Structure ID**	---
VTrans ID			
Assessment Date	08/08/2006	**Observers**	kU/SMRC, MS/PMWP, SH/VTDEC
Town	Castleton		
Location	Approximately 130 feet west of intersection with Birdseye Road.		
Latitude	43.61	**Longitude**	-73.13
Road Name	WOODBURY RD	**Road Type**	Gravel
Stream Name	Gully Brook/Castleton River		
Channel width	26 ft. (Curve)	**High flow stage**	No

Bridge/Arch Information

Material	Steel	**Number of bridge piers/arches**	0
Bridge Width	15 ft.	**Skewed to roadway?**	No
Bridge Clearance	9 ft.		
Bridge/Arch Span	37 ft.		

Geomorphic Information

Floodplain filled by roadway approaches	Entirely
Structure is located at significant break in valley slope	Yes
Obstructions at the opening of the structure	---
Steep riffle present immediately upstream of structure	Yes
If channel avulses, stream will	Cross Road
Estimated distance avulsion would follow road	--- ft.
Angle of stream flow approaching structure	Channelized Straight
Pool present immediately downstream of structure	No
Downstream bank heights are substantially higher than upstream bank heights	No
Stepped footers	No

More Geomorphic Information

	Upstream	Downstream	In Structure
Dominant Bed Material	Cobble	Gravel	Cobble
Bedrock Present	No	No	No
Type of Sediment Deposits	---	---	---
Elevation of sediment deposits greater than 1/2 bankfull	No	No	No
Bank Erosion	High	Low	
Hard Bank Armoring	Intact	Intact	
Stream bed scour causing undermining around or under structure	---	---	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)	---	---	

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Shrub/Sapling	Shrub/Sapling	
Dominant Vegetation Type - Right	Shrub/Sapling	Shrub/Sapling	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

	Upstream	Downstream
Vegetation Band - Left	No	No
Vegetation Band - Right	No	No

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	---	---	---

Other Information

Spatial location data collected with GPS?	Yes	**Photos taken?**	Yes
Comments	Steel I-beams, timber decking.		

Stream Geomorphic Assessment VT DEC

Bridge Summary Report

General Information

Structure ID	700000000310853	**Local Structure ID**	---
VTrans ID			
Assessment Date	08/04/2006	**Observers**	KU/SMRC, HS/PMWP
Town	Poultney		
Location	At crossing of jeep trail depicted on USGS topo leading SW from Birdseye Rd, approx 2.1 mile S of Rte 4A		
Latitude	---	**Longitude**	---
Road Name	Logging road	**Road Type**	Trail
Stream Name	Gully Brook/Castleton River		
Channel width	21 ft. (Curve)	**High flow stage**	No

Bridge/Arch Information

Material	Timber	**Number of bridge piers/arches**	0
Bridge Width	14 ft.	**Skewed to roadway?**	No
Bridge Clearance	5 ft.		
Bridge/Arch Span	31 ft.		

Geomorphic Information

Floodplain filled by roadway approaches	Not Significant
Structure is located at significant break in valley slope	No
Obstructions at the opening of the structure	---
Steep riffle present immediately upstream of structure	No
If channel avulses, stream will	Cross Road
Estimated distance avulsion would follow road	--- ft.
Angle of stream flow approaching structure	Naturally Straight
Pool present immediately downstream of structure	No
Downstream bank heights are substantially higher than upstream bank heights	No
Stepped footers	No

More Geomorphic Information

	Upstream	Downstream	In Structure
Dominant Bed Material	Bedrock	Bedrock	Bedrock
Bedrock Present	Yes	Yes	Yes
Type of Sediment Deposits	---	---	---
Elevation of sediment deposits greater than 1/2 bankfull	No	No	No
Bank Erosion	None	None	
Hard Bank Armoring	None	None	
Stream bed scour causing undermining around or under structure	---	---	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)	---	---	

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Deciduous Forest	Deciduous Forest	
Dominant Vegetation Type - Right	Deciduous Forest	Deciduous Forest	
Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?			
Vegetation Band - Left	Yes	Yes	
Vegetation Band - Right	Yes	Yes	

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	---	---	---

Other Information

Spatial location data collected with GPS?	No	**Photos taken?**	Yes
Comments	Crossing at approximate location of jeep trail crossing depicted on USGS topo map. Approx. 30 ft d/s of Waypoint 123 from Phase 2 project.		

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Vermont Department of Environmental Conservation

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Stream Geomorphic Assessment VT DEC

Bridge Summary Report

General Information

Structure ID	401117003611171	**Local Structure ID**	---
VTrans ID			
Assessment Date	08/03/2006	**Observers**	KU/SMRC, HS/PMWP
Town	Poultney		
Location	Birdseye Rd crossing at Poutlney/Ira town line approximately 3.2 miles S of route 4A intersection		
Latitude	43.57	**Longitude**	-73.12
Road Name	BIRDSEYE RD	**Road Type**	Gravel
Stream Name	Gully Brook		
Channel width	12 ft. (Curve)	**High flow stage**	No

Bridge/Arch Information

Material	Timber	**Number of bridge piers/arches**	0
Bridge Width	14 ft.	**Skewed to roadway?**	No
Bridge Clearance	5 ft.		
Bridge/Arch Span	12 ft.		

Geomorphic Information

Floodplain filled by roadway approaches	Entirely
Structure is located at significant break in valley slope	No
Obstructions at the opening of the structure	---
Steep riffle present immediately upstream of structure	Yes
If channel avulses, stream will	Cross Road
Estimated distance avulsion would follow road	--- ft.
Angle of stream flow approaching structure	Mild Bend
Pool present immediately downstream of structure	No
Downstream bank heights are substantially higher than upstream bank heights	No
Stepped footers	No

More Geomorphic Information

	Upstream	Downstream	In Structure
Dominant Bed Material	Gravel	Cobble	Gravel
Bedrock Present	No	No	No
Type of Sediment Deposits	---	---	---
Elevation of sediment deposits greater than 1/2 bankfull	No	No	No
Bank Erosion	None	None	
Hard Bank Armoring	Intact	Intact	
Stream bed scour causing undermining around or under structure	---	---	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)	---	---	

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Deciduous Forest	Deciduous Forest	
Dominant Vegetation Type - Right	Shrub/Sapling	Shrub/Sapling	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

	Upstream	Downstream	In Structure
Vegetation Band - Left	Yes	Yes	
Vegetation Band - Right	No	Yes	

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	---	---	---

Other Information

Spatial location data collected with GPS?	Yes	**Photos taken?**	Yes
Comments	Steep riffle u/s of BRD coincident with (impacted by) ford.		

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Stream Geomorphic Assessment VT DEC

Bridge Summary Report

General Information

Structure ID	700000000110453	**Local Structure ID**	---
VTrans ID			
Assessment Date	08/03/2006	**Observers**	KU/SMRC, HS/PMWP
Town	Ira		
Location	Approximately 290 ft u/s (SE) of Birdseye Rd. Crossing Approximately 3.2 miles S of Route 4A.		
Latitude	43.57	**Longitude**	-73.12
Road Name	logging private road	**Road Type**	Gravel
Stream Name	Gully Brook		
Channel width	12 ft. (Curve)	**High flow stage**	No

Bridge/Arch Information

Material	Steel	**Number of bridge piers/arches**	0
Bridge Width	11 ft.	**Skewed to roadway?**	No
Bridge Clearance	3 ft.		
Bridge/Arch Span	7 ft.		

Geomorphic Information

Floodplain filled by roadway approaches	Entirely
Structure is located at significant break in valley slope	No
Obstructions at the opening of the structure	---
Steep riffle present immediately upstream of structure	No
If channel avulses, stream will	Cross Road
Estimated distance avulsion would follow road	--- ft.
Angle of stream flow approaching structure	Mild Bend
Pool present immediately downstream of structure	No
Downstream bank heights are substantially higher than upstream bank heights	No
Stepped footers	No

More Geomorphic Information

	Upstream	Downstream	In Structure
Dominant Bed Material	Gravel	Gravel	Gravel
Bedrock Present	No	No	No
Type of Sediment Deposits	---	---	---
Elevation of sediment deposits greater than 1/2 bankfull	No	No	No
Bank Erosion	None	None	
Hard Bank Armoring	Intact	Intact	
Stream bed scour causing undermining around or under structure	---	---	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)	---	---	

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Deciduous Forest	Deciduous Forest	
Dominant Vegetation Type - Right	Deciduous Forest	Deciduous Forest	
Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?			
Vegetation Band - Left	Yes	Yes	
Vegetation Band - Right	Yes	No	

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	---	---	---

Other Information

Spatial location data collected with GPS?	Yes	**Photos taken?**	Yes
Comments	Steel I-beams; timber decking; log abutments.		

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APPENDIX F

Reach Segmentation

Reach	Segment	Feature	Point	Total Reach Length (ft)	Segment Lengths (ft)	Elevation (ft)	Segment Slopes	Reach Slope	Comparison to Phase 1 Slope: Elevation (ft)	Comparison to Phase 1 Slope: Reach Slope	Change in Ph 1 slope
Main Stem											
T02.01	--	d/s end reach	--			297			290		
	--	u/s end reach	--	3,626		299		0.1%	295	0.14%	
T02.02		d/s end reach				299			295		
	A	segment break	A/B		5,292	300	0.02%				
	B	u/s end reach		12,230	6,938	303	0.04%	0.03%	318	0.19%	
T02.03	--	d/s end reach	--			303			318		
	--	u/s end reach	--	1,996		350		2.4%	355	1.85%	c to b
T02.04	--	d/s end reach	--			350			355		
	--	u/s end reach	--	3,389		353		0.1%	356	0.03%	
T02.05	--	d/s end reach	--			353			356		
	--	u/s end reach	--	7,849		357		0.1%	358	0.03%	
T02.06	--	d/s end reach	--			357			358		
	--	u/s end reach	--	5,302		362		0.1%	370	0.23%	
T02.07	--	d/s end reach	--			362			370		
	--	u/s end reach	--	9,350		380		0.2%	391	0.22%	
T02.08	--	d/s end reach	--			380			391		
	--	u/s end reach	--	9,625		399		0.2%	420	0.30%	
T02.09	--	d/s end reach	--			399			420		
	A	segment break	A/B		3,190	407	0.3%				
	B	u/s end reach	--	5,234	2,045	420	0.6%	0.4%	421	0.02%	
T02.10	--	d/s end reach	--			420			421		
	--	u/s end reach	--	2,626		428		0.3%	433	0.46%	
T02.11		d/s end reach				428			433		
	A	segment break	A/B		5,145	441	0.3%				
	B	u/s end reach		11,021	5,876	461	0.3%	0.3%	473	0.36%	
T02.12	--	d/s end reach	--			461			473		
	--	u/s end reach	--	12,493		476		0.1%	478	0.04%	

Reach	Segment	Feature	Point	Total Reach Length (ft)	Segment Lengths (ft)	Elevation (ft)	Segment Slopes	Reach Slope	Comparison to Phase 1 Slope: Elevation (ft)	Comparison to Phase 1 Slope: Reach Slope	Change in Ph 1 slope
Gully Brook Tributary											
T02.11-s1.01	--	d/s end reach	--			461			471		
	--	u/s end reach	--	1,346		480		1.4%	480	0.67%	
T02.11-s1.02		d/s end reach				480			480		
	A	segment break	A/B		529	488	1.5%				
	B	u/s end reach		4,275	3,746	606	3.2%	2.9%	610	3.04%	
T02.11-s1.03	--	d/s end reach	--			606			610		
	--	u/s end reach	--	6,201		850		3.9%	950	5.48%	a to b
T02.11-s1.04		d/s end reach				850			950		
	A	segment break	A/B		5,395	1100	4.6%				
	B	segment break	B/C		1,442	1155	3.8%				
	C	segment break	C/D		1,297	1200	3.5%				
	D	u/s end reach		9,130	995	1255	5.5%	4.4%	1265	3.45%	b to a
North Bretton Brook Tributary											
T02.09-s1.01		d/s end reach				420			422		
	A	segment break	A/B		2,745	440	0.7%				
	B	u/s end reach		4,507	1,762	460	1.1%	0.9%	455	0.73%	
T02.09-s1.02	--	d/s end reach	--			460			455		
	A	segment break	A/B		434	462	0.5%				
	B	u/s end reach		3,964	3,530	481	0.5%	0.5%	495	1.01%	
T02.09-s1.03	--	d/s end reach	--			481			495		
	--	u/s end reach	--	7,467		580		1.3%	590	1.27%	
T02.09-s1.04		d/s end reach				580			590		
	A	segment break	A/B		827	590	1.2%				
	B	segment break	B/C		342	600	2.9%				
	C	segment break	C/D		2,960	625	0.8%				
	D	segment break	D/E		1,566	635	0.6%				
	E	u/s end reach		6,709	1,014	645	1.0%	1.0%	650	0.89%	
T02.09-s1.05	--	d/s end reach	--			645			650		
	--	u/s end reach	--	3,458		675		0.9%	675	0.72%	

									Comparison to Phase 1 Slope		
Reach	Segment	Feature	Point	Total Reach Length (ft)	Segment Lengths (ft)	Elevation (ft)	Segment Slopes	Reach Slope	Elevation (ft)	Reach Slope	Change in Ph 1 slope
Pond Hill Brook Tributary											
T02.08-s1.01		d/s end reach				399			415		
	A	segment break	A/B		513	410	2.1%				
	B	segment break	B/C		927	420	1.1%				
	C	segment break	C/D		677	445	3.7%				
	D	segment break	D/E		1,622	465	1.2%				
	E	u/s end reach		5,451	1,711	490	1.5%	1.7%	490	1.38%	
T02.08-s1.02	--	d/s end reach	--			490			490		
	--	u/s end reach	--	2,537		540		2.0%	540	1.97%	
T02.08-s1.03	--	d/s end reach	--			540			540		
	--	u/s end reach	--	1,256		650		8.8%	750	16.72%	
T02.08-s1.04		d/s end reach				650			750		
	A	segment break	A/B		384	675	6.5%				
	B	segment break	B/C		1,405	716	2.9%				
	C	u/s end reach		2,425	636	760	6.9%	4.5%	760	0.41%	c to a
T02.08-s1.05		d/s end reach				760			760		
	A	segment break	A/B		1,687	841	4.8%				
	B	segment break	B/C		1,034	879	3.7%				
	C	segment break	C/D		341	905	7.6%				
	D	segment break	D/E		827	930	3.0%				
	E	u/s end reach	E/F		613	1000	11.4%				
	F	u/s end reach		4,802	300	1003	1.0%	5.1%	1010	5.21%	

APPENDIX G

Opportunities for Geomorphically-Compatible River Corridor Management Practices

Abbreviations used in Table G.1

Reach/Segment Condition

EQ - Ref	Equilibrium: Stable-Reference
EQ - Min	Equilibrium: Minor Instability
UN - Mod	Unstable: Moderate Departure
UN - Incis	Unstable: Incising Reach
UN - Sev	Unstable: Severe Stream Type Departure

Site Description

LB	Left Bank, facing downstream
RB	Right Bank, facing downstream
US	Upstream
DS	Downstream

Objectives

AV	Avoidance
FP	Floodplain Access
SA	Sediment Attenuation
NA	Nutrient Attenuation
FA	Flow Attenuation
SR	Sediment Reduction
NR	Nutrient Reduction
EQ	Accelerate return to equilibrium condition
EC	Ecologic
- lt	Long-term
- st	Short-term

Partner Agencies

NVRCDC	Northern Vermont Resource Conservation and Development Council	
	BBR	Better Backroads Grant Program
USDA NRCS	US Department of Agriculture, Natural Resources Conservation Service	
	AMA	Agricultural Management Assistance
	CRP	Conservation Reserve Program
	EQIP	Environmental Quality Incentives Program
	WHIP	Wildlife Habitat Incentives Program
	WRP	Wetlands Reserve Program
USFW	US Fish & Wildlife	
	Partners	Partners for Fish and Wildlife Program
VTAA	Vermont Agency of Agriculture	
	CREP	Conservation Reserve Enhancement Program
	BMPs	Best Management Practices (cost-share program)
	ICM	Integrated Crop Management (cost-share program)
VTDEC WQD	Vermont Department of Environmental Conservation, Water Quality Division	
	RMS	River Management Section (River Corridor Grants - Clean & Clear Action Program
	WS	Wetlands Section (Wetland Restoration Grants - Clean & Clear Action Program)
VTDEC FED	Vermont Department of Environmental Conservation, Facilities Engineering Division	
	DSH	Dam Safety & Hydrology Section
Vtrans	Vermont Department of Transportation	
VLT	Vermont Land Trust	
VRC	Vermont River Conservancy	
TNC	The Nature Conservancy	

The attached Table G.1 identifies opportunities for geomorphically-compatible river corridor management along select reaches of the Castleton River and tributaries that were assessed during 2005 and 2006 following Vermont Agency of Natural Resources protocols for stream geomorphic assessment. Phase 1 and 2 Stream Geomorphic Assessment data were analyzed to identify corridor management strategies that could support the river's return to a more balanced condition, thereby reducing erosion hazards and improving water quality and riparian habitats over the long term. See the Phase 2 report for more details.

On the following page is a listing of abbreviations used in Table G.1.

	Reach / Segment; Condition	Site Description	Project Description	Objectives Addressed short-term (ST) long-term (LT)	Technical Feasibility	Cost	Priority	Landowner Approval	Potential Partners - Programs
P-1	**T02.11-s1.04-B** Gully Brook Un-Sev	**Traverse property -** **Birdseye Rd, Poultney** Historic channelization along Birdseye Road has left the channel entrenched and formerly converted a naturally aggradation setting (alluvial fan) to a transport dominated setting. Channel is actively aggrading, braiding and widening. Streambank erosion into adjacent fields with possible legacy of nutrients.	Support a return to reference sinuosity, restore sediment attenuation function, and restore floodplain access through restoration of woody buffers, and possible limited term or permanent corridor easement. Refrain from future channel management, such as channelization, dredging, berming, armoring. Refrain from developments in the corridor to prevent future fluvial erosion losses.	EQ - lt FP - lt SA - lt SR - lt NR - lt AV - lt	High	Low	High	Possible	USDA - CRP, EQIP? VTAA - CREP? USDA-WHIP USFW - Partners VTDEC RMS VRC
P-2	**T02.11-s1.04-A** Gully Brook EQ-Ref	**various properties -** **Birdseye Rd, Poultney** Downstream half of the reach: equilibrium channel with forested buffer along both banks. Includes several scenic waterfalls, and historic site of town of Castleton drinking water reservoir and dam (breached).	Preserve equilibrium channel offering instream and riparian habitat functions and values, as well as recreational, scenic, and cultural opportunities. Landowner education/ outreach. Possible limited-term or permanent easements. Careful management of surrounding watershed land uses can reduce potential for hydrologic impacts and sedimentation to the Gully Brook, that is occurring in downstream reaches and their tributaries.	EQ - lt FP - lt EC - st, lt	High	Mod	High	Unknown	USDA-WHIP USFW - Partners VTDEC RMS VLT VRC TNC
P-3	**T02.11-s1.02-B** Gully Brook EQ-Min	**various properties -** **Birdseye Rd, Castleton** Equilibrium channel with mature forested buffer along both banks. Limited sediment attenuation areas, in an overall transport-dominated channel. Receiving sediments from upstream reach and tributaries, particularly those draining slopes to the east of the channel.	Preserve equilibrium channel offering instream and riparian habitat functions and values, limited sediment attenuation functions, as well as recreational and scenic opportunities. Possible limited-term or permanent easements. Careful management of surrounding watershed land uses and Birdseye Road can reduce potential for hydrologic impacts and sedimentation to the Gully Brook.	EQ - lt FP - lt EC - st, lt	High	Low	High	Unknown	USDA-WHIP USFW - Partners VTDEC RMS VLT VRC TNC BBR
P-4	**T02.11-s1.02-A** Gully Brook Un-Sev (alluvial fan)	**Savage & other properties -** **Birdseye Rd, Castleton** Short alluvial fan setting. History of channelization, windrowing, dredging, berming has constrained the natural tendencies for active lateral adjustments, braiding and deposition. Stream type departure from D-braided to Fc-plane bed. Channel modifications are not sustainable and require repeated, costly maintenance. Bridge crossing for Woodbury Road has failed repeatedly.	Refrain from further construction or other floodplain encroachment within the corridor. Evaluate the feasibility of removing the bridge crossing and providing access to western residential properties via an alternate crossing outside of the alluvial fan setting. Preserve woody buffers within the geomorphically defined corridor. Consider limiting recreational vehicle access to the river corridor.	AV - st EQ - lt FP - lt SA - lt	Mod	Unk	High	Unknown	VTDEC - RMS Town of Castleton Vtrans

	Reach / Segment; Condition	Site Description	Project Description	Objectives Addressed short-term (ST) long-term (LT)	Technical Feasibility	Cost	Priority	Landowner Approval	Potential Partners - Programs
P-5	**T02.11-s1.01** Gully Brook Un-Mod (alluvial fan at u/s end)	**Traverse property - Birdseye Rd, Castleton** History of channelization, windrowing, and berming, and repeated gravel extraction from the Gully Brook and Castleton River in vicinity of the confluence. Gully Brook was entrenched, and converted from sediment deposition area to transport-dominated. In 2004, right-bank floodplain restored through berm removal and sediment excavation. Channel now beginning to regain sinuosity through active planform deposition, aggradation and widening.	Support continued return toward equilibrium by allowing the Gully Brook to re-establish meanders on a natural timeline. Continue wildlife habitat enhancements, including tree plantings in the new floodplain. Continued limited-term or possible permanent easements to support a return to geomorphic regime channel, and prevent future channelization, dredging and berming.	SR - st SA - lt EQ - lt FP - lt	High	Low	High	Likely	USFW-Partners VTDEC RMS
P-6	**T02.08-s1.05-E** Pond Hill Brook EQ-Ref	**Pond Hill Ranch property - Pond Hill Ranch Rd, Poultney** Bedrock channel receiving stormwater runoff, sediments and debris from adjacent gravel road.	Improve road bed materials, drainage to reduce stormwater/sediment runoff to the river, which will improve water quality and reduce geomorphic impacts to downstream reaches.	SR - st EC - st, lt	High	Mod	High	Unknown	VTDEC RMS BBR Town of Poultney
P-7	**T02.08-s1.05-D** Pond Hill Brook Un-Sev	**Pasture - Pond Hill Ranch Rd/ Pond Hill Rd, Poultney** Direct pastured area exhibiting streambank erosion (trampling), localized channel widening and nutrient inputs. Channel re-establishing sinuosity in response to historic and recent channelization, but incipient floodplain is narrow in width (Cb to B stream type departure). Channel-contiguous wetlands may offer flow, sediment and nutrient attenuation function. High recovery potential.	Livestock exclusion (fencing), accompanied by provision for alternative water source and installation of stabilized livestock crossing(s). Restoration of woody buffers within the geomorphically defined corridor. Possible limited-term or permanent corridor easements. Improved farm road grading and base material to reduce stormwater and sediment runoff direct to the stream. Evaluate feasibility of utilizing channel-contiguous wetland for flow / sediment / nutrient attenuation.	NR - st SR - st SA - lt FA - lt EC - st, lt EQ - lt FP - lt	High	Mod	High	Unknown	USDA - CRP, EQIP VTAA - CREP, BMP USDA - WHIP, WRP USFW - Partners VTDEC - RMS, WS
P-8	**T02.08-s1.05-B** Pond Hill Brook EQ-Min	**Parcel 9-01-35; Wooded pasture - Pond Hill Rd, Poultney & Castleton** Local, limited sediment attenuation area between bedrock gorges. Livestock with direct access to the stream. Undersized culvert crossing is the site of frequent fluvial erosion losses.	Livestock exclusion (fencing), accompanied by provision for alternative water source(s) and installation of stabilized livestock crossing(s) if needed. Possible limited-term or permanent corridor easements. Replacement of culvert with a structure (bridge) of larger span at next opportunity.	NR - st SR - st SA - lt EQ - lt EC - st, lt	High	Mod	Mod	Unknown	USDA - CRP, EQIP VTAA - CREP, BMP VTDEC RMS BBR Town of Castleton

	Reach / Segment; Condition	Site Description	Project Description	Objectives Addressed short-term (ST) long-term (LT)	Technical Feasibility	Cost	Priority	Landowner Approval	Potential Partners - Programs
P-9	**T02.08-s1.04-B** Pond Hill Brook Un-Sev	**Parcels 9-01-34, 9-01-35 - ag fields** **Pond Hill Rd, Castleton** Historic channelization, berming, armoring has resulted in channel entrenchment (Cb to F stream type departure) and converted a naturally aggradational setting to a more transport-dominated setting. Channel is actively aggrading and widening in downstream half. Streambank erosion into adjacent fields with possible legacy of nutrients. Undersized culvert crossing is the site of frequent fluvial erosion losses. Livestock with direct access to the stream.	Support a return to reference sinuosity, restore sediment attenuation function, and restore floodplain access through restoration of woody buffers, and possible limited-term or permanent corridor easements. Refrain from future channel management, such as channelization, dredging, berming, armoring. Refrain from developments in the corridor to prevent future fluvial erosion losses. Replacement of culvert with a structure (bridge) of larger span at next opportunity. Livestock exclusion (fencing), accompanied by provision for alternative water source(s) and installation of stabilized livestock crossing(s) if needed.	NR - st SR - st SA - lt EQ - lt FP - lt EC - st, lt AV-lt	High	Mod	High	Unknown	USDA - CRP, EQIP VTAA - CREP, BMP USDA-WHIP USFW - Partners VTDEC RMS BBR Town of Castleton
P-10	**T02.08-s1.03** Pond Hill Brook EQ-Ref	**Parcels 9-01-51 - forested gorge, hist. dams** **Between Pond Hill Rd/Staso Rd, Castleton** Equilibrium channel with mature hemlock forest buffer along both banks. Includes several scenic waterfalls, and sites of historic large dam (partially breached) and reservoir and small, low-head dam.	Preserve equilibrium channel offering instream and riparian habitat functions and values, as well as recreational, scenic, and cultural opportunities. Landowner education/ outreach. Possible limited-term or permanent easements with willingness of landowners. Careful management of surrounding watershed land uses can reduce potential for hydrologic impacts and sedimentation to the Pond Hill Brook. Former reservoir at head of reach may be serving important sediment and flow attenuation function. Evaluate dam sites for public safety and flood risks, and to identify jurisdiction and potential future management options.	EQ - lt FP - lt EC - st, lt SA - lt FA - lt	High	Mod	High	Unknown	VTDEC RMS VLT VRC TNC VTDEC DSH
P-11	**T02.08-s1.02** Pond Hill Brook Un-Sev	**Parcels 9-01-20 - adjacent to quarries** **Staso Rd, Castleton** Historic dredging, channelization, berming, armoring and floodplain encroachments have resulted in channel entrenchment (C to F stream type departure) and converted a naturally aggradational setting to a more transport-dominated setting. Undersized culvert crossing for driveway to Hadeka Stone Corp has developed large downstream scour pool. Historic dams on Pond Hill Bk and RB tributary at upstream end of reach. Stormwater inputs and gullying from vicinity of town highway department at RB, downstream end of reach.	Long history of encroachments and high density of human investments in the corridor suggest minimal opportunities for stream restoration - i.e., maintenance of a Modified Reference Stream Type is likely. Conduct landowner and public education/ outreach to address Extreme sensitivity of the reach. Refrain from future investments in this corridor; possible town planning or zoning options. Careful management of upstream watershed land uses and passive geomorphic restoration measures in upstream reaches can reduce potential for hydrologic and sediment impacts to this reach. Evaluate dam sites for public safety and flood risks, and to identify jurisdiction and potential future management options.	AV - st, lt SR - st	High	Low	High	Unknown	VTDEC RMS VTDEC DSH Town of Castleton

	Reach / Segment; Condition	Site Description	Project Description	Objectives Addressed short-term (ST) long-term (LT)	Technical Feasibility	Cost	Priority	Landowner Approval	Potential Partners - Programs
P-12	**T02.08-s1.01-E** Pond Hill Brook EQ-Min	**Parcels 25-21-36, 9-01-20 - along RR spur Crossing South St., Castleton** Channel is actively aggrading, widening and adjusting its planform in response to historic channelization and encroachment by Staso Road (RB) and former railroad (LB). Section of the railroad grade is being actively undermined at upstream end of segment. Undersized and low-clearance arch crossing of South Street. Receiving translated erosional energies and sediments from upstream intensely modified and entrenched reach. This segment has high recovery potential, and is a strategic energy dissipation and flow/sediment attenuation reach positioned between upstream quarry reach and downstream Castleton State College and Castleton village.	Support a return to reference sinuosity and equilibrium through restoration of woody buffers. Evaluate the feasibility of abandoned railroad grade removal upstream of South Street where the railroad grade most closely confines the channel. Enhance and preserve sediment and flow attenuation functions through possible limited-term or permanent corridor easements. Refrain from future channel management, such as channelization, dredging, berming, armoring. Refrain from developments in the corridor to prevent future fluvial erosion losses. Replace arch crossing with a structure (bridge) of larger span at next opportunity.	EQ - lt FP - lt SA - lt FA - lt NR - lt SR - lt EC - st, lt AV - lt	High	High	**High**	Unknown	VTDEC RMS USDA-WHIP USFW - Partners VTrans Town of Castleton
P-13	**T02.08-s1.01-D** Pond Hill Brook EQ-Min	**Parcels 25-21-09 - Castleton State College West of South St., Castleton** Planform of this segment of Pond Hill Brook was substantially re-directed to allow development of Castleton State College athletic fields in the late 1960s. Flows diverted to the west of a bedrock knoll into pre-existing wetlands which drain to a 2-acre impoundment behind Castleton State College dam. Athletic fields encroach directly on the eastern shore of the impoundment. High algae growth observed in impoundment.	Outreach to Castleton State College. Evaluate potential collaborations for future management options for the dam and impoundment.	AV - st, lt NR - st	High	Low	Low	Unknown	VTDEC RMS VTDEC DSH Castleton State Coll.
P-14	**T02.08-s1.01-B** Pond Hill Brook EQ-Min	**Parcels 45-52-17, -18, -20 - South of Main St., Castleton** Channel appears to serve a local flow and sediment attenuation role, and is strategically located in an area of moderately dense development. A small dam and impoundment supplies an apparent flow diversion to an adjacent pond.	Enhance and preserve sediment and flow attenuation functions through possible limited-term or permanent corridor easements. Support near equilibrium conditions through preservation of undisturbed woody buffers and appropriate stormwater controls. Refrain from future encroachment and channel management, such as channelization, dredging, berming, armoring. Possible town planning or zoning options (corridor overlay district). Landowner outreach to evaluate purpose and jurisdiction of low-head dam and apparent diversion structures.	EQ - lt FP - lt SA - lt FA - lt NR - lt SR - lt EC - st, lt AV - lt	High	Mod	High	Unknown	VTDEC RMS USDA-WHIP USFW - Partners Town of Castleton VTDEC DSH

	Reach / Segment; Condition	Site Description	Project Description	Objectives Addressed short-term (ST) long-term (LT)	Technical Feasibility	Cost	Priority	Landowner Approval	Potential Partners - Programs
P-15	**T02.03** Castleton River EQ-Min	**Three historic low-head dams** **Between River Rd and Adams St crossings** **Fair Haven** Impounded, bedrock channel with three prominent bedrock falls, each with a historic dam developed on them.	Conduct historical research; landowner and dam-owner outreach. Evaluate dam sites for potential future management options. Review potential flood risks and erosion hazard risks. ***This project is ongoing.***	EQ - lt EC - st, lt AV - lt	Unk	High	High	Unknown	VTDEC RMS VTDEC DSH VRC Town of Fair Haven
P-16	**T02.02** Castleton River Un-Mod	**Fair Haven landfill (former) in vicinity of** **Wastewater Treatment Facility** **off Montgiven St, Fair Haven** High-bank erosion from meander extension is exposing household rubbish and other discarded items in the former Fair Haven landfill along the north bank of the river.	Public education / outreach to support the town of Fair Haven in evaluating future management and landfill closure options.	SR - lt EC - st, lt AV - st, lt	High	Low	High	Unknown	VTDEC RMS Town of Fair Haven
P-17	**T02.01** Castleton River EQ-Min	**Vicinity of US Route 4 highway crossing** **Fair Haven** Mass failure on LB approx 50 ft US of highway crossing. Minimal tree buffers along RB downstream of the crossing along agricultural fields, contributing to high-bank failures.	Stabilize LB mass failure through toe stabilization, bank vegetation, and/or bioengineered revetments. Enhance woody buffers along RB along ag fields. Restoration of woody buffers within the geomorphically defined corridor. Possible limited-term or permanent corridor easements.	NR - st SR - st EC - st, lt	High	Mod	Mod	Unknown	USDA - CRP, EQIP VTAA - CREP, BMP USDA-WHIP USFW - Partners VTrans