PHASE I STREAM GEOMORPHIC ASSESSMENT

Conducted on Select Poultney Tributaries

by
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with support from
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FINAL REPORT and DATA

Study Completed between November, 2005 and March, 2007
Report Completed May 2007

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INTRODUCTION

In 2005, the Poultney Mettowee Natural Resources Conservation District (PMNRCD) was awarded a grant by Vermont DEC, Rivers Management Section. The grant, funded through Vermont's Clean and Clear Initiative, was to complete Phase 1 and Phase 2 Geomorphic Assessments and a Corridor Protection Plan on the Poultney River mainstem and a Phase 1 Assessment on 14 major Tributaries to the Poultney River. *This report describes the results of the Phase 1 Geomorphic Assessment on the Poultney Tributaries.*

Fluvial geomorphology is the study of the interaction between streams and the landscape through which they travel. The phase 1 geomorphic assessment specifically looked at how changes on the landscape have translated to potential changes within the stream channels of 14 streams that drain to the Poultney River. This study was completed through use of remote sensing tools such as maps, public records and files, aerial and orthophotos, and digital mapping programs. The assessment was conducted using the Vermont Geomorphic Assessment Protocols (the most current versions available between November 2005 and May 2007), which were designed to standardize geomorphic assessments conducted by different organizations around the state.

Steps 1-4 of this study assessed the deterministic watershed characteristics such as valley width, stream channel slope and prevailing soil types. Steps 5 and 6 assessed changes that have occurred on the landscape through human activities such as development, berms and roads, and rip-rap placed along the streambanks or in the flood plain. Step 7 included a field survey of the selected tributaries between December 2005 and March 2007. Information from the field survey was used to verify the remote sensing information compiled in this assessment.

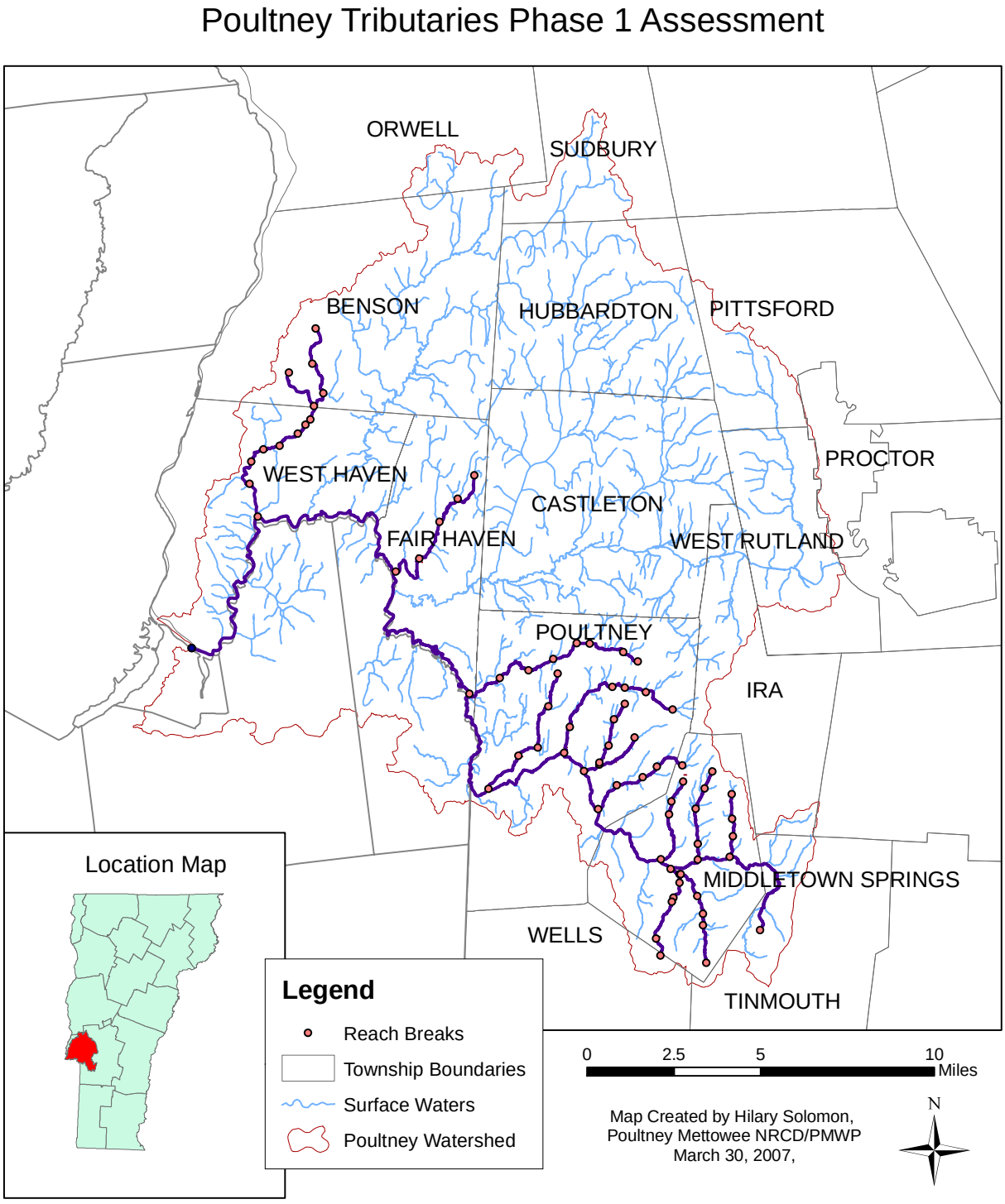
An additional and more in-depth field survey, or a phase 2 geomorphic survey, was conducted on two of the tributaries (Finnel Brook and Lewis Brook) during the spring of 2006. This survey was conducted by Lisa Godfrey. For more information on the phase 2 field survey, please contact the PMNRCD or Shannon Pytlik of the Vermont DEC Rivers Management Program.

Results from both the phase 1 and phase 2 studies will provide much needed baseline data about the current conditions in the Poultney watershed. This data will be used to provide recommendations for future restoration or conservation project locations, land use planning decisions, tree planting sites, erosion hazard areas, and the types of restoration projects that may be successful along the creek.

Remote sensing data used in this study was obtained from the Vermont Center for Geographic Information (VCGI), Vermont DEC, the Rutland Natural Resource Conservation Service (RNRCS), the Rutland Regional Planning Commission (RRPC), South Mountain Research and Consulting, Lisa Godfrey, and Field Geologic Services. GIS support was provided by Shannon Pytlik of Vermont DEC and John Van Hoesen of Green Mountain College.

The following map depicts the location of the study area.

Map 1: Watershed Location map with the Poultney River and assessed Tributaries



METHODOLOGY

This assessment was completed using the methodologies outlined in the Vermont Geomorphic Assessment Phase I Handbook, dated April 2005 (plus subsequent updates). Computer mapping functions were completed by Vermont DEC's Shannon Pytlik through the automated GIS extension/tool, Stream Geomorphic Assessment Tool (SGAT), version 3 and version 4.53. Post-SGAT steps were completed by Hilary Solomon (PMNRCD/PMWP). All data resulting from this study has been entered into Vermont DEC's online Data Management System (DMS) and checked for quality by qualified Vermont DEC staff.

POULTNEY RIVER TRIBUTARIES (SUB)WATERSHEDS: STUDY AREA BACKGROUND

Poultney River Watershed

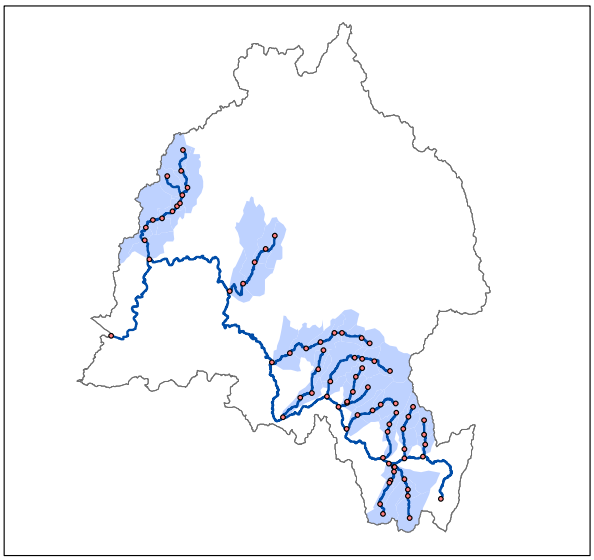
The Poultney River Watershed is primarily located in Rutland County, with approximately ten percent in Washington County, New York, and a small section in southern Addison County. The Poultney River originates in the Tinmouth Township and flows westerly through Middletown Springs and Poultney, Vermont, creating the Vermont/New York border for approximately half of its length and finally to Lake Champlain. According to the phase 1 ArcView extension, the Stream Geomorphic Assessment Tool (SGAT), the Poultney River watershed is approximately 262 $miles^2$.

Over the past several years, many assessment projects have been conducted within this watershed. This work has been largely driven by PMNRCD, Vermont ANR/DEC, and The Nature Conservancy conservation efforts; and Vermont ANR and RRPC regional planning efforts.

The PMNRCD has recently completed its fourth season of water quality monitoring (analytical support provided by a grant from the LaRosa Laboratory (VT DEC) in Waterbury). The PMNRCD and the PMWP are currently monitoring total phosphorus, E. coli, and turbidity on the Poultney River, but none of its tributaries.

For more information about any of these studies please contact the PMNRCD.

Tributary Subwatersheds

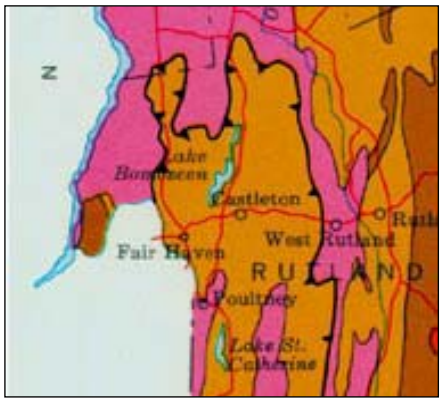


This study focuses on *tributaries* to the Poultney River. The 14 tributaries that were assessed include: Coggman Creek (and one of it's tributaries), Mud Brook, Lewis Creek, Barrett Brook in Poultney, Finel Hollow Brook, Hampshire Hollow Brook, Clark Hollow Brook, Lavery Brook, Vail Brook, South Brook, Coy Brook, North Brook and Train Brook. These tributaries flow through the towns of West Haven, Fair Haven, Poultney, Castleton and Middletown Springs.

The assessed tributaries are shown in blue in the figure to the left.

Geologic Setting

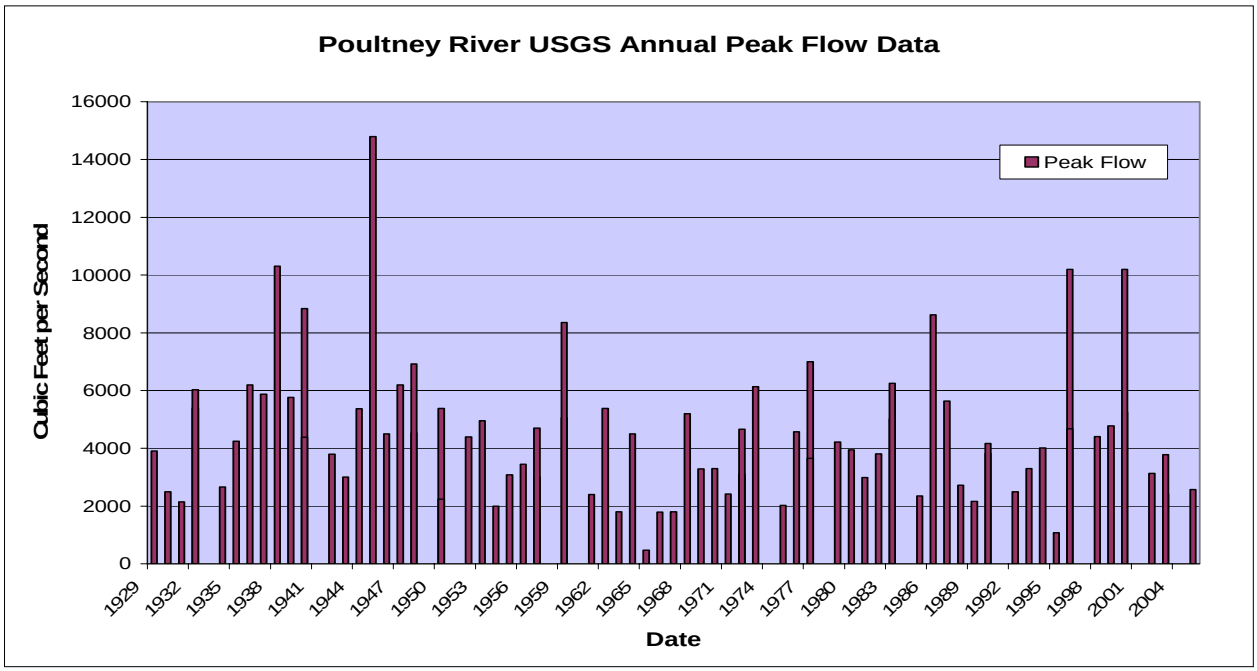
Except for Coggman Creek, all of the tributaries are located inside the Taconic Klippe feature (GGM, 1970). The bedrock origins are Ordovician (pink in graphic to right) and Cambrian (orange). Vermont bedrock classification in the Taconic Mountains is non-calcareous slates, greywackes, and conglomerates (Thompson and Sorenson, 2000). The Generalized Geologic Map (1970) includes quartzite, limestone, phyllite, sandstone, marble, dolomite, and shale as other potential bedrock types for this area. The former Lake Vermont site (extending from Lake Champlain to the Castleton area) has affected the geology in the lower reaches of many of the tributaries.



Flood History

The highest peak flow measured at the Poultney River gauging station (near Fair Haven) between 1929 and 2005 (the period for which this data is available) was 14,800 ft^3 per second on July 20, 1945. Other flows over 8,000 ft^3 per second were measured in 1938, 1940, 1959, 1986, 1996, and 2000. (I don't know what return period this flow represents).

Graph 1: Poultney River Annual Peak Flow as measured at the USGS Gaging Station near Fair Haven, Vermont.



DATA INPUTS/STUDY RESULTS

The results of this study are derived from the following data inputs: watershed location; valley and channel characteristics; soils data; land use and riparian buffer data; post-settlement changes to the channel, floodplain, stream corridor and watershed and a comparison of the expected stream channel characteristics to the measured characteristics. All of the phase 1 data (drawn upon in the following summaries) can be found in Appendix A or may be accessed through the Vermont DEC geomorphic assessment Data Management System (DMS).

Reach Location

Each reach is a like area studied as one geologic unit. Please refer to Appendix A, report 1, for a complete list of the reaches and their characteristics. The following map details the location of each reach and a representation of its subwatershed area, while Table 1 denotes the location and length of each tributary.

Map 2: Tributary Subwatersheds by Reach

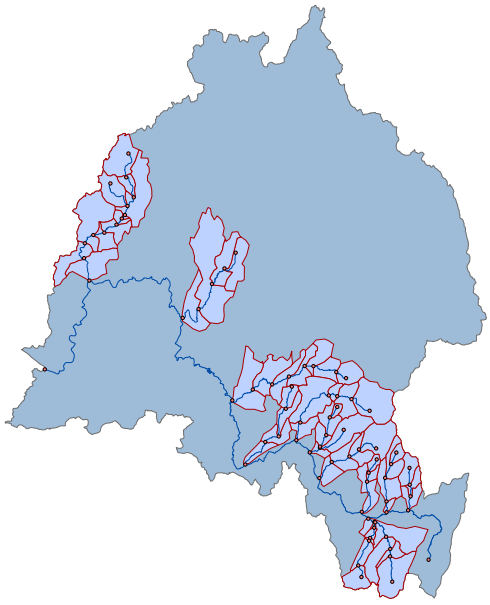


Table 2: Tributary ID's, length and subwatershed size.

Tributary ID	Tributary Name	Length (Mi)	Watershed Size (Mi2)
M01-S1	Coggman Creek	6.98	10.9
M01-S1.08-Sl	Coggman Trib	1.50	1.21*
M05-S1	Mud Brook	5.73	8.67
M08-S1	Lewis Brook	6.67	7.89
M10-S1	Barrett Brook (Unnamed Trib)	4.68	2.48
M11-S1	Finnel Hollow Brook	5.42	6.63
M12-S1	Hampshire Hollow Brook	2.64	3.25
M12-Sl.01-S1	Clarke Hollow Brook	1.46	1.61*
M13-S1	Lavery Brook	3.51	4.04
M14-S1	Vail Brook	2.72	1.45
M15-S1	North Brook	2.82	2.28
M15-S2	Train Brook	2.03	1.63
T3.01	South Brook	3.56	7.2
T3.01-S1	Coy Brook	2.67	1.67

*also counted in the watershed area of the higher order tributary

Reference Stream Types

All stream reaches in this study were classified as having Rosgen (1996) and Montgomery Buffington (1996) reference stream types A, B, C or E.

Stream type "A"- steep, cascading, headwater reaches
Stream type "B"- include moderately steep, step-pool streams
Stream type "C"- include less-steep, pool-riffle streams with floodplain access
Stream type "E"- low-gradient, highly sinuous streams with floodplain access

The "E" stream type predominated where the tributary was located in a large river valley, with Coggman Creek, Mud Brook and South Brook being predominantly "E" streams. The other Tributaries were often a mix of "A", "B" and "C" stream types with Lewis and Barrett Brook (the unnamed tributary in the data) being predominantly "C" streams, Finel, Hampshire and Lavery were mixed, and Lavery, Vail, North and Coy were more confined "B" and "A" types. These stream types will be verified during the phase 2 assessment and any reclassification or deviations noted at that time.

Basin Characteristics: Geology and Soils

As stated in the Vermont DEC protocols, "A stream carries not only water but also sediment. Geology determines the source material that the river is carrying, the way that material is carried and the rate of channel adjustments."

Based on the phase 1 results, the dominant geological parent materials in the Poultney tributary subwatersheds include glacial lake sediments, glacial till, alluvial materials and the subdominant materials include ice-contact deposits.

Glacial lake deposits were formed from the sand, silt and silty clay deposits in the lakes formed from glacial meltwater after the last period of glaciation in Vermont valleys.

Glacial till consists of sediments dropped by the glaciers when they melted. It is the most widespread surficial deposit in Vermont. Most of the silt and clay washed away into the glacial lakes, leaving till with a sandy matrix. There are two types of till, lodgement and ablation. The lodgement is the material that was caught under the glacier. It forms a hardpan crust in many areas. The ablation was the till carried in the glacier that dropped when the glacier receded.

Alluvium is sediment deposited by a stream and may include boulders, cobbles, sand or silt. Alluvial deposits in flood plains are often composed of fine sand or silt. All alluvial deposits in Vermont postdate the last glacial period.

Ice-contact deposits are formed of sediments that accumulated in lakes, ponds or streams in contact with glacial ice. Unlike till material, these sediments show evidence of sorting and layering due to the action of flowing water. Particles range in size from silt and clay up to boulders, but most of the material is sand-size or coarser (Vermont ANR, 2004, VT SGA App F, Geologic Information).

The characteristics of the dominant soil types in the watershed show occasional flooding, and only slight to moderate erodability. The erosion potential throughout much of the watershed may be relatively low due to the moderate slope found throughout the valley.

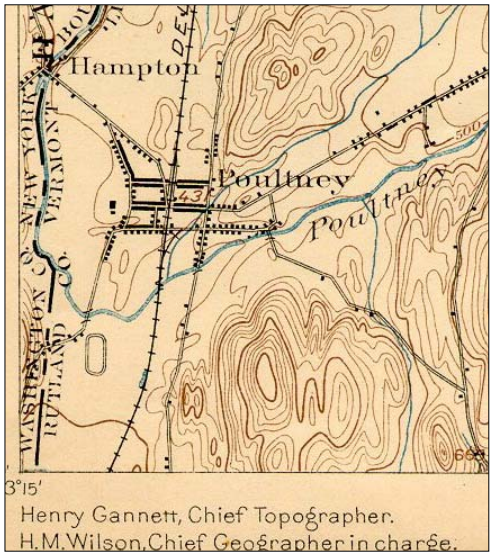
Table 1 illustrates the predominance of glacial lake sediments being the parent materials for soils in Coggman Creek and Mud Brook and many of the lower reaches of the other tributaries. Other common parent materials include glacial till and alluvial materials.

Table 3: Parent materials in Tributary subwatersheds.

Tributary Name	Primary downstream	Primary upstream	Secondary
Coggman Creek	Glacial lake	Glacial lake	Till
Coggman Trib	Till	Till	Till
Mud Brook	Glacial Lake	Glacial Lake	Alluvial/Till
Lewis Brook	Glacial Lake	Till	Alluvial
Unnamed Trib	Glacial Lake	Till	Ice Contact
Finnel Hollow Bk	Till	Till	Alluvium
Hampshire Hollow Bk	Ice contact	Till	Alluvium
Lavery Brook	Alluvium	Till	
Vail Brook	Till		Alluvium
North Brook	Ice contact		Till
Train Brook	Ice contact		Till
South Brook	Till		Till
Coy Brook	Ice contact		Alluvium

Land Cover and Reach Hydrology

Landuse in the subwatersheds is mainly forested. Historically, a much higher percent of the watershed was cleared for pasture and croplands. The following picture is from an 1896 USGS topographic map (Castleton, southwest quadrant, UNH). Historic maps like this can help us understand changes on the landscape over time and how these changes may be affecting current stream condition and adjustment processes.



Landuse in the stream corridors is a mix of forested land, crops and fields and occasionally, urban areas and wetlands.

Woody riparian buffers were of varied quality throughout the study area. Many of the reaches had long stretches of minimal vegetation where fields or roads occurred next to the stream.

Groundwater and wetland inputs were abundant throughout the basin.

Instream Channel Modifications

Instream channel modifications include the impact or frequency of bridges and culverts, bank armoring, channel straightening and dredging on the river.

Because the exact location of stream alteration permits was not usually available, information on bank armoring was not collected during the phase 1 survey.

According to NRCS district conservationist, Bill Forbes, no dredging has been reported along the tributaries to the Poultney River (Personal communications, 2005-2007).

Floodplain Modifications and Planform Change

Floodplain modifications include roads, berms and development within the floodplain that alter the ability of the river to migrate in response to changes within the system. Planform changes include depositional features, meander migration and a deviation (usually a decrease) in the sinuosity of a river from the predicted or reference condition.

Most tributaries had development impacts listed as low or not significant.

The planform changes, which include in-stream depositional features, meander migration and a deviation from expected sinuosity, show adjustments within the system that appear to be in response to historic land clearing, channelization, and bank armoring.

Windsheild Survey

The windshield survey provided a means of limited field verification of the phase 1 data. Brief observations were taken at select points of vehicular and/or public access along the creeks in the study. The windshield survey was not a comprehensive field verification and the results of the phase 1 study should be considered preliminary.

Impact Ratings

Impact ratings are result of a compilation of points for all of the potential stressors to the creek. Each reach receives a score (out of a possible 32 points) that represents potential impacts. Scores for the Poultney Tributaries were variable ranging from 1 (Finel Brook headwaters) to 17 (Barrett Brook in Poultney).

Adjustment processes

The Vermont DEC DMS also calculated scores for the (predicted) current channel adjustment process. These scores are created by a model that uses the data provided for each reach and looks for trends. The following processes are evaluated:

Degradation is the process of channel downcutting or scour that can result from increased slope, velocities or lack of floodplain access.

Aggradation is the process of building up the channel bed through deposition of sediments.

Widening is the process of increasing the width of the channel through erosion on both banks, often until a new floodplain forms within the old, widened channel. Usually this happens when a creek is cut off from its original floodplain.

Planform Changes include changes to the path or the sinuosity of the creek over time.

Other information generated includes *sensitivity* to change on the landscape and *reach condition* as compared to others within the project area and as compared to other streams statewide.

TRIBUTARY SUMMARIES

COGGMAN CREEK AND TRIBUTARY

Coggman Creek originates in Benson and flows through West Haven to its confluence with the Poultney River near Lake Champlain. Nine reaches were assessed on Coggman Creek for a total length of approximately 7 miles and a watershed area of 11 mi^2. The first reach was excluded because it is a wetland.

Coggman Creek is predominantly an "E" type stream with ample floodplain access and a relatively deep meandering channel. The creek flows through many substantial wetlands and has many groundwater inputs.

One reach (reach 7) showed increased confinement and a steeper slope. The reaches upstream of this area are listed as "C", though these tend toward "E" characteristics, with no confinement and deep channels. These reaches may have lost their characteristic sinuosity through historic straightening.

The majority of soils through which Coggman Creek flows originated in Lake Vermont after the glaciers receded. The soil subdominant parent material includes glacial till. The tributary predominantly flows through glacial till-derived soils.

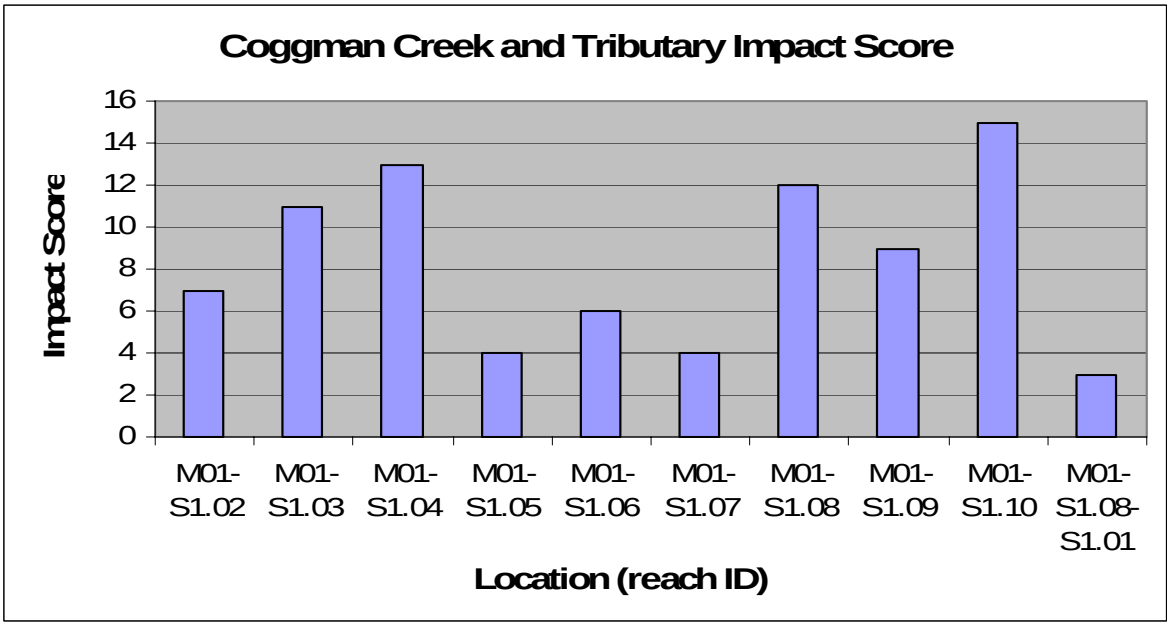
Historically the land cover in this subwatershed was heavily agricultural with crop and field covers dominating. Currently, the land cover is predominantly forest with a relatively high percentage of fields remaining. The forested riparian buffers remain narrow in the agricultural areas (reaches 2-4 and 9-10), however, reaches 5-8 have wide, forested buffers.

Instream and floodplain modifications along Coggman Creek are minimal with several culverts, but little found in the way of armoring, straightening or dredging and with few roads or berms and little development near the creek.

Ice jam potential is seen at the bridges and culverts, which are severely undersized throughout the subwatershed. All of the culverts surveyed were undersized and quite full during spring runoff season.

The impact scores are mainly the result of historic agricultural landuse and, in some areas, persistent narrow riparian buffers. The upstream and downstream reaches of the creek still run through hayfields and livestock pastures and in these areas show signs of straightening. In some cases livestock have access to the creek for water.

Graph 2: Impact Scores for Coggman Creek and Tributary



Adjustment processes appear to be a mix of aggradation and degradation, with aggradation being more dominant in the downstream reaches and degradation being more dominant in the center reaches. To a lesser extent planform changes and widening are predicted based on the available data, though reaches that experienced historic straightening showed higher planform adjustment scores. Reach condition as compared to other streams in the project area was good overall and many reaches compared very favorably to similar streams across the state. Due to the small substrate size, Coggman Creek is highly sensitive to changes on the landscape. Table x. shows predicted adjustment scores based on the results of the geomorphic assessment.

Table 4: Predicted adjustment scores for Coggman Creek and Tributary

Reach ID	Stream Type	Total Impact	Predicted Adjustment Scores				Reach Condition		Reach Sensitivity
			Degrad.	Aggrad.	Widen.	Planf.	Project	Statewide	
M01-S1.02	E	7	2	4	2	4	Good	Reference	
M01-S1.03	E	11	3	5	4	7	Fair	Good	High
M01-S1.04	E	13	5	8	7	9	Poor	Fair	High
M01-S1.05	E	4	3	3	2	1	Good	Reference	
M01-S1.06	E	6	4	3	2	0	Good	Reference	
M01-S1.07	B	4	4	2	2	0	Good	Reference	
M01-S1.08	C	12	6	6	5	6	Fair	Good	
M01-S1.08-S1.01	B	3	3	2	0	0	Reference	Reference	
M01-S1.09	C	9	5	6	5	7	Fair	Good	High
M01-S1.10	C	15	7	7	7	9	Poor	Fair	High

Potential projects along Coggman Creek include riparian buffer plantings and livestock exclusion fencing. Bridge and culvert surveys should be filled out for all crossings on this creek and the crossings assessed for possible replacement. Coggman Creek may be an ideal candidate for conservation easements, due to the overall lack of development and the wetland nature of the soils and plants along much of the creek.

MUD BROOK

Mud brook originates to the west of Lake Bomoseen and flows through Fair Haven to the Poultney River. Four reaches were assessed for a total of 5.73 miles and a watershed area of 8.67 mi^2. The downstream reaches of Mud Brook are "C" and "E" type streams with broad river valleys and good floodplain access. Reach 4 (the upstream reach), located in the Taconic foothills, is more confined and is a "B" stream type.

The dominant surficial deposits or parent soil materials are glacial lake deposits for the entire length of the stream. The secondary materials include alluvium downstream and glacial till upstream. The soils are predominantly hydrologic group D, which means slow infiltration rates throughout the subwatershed. The soil types indicate that flooding is rare in reaches 1 and 4, but frequent in reaches 2 and 3. In addition, the soils found in reaches 1 and 4 are highly erodable.

The historic land cover in the Mud Brook subwatershed was crop and forest, with crops and pastures dominating in the valleys and forest common in the hills. Currently, forested land cover dominates throughout the watershed, though fields are found along reach 3 north of the airport. Consequently, wide, forested riparian buffers are found for much of the brook, except in reach 3, where the dominant buffer width is less than 25 feet.

Mud Brook has been straightened and re-routed as it passes under Route 4 just north of Fair Haven. The channelization at Route 4 and another section of straightening through a agricultural field created the most obvious areas of planform changes along the creek. The impact scores for the first reach showed the influence of the Route 4 channelization. Reaches 1-3 also showed poor meander geometry, which may be the result of historic straightening or degradation through lake (or post settlement clearing) sediments and subsequent local confinement.

The predicted adjustment scores were inconclusive, with low scores overall for each of the adjustment processes. Mud Brook was rated "good" compared to other streams within the project and "reference" as compared to other similar stream around the state. Reaches with small, glacial lake-derived substrate were listed as sensitive to changes on the landscape.

Table 5 summarizes the predicted channel adjustment process scores and reach condition.

Reach ID	Stream Type	Total Impact	Predicted Adjustment Scores				Reach Condition		Reach Sensitivity
			Degrad.	Aggrad.	Widen.	Planf.	Project	Statewide	
M05-S1.01	C	13	7	8	5	7	Fair	Good	High
M05-S1.02	E	10	5	5	5	7	Fair	Good	High
M05-S1.03	E	7	2	4	2	2	Good	Reference	
M05-S1.04	B	8	6	5	3	7	Fair	Good	

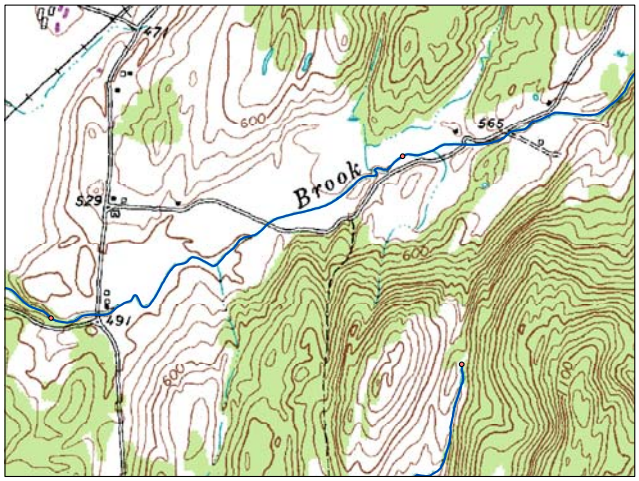
Potential projects include buffer plantings or potential easements in reach 3 and farther exploring the existing meander geometry.

LEWIS BROOK

Lewis Brook originates and flows through the northern section of the Poultney Township to its confluence with the Poultney River just over the Fair Haven line. The Brook flows through a mix of steep Taconic slopes and broad farm fields before reaching the Poultney River valley. Once in the valley the brook continues through farms and slate quarries until its confluence with the Poultney River.

Most of Lewis Brook is characterized as an unconfined "C" stream type. The parent materials are glacial lake in the valley, and a mix of till and alluvial materials upstream. Due to the wide variety of terrain through which Lewis Brook flows, the soils show a range of permeability and erosion rates. The soils along the entire length of the stream are types that indicate little flooding or inundation.

Historically, the land cover types in the Lewis Brook watershed included crops and slate quarries downstream, forest stands through the mountain slopes, and fields in the mountain valleys. Currently the cover types are predominantly forested with fields in the wider valleys. The riparian buffers range in width, with some areas (especially in the agricultural areas) having buffers less than 25 feet wide.

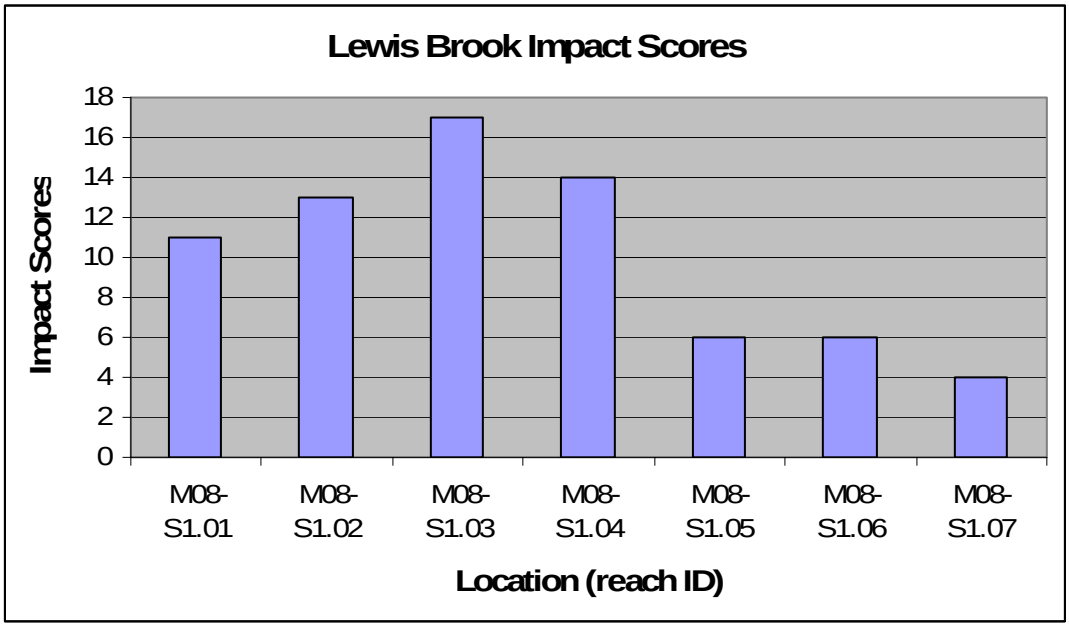


Reaches 1-4 have experienced significant amounts of straightening, some areas with berms to prevent future migration of the channel (reach 3 is pictured above and to the right). In these straightened areas, stream slope is increased (same elevation change over less distance) giving the stream more power to pick up and transport sediment. As a result, excess sediment is later deposited in locations along the length of the stream (especially areas downstream of the straightened areas, which exhibit lower slopes), leading to a buildup of sediment in the channel. Also contributing to the high levels of sediment deposition in this stream are tributaries that have degraded to form gullies in the headwaters (Godfrey, 2006). In many areas along Lewis Brook, roads create constraints and road runoff can additionally increase the sediment load.

The relatively high impact scores for Lewis Brook reaches reflect the historic straightening, heavy deposition of sediment, lack of adequate buffer widths, encroachment by roads, and the overall loss of natural meander geometry. The reaches with the highest scores (reaches 3 and 4) are coincident with the majority of straightening, though significant amounts of straightening

was also evident in the lower reaches. Most of the length of Lewis Brook was listed as highly sensitive to changes on the landscape.

Graph 3: Lewis Brook impact scores by reach.



The SGAT predicted adjustment processes, listed below, are again inconclusive. Results of the phase 2 assessment conducted on Lewis Brook in 2006 indicate that heavy sediment load and planform adjustment processes are occurring throughout the brook. The study found that, as a result, the geomorphic and habitat condition scored only "fair" overall. Much of the sedimentation and ongoing planform adjustment were attributed to results of the historic straightening.

Table 6: Phase 1 impact and predicted adjustment scores for Lewis Brook

Reach ID	Stream Type	Total Impact	Predicted Adjustment Scores				Reach Condition		Reach Sensitivity
			Degrad.	Aggrad.	Widen.	Planf.	Project	Statewide	
M08-S1.01	C	11	7	6	7	7	Fair	Good	High
M08-S1.02	C	13	5	5	5	7	Fair	Good	High
M08-S1.03	C	17	8	5	5	8	Fair	Good	High
M08-S1.04	C	14	6	6	5	7	Fair	Good	High
M08-S1.05	B	6	4	3	0	0	Good	Reference	Moderate
M08-S1.06	C	6	6	4	2	4	Fair	Good	High
M08-S1.07	A	4	3	3	0	1	Fair	Good	

The Lewis Brook has undergone a phase 2 assessment, completed by contractor Lisa Godfrey and funded by the Rutland Regional Planning Commission. The assessment report dated August 20, 2006, documents geomorphic and habitat condition as well as a list of potential implementation projects. **Potential projects** include buffer augmentation and the removal of berms and riprap to allow the channel to regain sinuosity and its connection with the floodplain. More detail on these projects can be found on pages 20 and 21 of the phase 2 report.

BARRETT BROOK

Barrett Brook originates in the Taconic Mountains to the north of Poultney. It flows south out of the hills and hugs the valley wall until flowing through Poultney, past the PMNRCD nature trail and education center at the Stonebridge, and into the Poultney River near the rail trail. In the photo to the right, it is flowing through a clear cut, possibly for a house site.

Except in the hills where it is more confined, Barrett Brook is a "C" type stream. The soils have ice-contact, till and glacial lake origins in the Poultney Valley and are mainly glacial till in the upstream reaches. The valley soils are richer, with moderate infiltration rates and erosion rates, while the mountain soils are more clayey with lower infiltration rates but higher erodability scores (likely due to increased slope) in the headwaters.

The historic land uses for reaches 1-3 were predominantly crops and fields. Forest landcover currently dominates within the entire subwatershed, with fields present at a lower rate. The riparian areas are mostly forested, with significant areas of less than 25 feet width in reaches 1, 2 and 4. The first reach is impacted by the town of Poultney, with much of its length through town is either bermed or flowing through bridges and culverts.

Much of reaches 1 and 2 appear to have been pushed up against the valley walls in the area between East Poultney and Poultney. As a result these reaches showed poor meander geometry. Increased erosion and deposition may result from this straightening, however, these predictions have not been verified in the field. The SGAT-generated predicted adjustment scores indicate that planform adjustment may be a concern in the lower reaches. Again, the scores for this creek were fairly inconclusive, being virtually equal between the adjustment processes.

The reach conditions were variable, ranging from "poor" to "good" within the project and "good" to "reference" when compared to other similar creeks across the state. Overall the stream showed high sensitivity to changes on the landscape.

Table 7: impact and adjustment process scores for Barrett Brook

Reach ID	Stream Type	Total Impact	Predicted Adjustment Scores				Reach Condition		Reach Sensitivity
			Degrad.	Aggrad.	Widen.	Planf.	Project	Statewide	
M10-S1.01	C	17	9	9	5	9	Poor	Fair	High
M10-S1.02	C	13	6	7	7	8	Fair	Good	
M10-S1.03	C	9	4	2	2	2	Good	Reference	High
M10-S1.04	B	6	5	5	3	6	Fair	Good	High

Potential projects along Barrett Brook include removing the berm in Poultney (near Bixby's), increasing the buffer width in areas with less than 25 feet of trees and allowing the brook to regain sinuosity in the areas that appear to be pushed against the valley wall.

FINEL HOLLOW BROOK

Finel Hollow Brook is also located entirely in the Poultney Township. It originates on the steep Taconic slopes and flows through several relatively narrow valleys (500-1200 feet wide) and a gorge (reach 3) before reaching the Poultney River.

Finel Hollow Brook is a mix of stream types, reaches 1 and 3 are stream type "B", semi-confined, 2 and 4 are stream type "C", unconfined, and the headwaters, reach 5, is stream type "A", confined. The parent soil materials are a mix of till and alluvial materials with some glacial lake materials found in reach 4. Due to the high variability of the terrain through which Finel Hollow Brook flows, the soils show a range of permeability and erosion rates, with reaches 1, 3, and 5 showing potential for severe erosion. The soils along the entire length of the stream are types that indicate little flooding or inundation.

Historically, the land cover types in the Finel Hollow Brook watershed included crops and forested lands. Currently the cover types are predominantly forested with fields occuring in the valleys. The riparian buffers are largely intact and greater than 100 feet wide, though along reach 2 buffer widths of less than 25 feet dominate.

Reach 2 has experienced significant amounts of straightening, some areas with berms to prevent future migration of the channel. In these straightened areas, stream slope is increased (same elevation change over less distance) giving the stream more power to pick up and transport sediment. As a result, excess sediment is later deposited in downstream pools, leading to a loss of instream habitat (Godfrey, 2006). In many areas along Finel Hollow Brook, roads encroach the floodplain and road runoff can increase the sediment load. Reach 2 is noted for having six crossing structures and reaches 1-4 had significant encroachment by roads.

The relatively high impact scores for Finel Hollow Brook reaches 2 and 4 reflect historic straightening, noticeable deposition of sediment in the pools, lack of adequate buffer width in reach 2, encroachment by roads, and the overall loss of natural meander geometry. Finel Hollow Brook is not listed as highly sensitive to changes on the landscape.

Table 8: Impact scores and adjustment processes for Finel Hollow Brook

Reach ID	Stream Type	Total Impact	Predicted Adjustment Scores				Reach Condition		Reach Sensitivity
			Degrad.	Aggrad.	Widen.	Planf.	Project	Statewide	
M11-S1.01	B	8	3	2	0	1	Reference	Reference	Moderate
M11-S1.02	C	12	5	7	5	7	Fair	Good	High
M11-S1.03	B	7	5	5	3	1	Good	Reference	Very Low
M11-S1.04	C	12	4	4	0	2	Good	Reference	Moderate
M11-S1.05	A	1	3	0	0	0	Reference	Reference	

Finel Hollow Brook has undergone a phase 2 assessment, completed by contractor Lisa Godfrey and funded by the Rutland Regional Planning Commission. The assessment report dated August 20, 2006, documents geomorphic and habitat condition as well as a list of potential implementation projects. **Potential projects** include buffer augmentation and the removal of berms and riprap to allow the channel to regain sinuosity and its connection with the floodplain. More detail on these projects can be found on pages 20 and 21 of the phase 2 report.

HAMPSHIRE HOLLOW BROOK AND CLARK HOLLOW BROOK

Hampshire Hollow and Clark Hollow Brooks are located entirely within the Taconic Mountains in the Poultney Township. They are a mix of confined, "C", and semi-confined, "B", stream types. Though the two streams are very close in proximity, they appear to have very different characteristics. Hampshire Hollow Brook (pictured at left and on the next page) flows through silty areas with wetland vegetation, while Clark Hollow Brook (grade control pictured below) flows through cobbled areas with mixed deciduous and coniferous forest.

The soils are a mix of ice-contact, till and alluvial origins, with ice contact dominant in Clark Hollow Brook and Hampshire Hollow reach 1 (downstream of the Clark Hollow confluence). Soils in the Clark Hollow watershed are permeable with little sign of frequent flooding. The soils in the Hampshire Hollow watershed are less permeable with more signs of frequent inundation (specifically along reach 3). Erosion potential ranged from slight in reaches 1 and 3 to potentially very severe in Clark Hollow Brook and reaches 2 and 4 of Hampshire Hollow Brook.

The historic land use for both brooks was predominantly crop lands. Forest landcover currently dominates throughout the subwatershed, with fields as the subdominant land use. The riparian areas are mostly forested, though the dominant buffer width in Hampshire Hollow Brook reaches 1, 2 and 3 is less than 25 feet. Buffers are generally greater than 100 feet wide along Clark Hollow Brook.

The entire length of Hampshire Hollow Brook has been affected by historic straightening, with reach 3 entirely straightened. As a result several reaches showed poor meander geometry. Roads encroach along the length of Clark Hollow Brook and reach 4 of Hampshire Hollow Brook. Development is also a potential stressor along most of Hampshire Hollow Brook and some of Clark Hollow Brook.

The SGAT-generated, predicted adjustment scores indicate that planform adjustment may be a concern in reaches 1 and 4. Degradation scores are slightly higher than aggradation or widening scores throughout the study area. .

The reach conditions were variable, ranging from "poor" to "good" compared to other streams within the project and "fair" to "reference" when compared to other similar creeks across the state.

Table 9: Impact scores and predicted adjustment processes for Hampshire Hollow and Clark Hollow Brooks

Reach ID	Stream Type	Total Impact	Predicted Adjustment Scores				Reach Condition		Reach Sensitivity
			Degrad.	Aggrad.	Widen.	Planf.	Project	Statewide	
M12-S1.01	C	15	7	6	5	9	Fair	Good	High
M12-S1.01 -S1.01	B	11	6	5	3	5	Fair	Good	Moderate
M12-S1.02	B	5	4	3	0	2	Good	Reference	
M12-S1.03	C	11	4	4	4	4	Good	Good	
M12-S1.04	B	12	11	7	5	9	Poor	Fair	

Potential projects include increasing the buffer width along much of Hampshire Hollow Brook and allowing the brook to meander in the straightened areas. Pending further assessment, Better Backroads projects to decrease the amount of road sediment from entering reach 4 could also be explored.

The picture to the left depicts a sandy stretch of stream in reach 4 that exhibits some wetland characteristics. The predominance of honeysuckle in the picture may indicate past clearing in this area. The debris in the lower-right corner is the edge of the road, which looks to have had recent work and may have been widened in this section.

The photo at right shows the straightened section of reach 3. In addition to the straightened channel visible in the aerial photo, there are tributaries feeding into this reach that have been straightened as well.

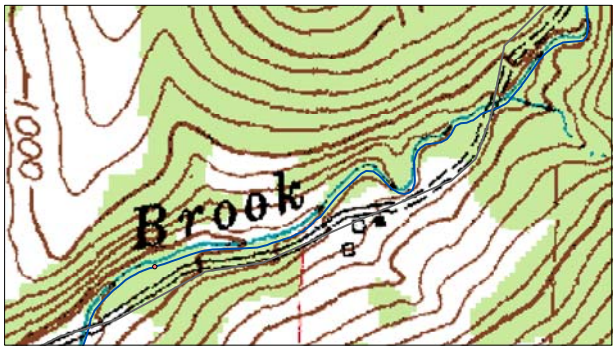
LAVERY BROOK

Lavery is Brook located entirely within the Taconic Mountains in the Poultney Township. It is a mix of unconfined, "C", semi-confined, "B", and confined, "A", stream types. Lavery Brook is located in a steep, narrow valley setting.

The soil parent materials are a mix of glacial till, found extensively in reach 1, and soils of alluvial origins in reaches 2-4. Some ice contact deposits are found in the downstream reaches 1 and 2. Soils in the Lavery Brook watershed are fairly impermeable with little sign of frequent flooding, except in reach 1. Potential for erosion is moderate in reach 1, but very severe throughout the rest of the watershed.

The historic land covers within the subwatershed were predominantly crops and forested lands. Forest land cover currently dominates throughout the subwatershed, with fields present at a lower rate. The riparian areas are mostly forested and are generally greater than 100 feet wide.

Much of the length of Lavery Brook is encroached by Morse Hollow Road (as seen in the graphic to the right). Development is also a potential stressor along most of the brook. During the windshield survey, high levels of sediment transport were noted in this brook. The photo above shows its confluence with the Poultney River. The waters flowing in from Lavery Brook (on the left) contain noticeably more sediment than the Poultney mainstem.



The SGAT-generated predicted adjustment scores indicate that degradation, aggradation and planform adjustment may be a concern in reach 1. Degradation and aggradation both appear as predicted adjustment processes in reaches 2 and 3. Widening appears to be less of a threat.

The reach conditions were "fair" compared to other streams within the project and "good" when compared to other similar creeks across the state. Reach 4, which is a confined mountain stream, appears to be in reference condition.

Table 10: Impact scores and predicted adjustment processes for Lavery Brook

Reach ID	Stream Type	Total Impact	Predicted Adjustment Scores				Reach Condition		Reach Sensitivity
			Degrad.	Aggrad.	Widen.	Planf.	Project	Statewide	
M13-S1.01	C	13	9	6	3	8	Fair	Good	High
M13-S1.02	B	10	5	5	3	4	Fair	Good	Moderate
M13-S1.03	A	9	5	5	3	4	Fair	Good	High
M13-S1.04	A	1	2	1	0	0	Reference	Reference	

Potential projects include completing a phase 2 assessment on Lavery Brook to determine the sources of sediment seen flowing to the Poultney River.

The picture below depicts a mass failure in the background, which is likely one contributing factor to the high sediment levels in the water.

VAIL BROOK

Vail Brook is located entirely within the Taconic Mountains in the Middletown Springs Township. It is largely a semi-confined, "B", stream type, with some areas of unconfined "C" stream type where the valley slopes allow. Vail Brook is located in a moderately sloping valley setting.

The soil parent materials are largely till with some inclusion of alluvium. Soils in the Vail Brook watershed are fairly permeable with little sign of frequent flooding (except locally). The soils are listed as severely erodable.

The historic land use within the subwatershed was predominantly crops and fields with some forested lands. Forest landcover currently dominates throughout the subwatershed, with fields present at a lower rate. The riparian areas are mostly forested with buffers in reach 1 largely greater than 100 feet wide, widths in reach 2 were 51-100 feet wide and widths in reach 3 less than 25 feet wide on the left bank.

Significant lengths of Vail Brook are encroached by Route 140 and Spruce Knob Roads. Development is also a potential stressor along reach 1. Reaches 1 and 3 appear to have undergone historic straightening. Deposition and meander migration were not noted during the windshield survey.

The SGAT-generated predicted adjustment scores indicate that degradation, aggradation, and planform adjustment may be a concern in reaches 1 and 3. The reaches show only moderate sensitivity to changes on the landscape.

The reach conditions were variable, ranging from "poor" to "reference" within the project and "fair" to "reference" when compared to other similar creeks across the state.

Table 11: Impact scores and predicted adjustment processes for Vail Brook

Reach ID	Stream Type	Total Impact	Predicted Adjustment Scores				Reach Condition		Reach Sensitivity
			Degrad.	Aggrad.	Widen.	Planf.	Project	Statewide	
M14-S1.01	B	13	9	9	5	6	Poor	Fair	Moderate
M14-S1.02	B	4	2	3	0	0	Reference	Reference	Moderate
M14-S1.03	B	15	7	6	3	6	Fair	Good	Moderate

Potential projects include completing a phase 2 assessment on Vail Brook. Also recommended are continuing or completing livestock exclusion and increasing the buffer width in the pastures and hayfields located on reaches 1 and 3.

NORTH BROOK

North Brook is located entirely within the Taconic Mountains in the Middletown Springs Township. It is largely a semi-confined, "B", stream type, with numerous areas having tall, steep valley walls continuous with the streambank. North Brook is located in a relatively steep mountain valley setting.

The soils are largely derived from till and ice contact parent materials. They are moderately permeable with little sign of frequent flooding. The soils are listed as very severely erodable.

The historic land uses within the subwatershed were predominantly crops and fields with some forested lands. Forest landcover currently dominates throughout the subwatershed, with fields present at a lower rate. The riparian areas are mostly forested with buffers along the brook largely greater than 100 feet wide. Though significant portion along reach 1 was less than 25 feet wide on the right bank, and much of reach 3 (pictured above) has been recently disturbed (improper logging practices that included skidding logs down the creek contributed to degeneration of this reach).

Significant lengths of North Brook are encroached upon by North Road. Development is also a potential stressor along reach 1. Reaches 1 and 3 appear to have undergone historic straightening. Deposition and meander migration in these reaches were noted during the windshield survey. In addition, at least one mass failure is occurring on reach 3.

The impact scores were relatively high for reaches 1 and 3. The adjustment processes predicted for these reaches include degradation and aggradation. In addition, reach 1 may be experiencing some planform adjustment. The reach condition was estimated as "fair" to "good" in these reaches. North Brook is only moderately sensitive to changes that occur on the landscape.

Table 12: Impact scores and predicted adjustment processes for North Brook.

Reach ID	Stream Type	Total Impact	Predicted Adjustment Scores				Reach Condition		Reach Sensitivity
			Degrad.	Aggrad.	Widen.	Planf.	Project	Statewide	
M15-S1.01	A	15	9	6	3	8	Fair	Good	Moderate
M15-S1.02	B	1	2	1	0	0	Reference	Reference	Moderate
M15-S1.03	B	12	7	6	3	6	Fair	Good	Moderate
M15-S1.04	B	4	3	3	0	0	Good	Reference	

Potential projects include additional assessment on reaches 1 and 3. Riparian plantings and invasive species removal are currently underway on reach 3. Additionally, the use of revetments at the base of the mass failures on reach 3 may be evaluated.

TRAIN BROOK

Train Brook is located entirely within the Taconic Mountains in the Middletown Springs Township. It is largely a confined, "A", stream type. Train Brook is located in a very steep mountainous valley setting.

The soils are largely till and ice contact. They are very permeable with no sign of frequent flooding. The soils are listed as very severely erodable.

The historic land uses within the subwatershed was predominantly fields and forested lands. Forest landcover currently dominates throughout the subwatershed. There are some fields and residential development present but a very low rate. The riparian areas are mostly forested with buffers in each reach greater than 100 feet wide, except as noted below.

No channel modifications or floodplain encroachments were noted during the windshield survey. Route 140 crosses Train Brook at the downstream end of Reach 1. The brook then passes through a cow pasture for several hundred feet before its confluence with the Poultney River. There are no vegetative buffers in the pasture. Deposition and meander migration were not noted during the windshield survey.

The impact scores and adjustment process scores were very low for Train Brook, which appears to be in nearly reference condition. Pictured above is a section constrained by the road. Most of Train Brook is not accessible from public access points.

Table 13: Impact scores and predicted adjustment processes for Train Brook

Reach ID	Stream Type	Total Impact	Predicted Adjustment Scores				Reach Condition		Reach Sensitivity
			Degrad.	Aggrad.	Widen.	Planf.	Project	Statewide	
M15-S2.01	A	3	3	1	0	0	Good	Reference	High
M15-S2.02	A	1	2	1	0	0	Reference	Reference	
M15-S2.03	A	1	2	1	0	0	Reference	Reference	

Potential projects for Train Brook include livestock exclusion and buffer planting in the cattle pasture at the confluence with the Poultney River. Building setback requirements might also help to protect this nearly pristine stream.

SOUTH BROOK

South Brook is located entirely within the Taconic Mountains in the Middletown Springs Township. It is largely an unconfined, "C" or "E", stream type. South Brook is located in a broad, gently sloping valley setting. South Brook passes through several wetlands and beaver ponds. An old dam, once associated with a factory acts as an impoundment in reach 1.

The soils are largely ice contact and alluvial. They are fairly permeable with little sign of frequent flooding. The soils are listed as severely erodable in reach 1, but only moderate to slightly erodable throughout the rest of the stream length.

The historic land uses within the subwatershed was predominantly crops and fields with some forested lands. Forest landcover currently dominates throughout the subwatershed, with fields present at a lower rate. The riparian areas are mostly forested with buffers in reach 1 and 5 less than 25 feet wide and a significant portion on reach 3 less than 50 feet wide.

Significant lengths reach 5 is encroached by Route 133. Development is also a potential stressor along reach 1. Nearly the entire length appears to be affected by historic straightening. Deposition and meander migration were not noted during the windshield survey, however the meander geometry is poorly developed in several reaches.

Impact scores are relatively high for reaches 1, 2 and 5. These reaches have the most development and agricultural landuse. The predicted adjustment processes for South Brook include degradation, aggradation and planform adjustment. Reaches 1 and 5 are predicted to have the most potential for planform adjustment, though planform adjustment scores were high in all reaches except number 4.

Table 14: Impact scores and predicted adjustment processes for South Brook.

Reach ID	Stream Type	Total Impact	Predicted Adjustment Scores				Reach Condition		Reach Sensitivity
			Degrad.	Aggrad.	Widen.	Planf.	Project	Statewide	
T3.01	C	16	7	7	5	11	Poor	Fair	High
T3.02	E	12	5	5	3	6	Fair	Good	High
T3.03	C	8	5	5	3	6	Fair	Good	High
T3.04	E	2	3	1	0	1	Reference	Reference	
T3.05	C	15	9	7	5	9	Poor	Fair	High

Potential projects include increasing the buffer width and conserving wetlands in reaches 2-5. Farther studies may determine the feasibility of allowing the brook to return to its natural meander geometry in reach 1.

COY BROOK

Coy Brook originates in Wells Township, but flows through and is located almost entirely within Middletown Springs. It flows down a steep valley in the Taconic range and is largely a semi-confined, "B", stream type.

The soils are largely derived from glacial till. They are characterized by a mix of permeability rates and are listed as severely erodable. They are not associated with frequent flooding.

The historic land uses within the subwatershed was predominantly crops and fields with some forested lands. Forest landcover currently dominates throughout the subwatershed, with fields present as a subdominant landuse. The riparian buffers are greater than 100 feet, except in reach 1, which has significant areas with buffers that are less than 25 feet wide.

Significant lengths of reach 4 are encroached by Coy Hill and Mountain Road. Reach 1 appears affected by historic straightening. Deposition and meander migration were not noted during the windshield survey, though reach 1 was not accessible (reach 4 is pictured above).

Impact scores are highest in reaches 1 and 4. The predicted adjustment processes show aggradation and planform adjustment processes as potentially occurring in reach 1. The other reaches predict degradation as the primary adjustment.

Table 15: Impact and predicted adjustment scores for Coy Brook

Reach ID	Stream Type	Total Impact	Predicted Adjustment Scores				Reach Condition		Reach Sensitivity
			Degrad.	Aggrad.	Widen.	Planf.	Project	Statewide	
T3.01-S1.01	B	8	5	7	5	9	Fair	Good	
T3.01-S1.02	A	1	2	1	0	0	Reference	Reference	
T3.01-S1.03	Ecxl								
T3.01-S1.04	B	9	6	5	3	5	Fair	Good	Moderate
T3.01-S1.05	A	4	3	2	0	1	Reference	Reference	

Potential projects include increasing the buffer width and potentially allowing for more natural meander geometry in reach 1. Additionally, Better Backroad projects to alleviate sediment draining to reach 4 may be explored.

Additional Studies

The PMNRCD is conducting ongoing water quality monitoring, geomorphic assessments and corridor planning within the watershed. Additionally, the Vermont DEC River Corridors Section is collecting data on stream geomorphology and potential erosion hazards. The Rutland Regional Planning Commission continues to work with towns to establish zoning to prevent future land use conflicts along Rutland's streams and rivers. Information about any studies conducted by these groups is available upon request.

Appendices

Appendix A- Phase 1 Data Reports by Reach
Appendix B- Quality Assurance (QA) Worksheet

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Appendix A

POULTNEY TRIBUTARIES PHASE 1 DATA REPORTS BY REACH

Appendix B

QUALITY ASSURANCE WORKSHEET