LaPlatte River Phase 2 Stream Geomorphic Assessment: Hinesburg Reaches

Prepared by the LaPlatte Watershed Partnership
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The LWP would also like to thank the volunteers who donated time to help with fieldwork and learn more about geomorphology. Special thanks to Elizabeth Ross, Mike Barsotti, Jason Gagne, Tony Higgins, Ted Godfrey, and James Donnegan for donating time to help with the assessment. We would also like to thank the many other folks who expressed interest in our watershed and project but who regrettably could not make it out to the field this year.

The LWP is grateful to the many landowners who granted permission to access the stream through their property and who shared their concerns and observations about the stream.

The LWP would also like to thank Shayne Jaquith and Mike Kline at the VT DEC for their time and assistance with the assessment.

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Executive Summary

Phase 1 and Phase 2 Stream Geomorphic Assessments (SGA) were completed for portions of the LaPlatte River and major tributaries. Phase 1 SGA were updated and the SGAT portion revised to include 2 additional reaches not previously assessed in the previous Phase 1 study (2004). The Phase 2 portion of this study included SGA of 7 reaches. All reaches in Hinesburg with Phase 2 completed are presented in this report, some having been assessed in a previous study (2004).

Methods for the assessments strictly followed the SGA protocols developed by the VT ANR DEC River Management Program (RMP). Please refer to the protocols for more information at: http://www.anr.state.vt.us/dec/waterq/rivers/htm/rv_geoassesspro.htm.

Phase 1 SGA indicated high impact ratings for much of the upper watershed reaches in Hinesburg. Historical channel straightening and mill activity, loss of riparian vegetation, channel constrictions and channel management through the village all contributed to stream instability. Some reaches were held relatively stably by resistant clay soils. Where more gravels were present and in hill reaches, adjustments appeared more intense.

Channel alteration and channel constrictions were major factors affecting geomorphic condition and function in study reaches. Geomorphic condition appeared “good” in the un-straightened lower valley reaches (M12, M13, M14), upper Patrick Brook (T4.06) and the confined ledge segment of Beecher Hill Brook (T5.01C), as there were few unnatural obstructions and little channel management. These reaches appeared “in regime” for their stream types, that is, they do not appear to be undergoing adjustment due to disturbance. However, a lack of riparian vegetation and buffer to provide channel roughness and organic debris kept RGA conditions from “reference” in the valley reaches. Erosion and aggradation lowered the RGA score of reach T4.06.

RGA condition also appeared “good” in some straightened reaches of the valley (T3.01, T3.02, M15S2.01, T5.01A). In these reaches, channel alteration in the form of straightening had occurred, however resistant boundary materials (clay soils) have limited channel adjustment, keeping the reaches fairly stable, although not with their reference form. So while these reaches appear in “good” condition, the score reflects little channel adjustment (relative stability) in altered channels.

Straightened valley reaches and the majority of Patrick Brook reaches appeared in “fair” condition. Channel obstructions, constrictions, and straightening interfered with natural geomorphic functions. Straightening and lack of riparian vegetation increased channel slope and reduced roughness, leading to higher velocities. Channel obstructions and constrictions modified flow and sediment loads and less resistant boundary materials provide for channel adjustments. In these reaches, adjustments were aggradation, widening and planform.

Major channel alterations including straightening and berms (M17, T5.01D) and channel constrictions (M18B) resulted in “poor” condition ratings. These streams have experienced a departure from their reference stream type due to human influences.

Stream sensitivity ranged from high to extreme with only one segment having a moderate sensitivity. This implies that continued or increased adjustments are likely with ongoing channel or watershed disturbance. Even the lower reaches (M12, M13, M14), which were in “good” geomorphic condition, were highly sensitive. Therefore continued or increased stressors from upstream could push these lower reaches into adjustment or departure. These lower reaches were acting to moderate upstream effects of channel adjustment to downstream reaches and protecting their geomorphic functions is important. Addressing stressors such as stream alteration and channel constrictions could alleviate pressures and reduce potential for further departure or help streams achieve a dynamic equilibrium state.

Habitat value was reduced by channel alteration, fine sediment and lack of woody riparian buffer. Lack of substrate variety and unstable banks in some areas also contributed to low habitat scores.

Reaches in the Hinesburg Valley assessed in this project were undergoing channel adjustment related to historical land use and channel management practices. These reaches were highly to extremely sensitive to future disturbances. Proper planning now could reduce future disturbances in order to limit damage to land and infrastructure in future flood events.

Introduction

The LaPlatte Watershed Partnership's (LWP) mission is to learn and disseminate information about the LaPlatte River, its tributaries, and the watershed as a whole to the communities that encompass the watershed: Shelburne, Charlotte, Hinesburg, and parts of Williston, St. George, and Richmond. As part of an ongoing exploration of the LaPlatte River Watershed, the LWP has begun the Stream Geomorphic Assessment process as developed by the Vermont Department of Environmental Conservation (DEC), River Management Program (RMP).

Scope

This report details work from Phase 1 Stream Geomorphic Assessment (SGA) on Beecher Hill Brook and the historical Patrick Brook to be added to a previous Phase 1 SGA. This report also details work from Phase 2 Stream Geomorphic Assessment (SGA) of the upper LaPlatte River watershed in Hinesburg and its tributaries Patrick Brook, Beecher Hill Brook, and an unnamed tributary. The Phase 2 SGA was completed in 2004 and 2005 through a Vermont Watershed Grant and a Clean & Clear Grant. The Phase 2 study utilized data collected from a Phase 1 study, which delineated the 53 square mile watershed, identified 52 distinct reaches, and collected remote sensing data such as slopes, stream type, land use, riparian buffers, soils, and channel modifications.

Included in this project was a Phase 1 SGA on 2 reaches, M15S2.01 and T5.01, to be added to the previous Phase 1 SGA. Phase 1 data was updated by the DEC RMP and non-SGAT data for the 2 new reaches was compiled as part of the 2004 Clean & Clear grant.

Through this stream assessment, the LWP has increased its information base of channel conditions, adjustment, and evolution in the upper watershed, which can now be used to plan and complete other projects in the basin and to guide town planning and zoning in and near the river and riparian areas. Information from this assessment can be used to identify high risk areas and areas in need of restoration to help reduce sediment and nutrient loading of the LaPlatte. This information base can also be used as an educational tool to help improve land use practices in the watershed and limit losses of infrastructure, houses, agricultural land and habitat, and reduce sedimentation and nutrient loading of the LaPlatte River and Shelburne Bay.

The LWP also educated community members on stream geomorphic processes through meetings, press releases and involvement in fieldwork. A copy of the data and report will be provided to the Town of Hinesburg and the LWP will continue to work with towns and landowners to use the information from this study in planning and in development review to protect the resources of the LaPlatte through development of a Stream Corridor Plan (SCP). Hinesburg will be making substantial changes to zoning and subdivision regulations and it is LWP's hope that this information will help guide that process for riparian areas and help protect natural, cultural, and recreational values.

Data from the assessment is provided to the VT DEC River Management Program to add to their Data Management System (DMS) of Vermont watersheds and to aid in meeting the requirements to address water quality problems, such as agricultural and urban sedimentation and pollution, stream bank erosion, and E. coli, in the LaPlatte River watershed.

Background

Setting

The LaPlatte River Watershed (Figure 1) encompasses 53 square miles, in the towns of Shelburne, Charlotte, and Hinesburg, with small sections in Williston, Richmond, and St. George. The LaPlatte is the largest watershed feeding Shelburne Bay, a drinking water source for much of Chittenden County, therefore sediment and nutrient loading through erosion are of major concern. Much of the LaPlatte River and its tributaries have been managed for mill power and agriculture. These past practices and now incremental development resulted in channel degradation and adjustment and extreme loss of instream and riparian habitat. Given the extensive channel management history, aging flow control dams and diversions, and changing runoff characteristics related to increased development in the watershed, there is a high likelihood of continued and increased channel adjustment. The reduction in use of land for agriculture has lead to development of these riparian areas within the watershed. Future channel adjustments combined with increased development in the watershed can lead to increased sediment and nutrient loads in the LaPlatte and therefore in Shelburne Bay and Lake Champlain.

The study area for the Phase 2 assessment included the valley reaches of the LaPlatte mainstem in the town of Hinesburg, the reaches of Patrick Brook below Lake Iroquois (except the reach encompassing Lower Pond, T4.5), Beecher Hill Brook, and an unnamed tributary.

Regional Geological Setting

The LaPlatte watershed from the headwaters of the mainstem in Hinesburg and Williston to the mouth a t Shelburne Bay is contained within the geologic province of the Champlain Valley. In recent geologic time (from 20,000 to 13,000 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. As the global climate warmed and the glaciers receded, a large fresh water lake inundated the Champlain Valley. At it highest stage, Lake Vermont's shoreline was located at the foot of the Green Mountains. As Lake Vermont waters receded in stages from about 12,800 to 10,200 years before present, marine waters inundated the valley from the St Lawrence Seaway. These Champlain Sea waters receded from the region by 10,000 years before the present as the land rise began to outpace the rate of sea level rise. River systems then went to work moving sediments left in the wake of the glaciers. "The LaPlatte River is distinct from these other rivers in that it follows the course of a deep, pre-glacial valley that is now filled with glacial, glacial-fluvial and/or lacustrine sediments. In the Hinesburg and Shelburne sections of the valley the fill is gravel, probably outwash, but in between lake silts and clays fill the valley."[1]

[1] Stewart, David P., 1973 Geology For Environmental Planning in the Burlington-Middlebury Region, Vermont

Hinesburg Valley Reaches

The valley section of the LaPlatte River mainstem, from reach M12 to M18 drains 27 square miles and includes the unnamed tributary (T3) and the lower reaches of Patrick Brook and Beecher Hill Brook. The unnamed tributary watershed is 2 square miles and enters the LaPlatte mainstem at reach M14. The LaPlatte mainstem and tributaries through these reaches are low gradient, unconfined streams, except for M18 with steeper slopes and forested riparian areas used as pasture. Typical land use is agriculture with dense development of the Hinesburg Village and increasing development both in and out of the village.

Soils of the Hinesburg valley reaches were alluvial deposits of a sand, clay and silt mix. Some clay was present along lower banks, which added bank stability. Bank vegetation was typically poor, being mainly grasses having little root structure to stabilize banks and no ability to shade the stream. Sixteen tributaries, including Patrick Brook, Beecher Hill Brook, and the unnamed tributary enter the mainstem along these reaches. Adjacent wetlands had typically been converted to agricultural land through ditching and dredging of side channels. On Patrick Brook through the village, floodplain encroachment, or elimination of floodplain through berming, significantly reduced stream function and adjacent wetlands.

Hill Reaches

The Patrick Brook watershed drains 7 square miles and is interrupted by Lake Iroquois and Lower Pond as it travels from the hills above Hinesburg Village, through the village to join the LaPlatte mainstem at reach M15. The Beecher Hill Brook watershed is 3 square miles and enters the LaPlatte mainstem at reach M16. Hill reaches were typically high gradient, confined reaches while the lower reaches (T4.01 and T4.02) were low gradient, unconfined reaches. Patrick Brook reaches were sources and transporters of sediment. A few low gradient meadow areas provided places for sediment attenuation. Patrick Brook had numerous grade controls in the form of bedrock ledges and falls and dams. Soils in the hill reaches were dense till and glacial outwash. Adjacent land use was forest, residential, and one industry, with evidence of old mill activity.

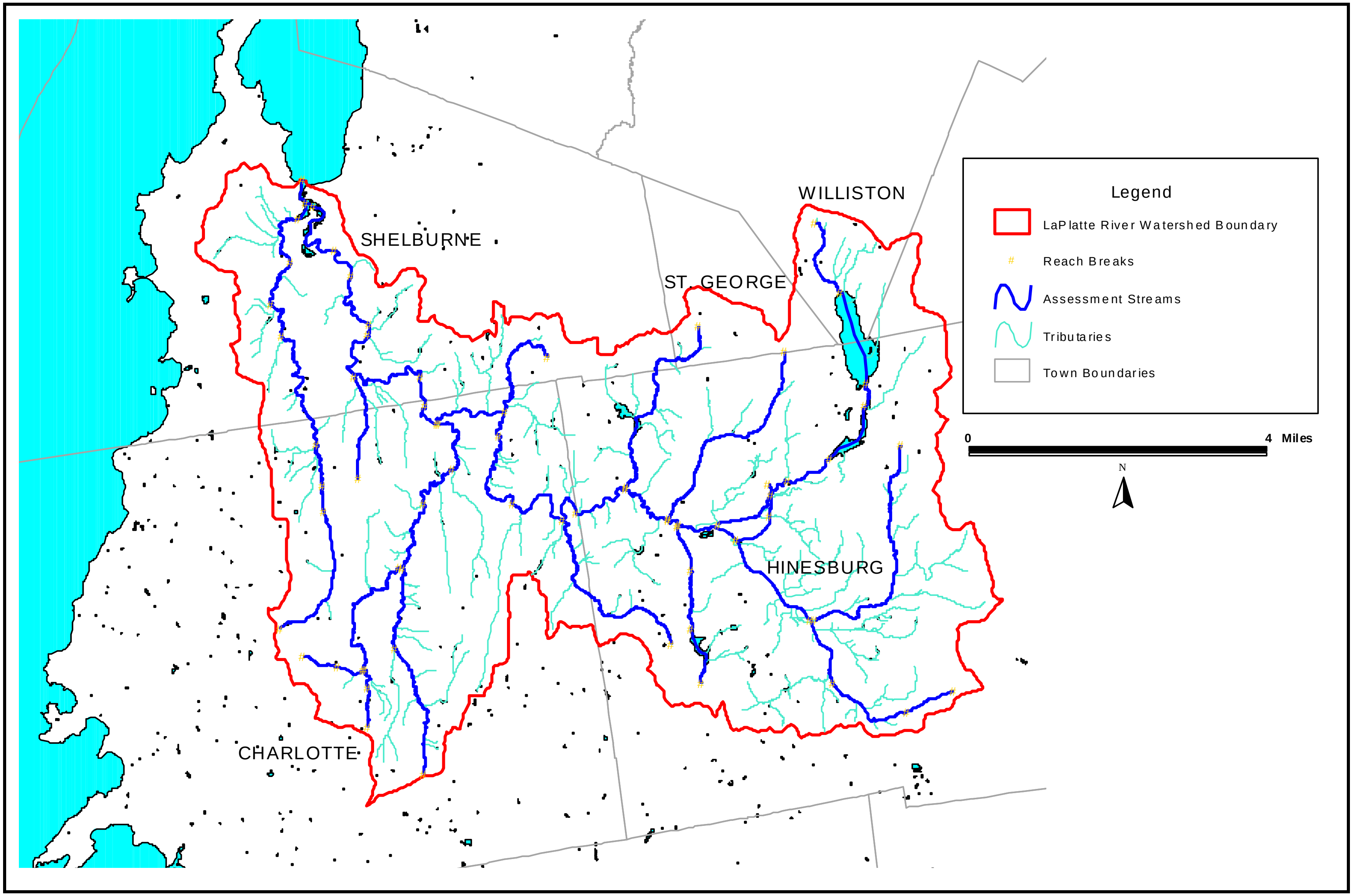

Figure 1. Map of the LaPlatte River Watershed

Phase 1 Assessment Methods

The Phase 1 process covered the LaPlatte mainstem from the mouth at Shelburne Bay to the headwaters in Hinesburg East of Rt. 116 and north of Hines Rd. This process delineated 52 reaches for assessment. The total watershed is 53 square miles and 48.26 total river miles were covered. The major tributaries included were McCabe's Brook, Mud Hollow Brook, Bingham Brook, Patrick Brook, Beecher Hill Brook, and an unnamed tributary in Hinesburg west of Rt. 116 and east of Baldwin Rd.

In this study, Phase 1 data were updated to reflect changes in the protocols since the initial study. Additionally, Phase 1 data for 2 reaches, the historical Patrick Brook section in the village (M15S2.01) and Beecher Hill Brook (T5.01), were collected in this study and added to the previous Phase 1 SGA.

The Phase 1 Geomorphic Assessment of the LaPlatte watershed followed the protocols of the April 2003 and April 2005 Vermont Stream Geomorphic Assessment Phase 1 Handbook published by the Vermont Agency of Natural resource (VTANR). Reference is hereby made to this protocol for the specific scope of work. GIS overages for the sub watersheds and valley walls were developed with SGAT and data from the Vermont Center for Geographical Information (VCGI).

In Phase 1, the watershed was studied to determine reaches, based on various in valley confinement, slope and sinuosity, as identified through analysis of topographic maps. The Phase 1 process results in a standardized method for identification of reaches and location of land features relative to the river system. In addition, Phase 1 provides a frame of reference for future restoration, and conservation work and additional water-based studies. (e.g. habitat, and natural communities mapping, surficial geological mapping and water quality assessments).

The SGAT was used to generate data on channel elevation, valley length and slope, channel length and slope, sinuosity, watershed size, channel width, valley width, confinement, geologic material, soil characteristics, watershed land cover/land use and corridor land cover/land use. Reference stream types were then assigned to each reach and assessed for dominant and sub-dominant land cover and soil types.

Orthophotographs were used to identify existing riparian buffer widths, sediment storage types, bridges and culverts, and any channel modifications such as straightening. Historic information was collected from Vermont Department of Environmental Conservation (VTDEC) River Management engineers on bank revetments dredging, or gravel mining. Current and historic orthophotographs were used to assess changes in land use and channel planform. A windshield survey was conducted to verify channel characteristics and remote sensing data and to identify channel bed substrates, bank erosion sites, and debris or ice jam potential.

Following Phase 1 protocol all data was entered into the Data Management System (DMS) maintained by VTDEC. This information was used to assign stream Impact rating and a Stream Sensitivity rating to each reach. "Like Reaches" in the watershed were then evaluated based on valley and stream types, geomorphic condition, and stream impact rating.

The DMS did not allow for data entry of step 5.3 Bank Armoring, 5.4 Channel Straightening, or 6.1 Berms and Roads, for reaches M15S2.01 and T5.01. River Management has been contacted and is investigating.

Phase 1 Assessment Results: Historical Patrick Brook & Beecher Hill Brook

Database reports are compiled in Appendix A.

Summary of Reaches

M15S2.01 – Historical Patrick Brook

This reach is what remains of the historical Patrick Brook after its flow was diverted into the canal, resulting in a high impact rating. Current flow was from a small tributary and what overflows from the canal. This reach had been straightened, significantly reducing meander width and increasing slope, likely to increase tillable land. Riparian vegetation was reduced, although about 5 feet of buffer remain in most areas. A large beaver pond was present toward the upstream end and had more of a buffer. Adjacent land use was hay or fallow field, with a high impact rating. A large residential development was under construction to the south.

Predicted channel adjustment processes for this reach were aggradation and planform. The process of planform adjustment in reaction to channel straightening would be a source of sediment, however due to the reduction of flow, the stream had less power to erode its banks. If flow were restored however, this reach may produce more sediment as it adjusts and regains sinuosity. This reach would likely be an area for sediment and flow attenuation due to the shallow slopes and unconfined valley type, however channel alteration limits its ability to function in this manner. Reach condition was “fair” with “high” sensitivity.

T5.01 – Beecher Hill Brook

Included as one reach in Phase 1, segmenting is likely for Phase 2 due to varied valley types, slopes, boundary conditions and adjustments identified in the reach. Current adjustment processes identified appeared to be aggradation, degradation and widening. Reach condition was “fair” with “moderate” sensitivity.

The upper portion of this reach, upstream of North Road, was inaccessible by windshield survey except for a road crossing. The presence of a woody riparian buffer and a ledge grade control at the downstream end indicate adjustments in this area may be minor, although incremental development may be altering flow or sediment regimes.

A mid section of this reach, near the town highway garage appears to have been straightened and bermed at one time (date unavailable). This area was degraded and erosion was visible. One area of riprap was noted. This area appeared to be under adjustment with incision and widening apparent. Downstream was a bedrock-controlled area of ledges and falls with an old mill footing and dam.

The lowermost section of this reach flowed through the flat valley south of the Hinesburg village and joined the LaPlatte mainstem at M16. This lower area appeared straightened (pre 1940s) with very slight berms, likely from windrowing. Adjacent land uses were cornfield, pasture and hay with 2 houses. Very little woody riparian vegetation remained on the banks and in the corridor.

Three areas in this reach appeared to be potential sediment and flow attenuation areas. The first would be the lowermost portion in the flat, wide valley, however straightening and windrowing have limited the streams functions in this area. The second area was just upstream of the culvert crossing Beecher Hill Brook, where the stream exits bedrock confined valley and enters a flat area. Sediment has accumulated upstream of the culvert in this area, however that is likely related to poor culvert sizing. Sediment has also accumulated in the small valley upstream where the channel has floodplain access. The third area was downstream of the bridge at the town highway garage. Here, another small but relatively flat valley was present and could provide attenuation. Some floodplain filling was noted.

Phase 2 Assessment Methods

A Phase 2 Stream Geomorphic Assessment was completed on the LaPlatte mainstem in Hinesburg and its major tributaries Patrick Brook, Beecher Hill Brook, and an unnamed tributary. This project exclusively used the VT DEC Stream Geomorphic Assessment Protocols (the Protocols) (VTANR, April 2003 and April 2005) to perform the Phase 2 Assessment and utilized data and information collected in the Phase 1 Assessment.

The following tasks were completed in the Phase 2 Stream Geomorphic Assessments according to the Protocols:

- Contacted volunteers and coordinated fieldwork days for those interested;
- Obtained permission from landowners along study reaches before performing the assessment along their segment of river;
- Trained volunteers as necessary;
- Used the Phase 1 data, field checked reaches and types identified in Phase I and segmented or modify as necessary;
- Walked the length of each reach to map features and evaluate conditions;
- Photographed and mapped reaches and segments (GPS points collected on some reaches);
- Identified natural and artificial features of the channel and adjacent valley (watershed zone, channel constraints, floodplain terrace, valley slope, habitat barriers);
- Measured channel dimensions, bankfull and flood elevations and depths, width-to-depth ratio, entrenchment ratio, riffle-step distribution, substrate size and verified stream

typing;

- Evaluated stream banks, buffer strips, and riparian corridor;
- Documented flow modifiers such as impoundments, springs, wetlands, drainage ditches, constrictions, and condition of the upper watershed;
- Identified evidence of channel bed and planform changes;
- Conducted a Rapid Habitat Assessment (RHA) using the RHA field form developed by VT ANR;
- Conducted a Rapid Geomorphic Assessment (RGA) using the RGA field form developed by VT ANR;
- Entered all data into ANR Stream Geomorphic Assessment Data Management System.

Please refer to the Vermont DEC River Management Section website for more information about the protocols and methods at:
http://www.anr.state.vt.us/dec/waterq/rivers/htm/rv_geoassesspro.htm.

Rapid Geomorphic Assessment

The RGA is useful in evaluating current stream processes, departures from a reference condition, and stages of channel evolution for a given reach. Three separate RGA forms are used in the Phase 2 SGA, one for unconfined streams, one for confined streams, and one for naturally occurring Plane-Bed streams. Parameters evaluated in the RGA are summarized as follows:

- **Degree of channel degradation or incision** (sharp changes in slope, measured incision and entrenchment ratios, loss of riffle-pool characteristics, floodplain encroachment, historical channel or flow alterations).
- **Degree of channel aggradation** (filling of pools, loss of riffle-pool characteristics, mid-channel or diagonal bars, increases in fine sediments, high width-to-depth ratios, flow alterations, sediment deposition upstream of constrictions).
- **Degree of channel widening** (high width-to-depth ratios, scour on both banks at riffles, mid-channel or diagonal bars, historical channel or flow alterations).
- **Change in channel planform** (bank erosion on outside meander bends, flood chutes or channel avulsions, mid-channel or diagonal bars, additional deposition and scour features, floodplain encroachment, sediment deposition upstream of constrictions).

Please refer to the VT ANR Protocols for more on the RGA (VTANR, April 2005).

According to protocols, once a RGA is completed and a “condition” category selected, a stage of channel evolution is determined. One of two channel evolution models can be used; either the F-stage model or the D-stage model.

In the F-stage model, a channel loses floodplain access either by undergoing degradation or a floodplain build-up (Stage II), due to a disturbance. This degradation is typically followed by channel widening (Stage III), then aggradation and planform adjustments (Stage IV), before then regaining stability with regard to its water and sediment loads (Stage V).

In the D-stage model, aggradation, widening, and planform changes are the main adjustment processes, with degradation being limited, sometimes by resistant bed material or grade controls. The D-stage process can include moderate entrenchment and loss of bed features (Stage IIb), channel widening and/or planform changes (Stage IIc), bed aggradation, bar formation (Stage IId), and regaining a balance similar to reference condition (Stage III).

Please refer to the VT ANR Protocols Appendices for more information on channel evolution models (VTANR, April 2005).

Parameters for the RGA and RHA were scored and assigned to the correlating "condition" category describing departure from a reference condition and degree of adjustment (VTANR, April 2005) as follows:

- Reference – Reaches in dynamic equilibrium, having stream geomorphic processes and habitats found in mostly undisturbed streams.
- Good – Reaches having stream geomorphology or habitat that is slightly impacted by human or natural disturbance, showing signs of minor adjustment, but functioning for the most part.
- Fair – Reaches in moderate adjustment, having major changes in channel form, process or habitat.
- Poor – Reaches experiencing extreme adjustment or departure from their reference (expected) stream type or habitat condition.

In some cases, where a score lies at one end limit of a category, the condition category that best described the reach was selected.

A "Stream Sensitivity Rating" was then generated for each reach or segment according to stream type and geomorphic condition. The range of sensitivity ratings includes: Very Low, Low, Moderate, High, Very High, and Extreme. These indicate the sensitivity of a reach or segment to ongoing disturbance or stressors.

Rapid Habitat Assessment

The RHA is useful in determining the ability of a given reach to support aquatic biota, the extent to which a given reach is impaired, and potential factors affecting habitat. Two separate RHA forms are used in the Phase 2 SGA, one for low gradient streams and one for high gradient streams. Parameters evaluated in the RHA are summarized as follows:

- Presence of a variety of substrate types suitable for aquatic insect colonization and cover for fish, reptiles and amphibians;
- Degree to which gravel, coble and boulder particles are surrounded by fine sediments;
- Type of bed material in pools;
- Presence of a variety of water speeds and depths to include fast-shallow, fast-deep, slow-shallow, and slow-deep;
- Variety of pool sizes to include large-shallow, large-deep, small-shallow, small-deep;
- Increase in sediment deposition on the channel bed or bars;
- Degree to which the channel bottom is exposed, reference being minimal channel bed exposed;
- Extent of channel alteration including dredging, straightening, berms, or riprap;
- Frequency of riffles or steps along the channel length;
- Channel sinuosity or degree of channel meandering;
- Amount of bank erosion;

- Amount and types of bank vegetation;
- Width of naturally vegetated riparian buffer.

Please refer to the VT ANR Protocols for more on the RHA (VTANR, April 2005).

QAQC Summary

The VT ANR Protocols were followed exclusively in conducting the Phase 2 SGA. The project's consultant had completed the required Phase 2 training conducted by personnel from the Vermont DEC River Management Division. As part of the VT DEC Quality Control program for stream geomorphic assessments, a member of the VT DEC's River Management Division, Shayne Jaquith, observed assessment procedures in the field to assure the Protocols were followed appropriately. All data entered into the States DMS have been reviewed as part of the quality control program.

Phase 2 Assessment Results

Table 1 presents results for each reach assessed in the Phase 2 SGA. Included in the table are the reach number, habitat condition category from the RHA, geomorphic condition category from the RGA, stream sensitivity rating. Please refer to Appendix A for database reports and summaries of each reach according to parameters evaluated during the assessment. Reaches T4.01 and T4.02 were included in this assessment, although they are the diversion canal from Patrick Brook through town along Mechanicsville Road, which used to serve Saputo and now serves as back-up for the fire department. These are highly managed reaches and so unlikely to follow a process of evolution and regain dynamic equilibrium while managed.

Accompanying maps show the distribution of stream geomorphic condition (Figure 2), channel evolution stage (Figure 11), stream sensitivity to ongoing or future disturbance (Figure 12), and habitat condition (Figure 13) for study reaches and segments throughout the watershed.

Table 1 Summary of results of Phase 2 Stream Geomorphic Assessment

Reach Number	Existing Stream Type	RHA Condition	RGA Condition	Stream Sensitivity	Channel Evolution Stage	Stream Condition
M12	E5 D-R	Fair	Good	High	I	Stable
M13	E5 D-R	Fair	Good	High	I	Eroding Banks
M14	E5 D-R	Fair	Good	High	III F	Eroding Banks
M15A	E5 D-R	Fair	Fair	Very High	II F	Moderate Departure
M15B	C5c D-R	Poor	Fair	Very High	III F	Moderate Departure
M16	C5 D-R	Fair	Fair	Very High	III F	Moderate Departure
M17	B5c D-R *C to B	Fair	Poor	High	III F	Severe Departure
M18A	C4 R-P	Good	Fair	Very High	IIc D	Moderate Departure
M18B	C4 R-P	Fair	Poor	Very High	II F	Down-cutting
T3.01	E5 D-R	Fair	Good	High	III F	Eroding Banks
T3.02	C5 D-R	Fair	Good	High	IIc D	Eroding Banks
M15S2.01	E4 D-R	Fair	Good	High	III F	Eroding Banks

Reach Number	Existing Stream Type	RHA Condition	RGA Condition	Stream Sensitivity	Channel Evolution Stage	Stream Condition
T4.01 (Canal)	C5 PB	Poor	Fair	Very High	II F	Eroding Banks
T4.02 (Canal)	F4 PB *C to F	Fair	Poor	Extreme	III F	Severe Departure
T4.03	C4 R-P	Good	Fair	Very High	III F	Moderate Departure
T4.04	B4a S-P	Good	Fair	High	IIc D	Moderate Departure
T4.06	C4 R-P	Good	Good	High	III F	Eroding Banks
T5.01A	E5 D-R	Fair	Good	High	IIc D	Eroding Banks
T5.01B	E4 R-P	Fair	Fair	Very High	IIc D	Eroding Banks
T5.01C	B3 S-P	Good	Good	Moderate	I	Stable
T5.01D	F4 PB *B to F	Fair	Poor	Extreme	II F	Severe Departure

*Stream Type Departure

Rapid Geomorphic Condition

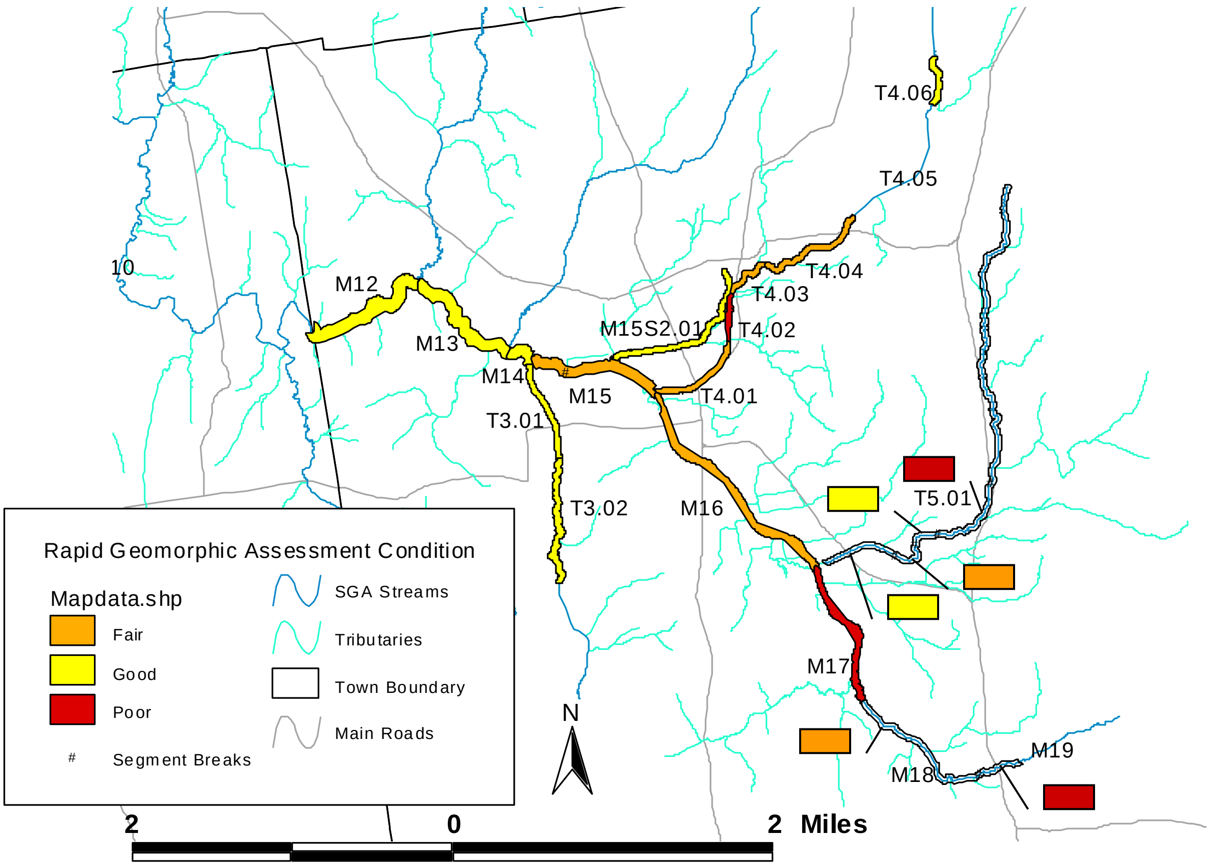

Figure 2. Rapid Geomorphic Assessment Condition category for study reaches.

Figure 2 shows RGA Condition categories for each of the study reaches and segments. Relatively little development has encroached into the stream corridor thus far in Hinesburg. Main factors affecting RGA condition were channel alteration and channel obstructions and constrictions, which are discussed in more detail below.

Geomorphic condition appeared “good” in the un-straightened lower valley reaches (M12, M13, M14), upper Patrick Brook (T4.06) and the confined ledge segment of Beecher Hill Brook (T5.01C), as there were few unnatural obstructions and little channel management. These reaches appeared “in regime” for their stream types, that is, they do not appear to be undergoing adjustment due to disturbance. However, a lack of riparian vegetation and buffer to provide channel roughness and organic debris kept RGA conditions from “reference” in the valley reaches. Erosion and aggradation lowered the RGA score of reach T4.06.

RGA condition also appeared “good” in some straightened reaches of the valley (T3.01, T3.02, M15S2.01, T5.01A). In these reaches, channel alteration in the form of straightening had occurred, however resistant boundary materials (clay soils) may have limited channel adjustment, keeping the reaches fairly stable, although not with their reference form. So while these reaches appear in "good" condition, the score reflects little channel adjustment (relative stability) in altered channels.

Straightened valley reaches and the majority of Patrick Brook reaches appeared in "fair" condition. Channel obstructions, constrictions, and straightening interfered with natural geomorphic functions. Straightening and lack of riparian vegetation increased channel slope and reduced roughness, leading to higher velocities. Channel obstructions and constrictions modified flow and sediment loads and less resistant boundary materials provide for channel adjustments. In these reaches, adjustments were aggradation, widening and planform.

Major channel alterations including straightening and berms (M17, T5.01D) and channel constrictions (M18B) resulted in "poor" condition ratings. These streams had experienced a departure from their reference stream type due to human influences.

Channel Alteration

Historical channel alteration appeared to have affected many of the reaches in Hinesburg. Straightening of streams in the valleys and ditching and draining wetlands allowed for increased tillable land for agriculture. Along with this came reduction or elimination of woody riparian vegetation (Figure 3). These activities reduced geomorphic and habitat conditions in many of the valley reaches, and in some cases have led to extreme adjustment or stream type departure (M17, T5.01D). Elsewhere in the valley (M12, M13, M14, and M15a) the channel does not appear to have been straightened, although riparian vegetation is still lacking.

Figure 3. Straightening and lack of woody riparian vegetation affected RGA and RHA condition in Hinesburg.

Eroding banks were common in the valley reaches, as the channel experienced adjustment to regain sinuosity. However, clay soils appeared to be slowing erosion, as little channel migration was observed since channel straightening occurred (est. 1930s).

Straightening combined with berming on M17 and T5.01D resulted in severe channel departure from reference. Reach M17 experienced a stream type departure (C to B) and currently appeared to be widening and aggrading, attempting to gain some floodplain and sinuosity in its incised and entrenched position (Figure 4).

Figure 4. Reach M17, entrenched and now widening and aggrading.

Segment T5.01D had been straightened, moved, and bermed historically, likely in conjunction with construction of North Road. Following the channel alteration, the stream had no access to floodplain and appears to have severely widened and incised. Continued incision and widening (channel enlargement) were evident in headcuts and scoured banks (Figure 5), leaving property at risk. This segment had ledge grade controls at both the upstream and downstream ends, helping confine these adjustments to this area.

Figure 5a. Signs of an old channel were evident to the left of the photo. The channel appeared to have been moved to its current location and held in place by a berm, seen in the center of the photo.

Figure 5b. Significant channel enlargement following straightening and berming.

Figure 5c. Channel enlargement leaving investments in danger.

Obstructions and Constrictions

Other factors affecting geomorphic and habitat condition in Hinesburg were structures obstructing or constricting of the channel. Historical structures included milldams and footings on the steeper reaches of Patrick Brook and Beecher Hill Brook. Many of these structures were in part still existing (Figure 6).

Figure 6. Mill footing on Beecher Hill Brook T5.01C (left) and mill dam on Patrick Brook T4.04 (right).

More recent channel constrictions included undersized bridges and culverts. These structures blocked the free passage of water, sediment and organic debris, and resulted in flooding of land, severe aggradation of the channel and floodplain, and severe degradation downstream. Two examples are the culvert on Beecher Hill Road in segment T5.01B (Figure 7) and the culvert crossing Route 116 in segment M18B (Figure 8).

Figure 7. Beecher Hill Brook (T5.01B) culvert. Note aggradation forming bars and splitting flow upstream. Some erosion was noted downstream, although the downstream end falls onto ledge and boulders.

Figure 8a. Culvert on segment M18B. The upstream end of the culvert was blocked by sediment and debris and was hardly visible (left). Extreme scour was apparent at the downstream end and beyond (right).

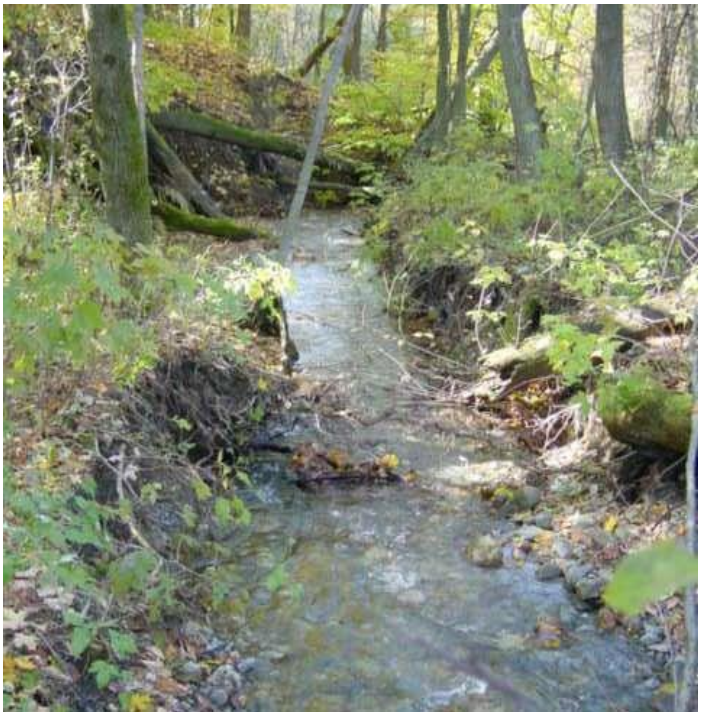

Figure 8b. Extreme effects of constricting the channel and blocking flow of sediment has led to property damage with aggradation upstream and erosion downstream.

Reaches M16 and M17 also had undersized bridges and culverts. These reaches passed through 3 culverts that were narrower than bankfull width, meaning that they would constrict the 1.5 to 2-year high flow. M16 passed through 2 bridges that were narrower than the floodprone width and therefore would constrict higher flood flows.

Reach T4.01 passed through one culvert and one bridge that would constrict the bankfull width, and one bridge that would constrict the floodprone width. One undersized culvert and 3 old mill abutments and dams would constrict the bankfull width of T4.03. Two culverts, several old mill abutments and bedrock outcrops, constricted the bankfull width of T4.04. One bridge, one culvert, and a bedrock outcrop constricted the bankfull width of T4.06 and another bridge constricted the floodprone width.

Other Influences

Runoff from roads and road washouts during storms also appeared to be a source of increased sediment in the streams (Figure 9). Driveways and roads had essentially dammed floodplains and channeled runoff directly to streams, which was especially evident in hill reaches. Exposed soil from incremental development in the watershed was another source of sediment to stream channels.

Figure 9. Sand and gravel from roads washing into the channel.

Some vital flow and sediment attenuation zones were being filled and bermed as on T5.01D (Figure 10) and M17.

Figure 10. Floodplain fill replaced after January 18, 2006 storm flows, reducing sediment and flow attenuation in this area, which was between 2 degrading areas.

Channel Evolution Stage

Figure 11 shows the stage of channel evolution for study reaches. Lower valley reaches (M12, M13) appeared to be “in regime” with only minor planform adjustments fitting for a low-gradient, meandering stream. Reach M13 also showed signs of minor aggradation, likely from upstream adjustment processes. The other area considered “in regime” was segment T5.01C, which was bedrock controlled with ledges and falls and so not as susceptible to watershed disturbance, although mill footings and dam remnants were present and confining the channel in these areas.

Valley reaches that had been straightened but not bermed and Patrick Brook reaches appeared to be in stage II of the F-stage channel evolution process, meaning experiencing aggradation, widening, and planform adjustments, with some incision but not enough to be entrenched. In the valley, resistant clay soils likely limited channel incision and slowed the rate of planform adjustment. On Patrick Brook, grade controls have likely limited bed degradation in reach T4.04. Given the adjustment processes of widening and planform, these were reaches where sediment was being produced in the channel’s effort to regain a dynamic equilibrium.

As discussed earlier, M18B and T5.01D appeared entrenched, indicating they were in stage II of the F-stage evolution process, where the channel had lost access to its floodplain. Segment T5.01D had experienced a stream type departure, while M18B had not yet reached that level of degradation. Both segments were sources of sediment due to erosion.

Reaches M14, M15, M16 and M17 had degraded and lost floodplain access (stage II of the F process), likely from straightening and berming activities. Now, they appeared to be in stage III of the F-stage process, widening and aggrading and attempting to regain some sinuosity (Figure 4).

So again, more extreme adjustments and production of sediment appeared to be higher in the watershed, with the clay soils of the valley providing some resistance to adjustment. The lower, un-straightened reaches acted as buffers to downstream.

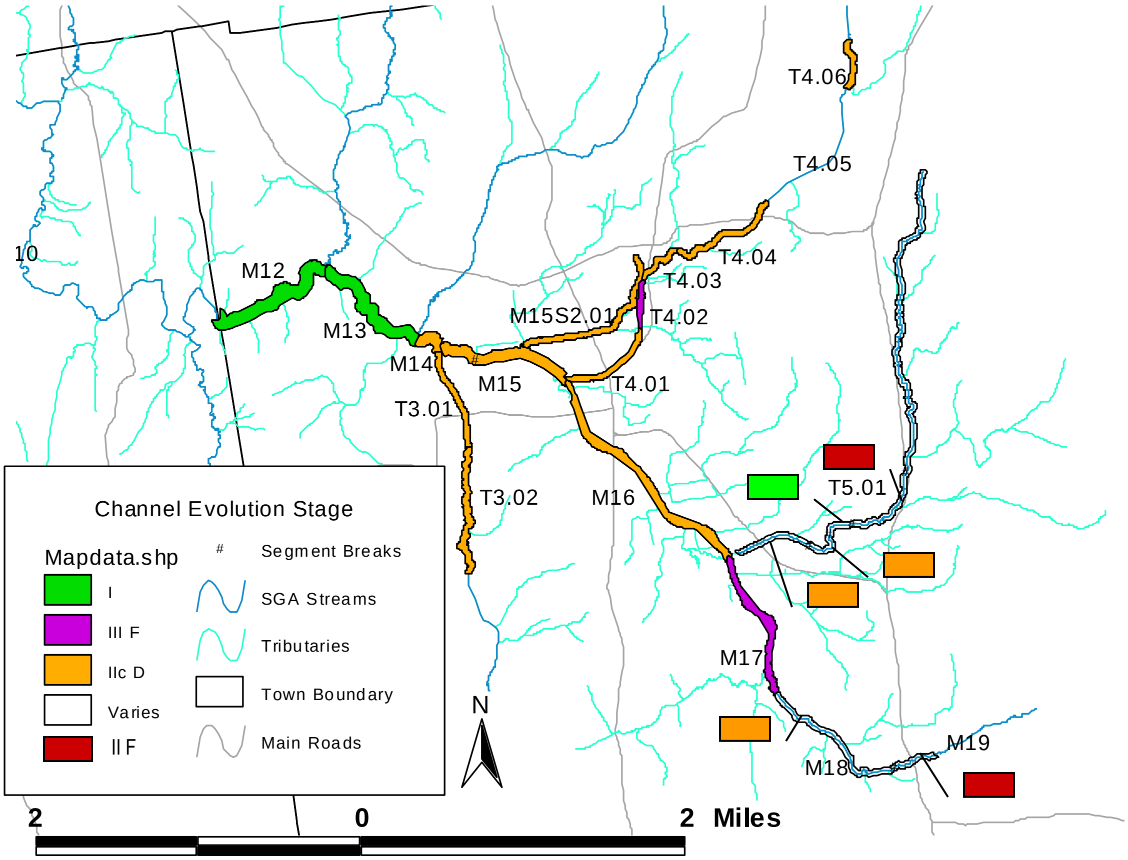

Figure 11. Channel Evolution Stage for study reaches.

Stream Sensitivity

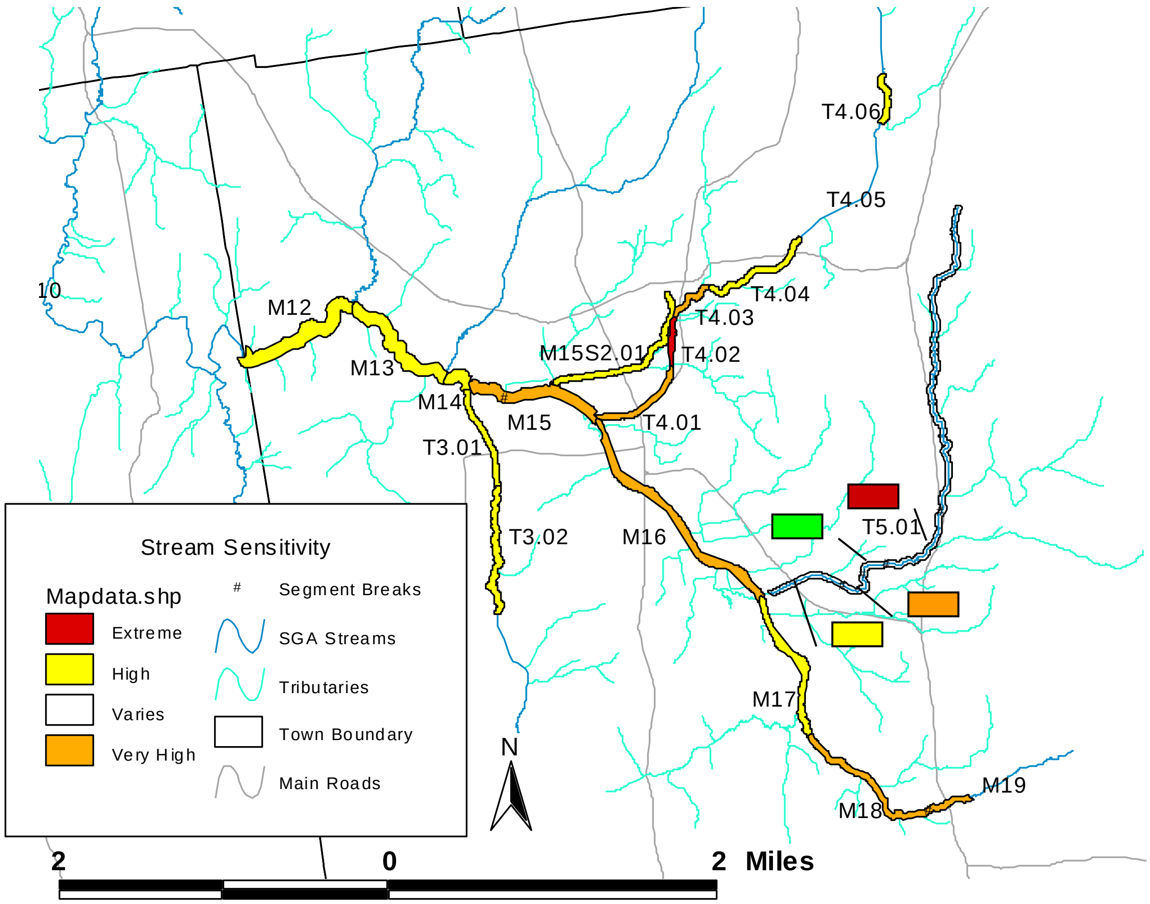

Figure 12. Stream Sensitivity Rating for study reaches. Note only segment T5.01C had "moderate" sensitivity.

Figure 12 shows stream sensitivity ratings for study reaches and segments. Reaches were highly to extremely sensitive to ongoing or future disturbance except for T5.01C, in "moderate" condition, which was bedrock controlled and "in regime."

Even the lower reaches (M12, M13, M14), which were in "good" geomorphic condition, were highly sensitive. Therefore continued or increased stressors from upstream could push these lower reaches into adjustment or departure. These lower reaches were acting to moderate upstream effects of channel adjustment to downstream reaches and protecting their geomorphic functions is important.

Addressing stressors such as stream alteration and channel constrictions could alleviate pressures and reduce potential for further departure or help streams achieve a dynamic equilibrium state.

Rapid Habitat Assessment

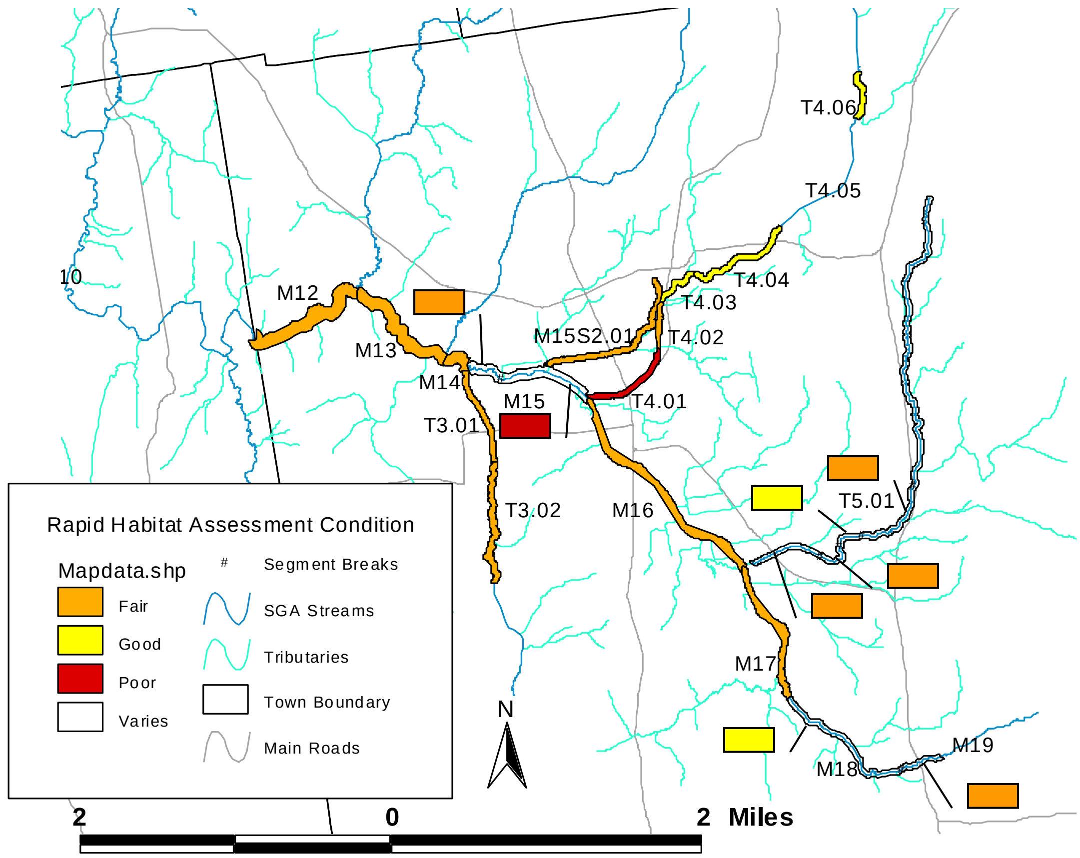

Figure 13. Rapid Habitat Assessment Condition Category for study reaches.

Figure 13 shows RHA condition categories for the study reaches. RHA conditions of the valley reaches were evaluated in “fair” condition except for segment M15B, which was in “poor” condition. Lack of diverse substrates for instream habitat, channel straightening, and lack of riparian buffer were the major factors contributing to these low scores. Segment M15B also suffered from exposed channel substrates, sediment deposition, and moderately unstable banks.

Habitat in reach T4.01 was in poor condition due to extensive channel management and lack of riparian buffer. Variety in channel substrates and pools was also lacking. T4.02 was in fair condition with some variety of substrates and pools, but limited riparian vegetation and extensive channel management. Habitat in upstream reaches (T4.03, T4.04, and T4.06) was in good condition, having riparian vegetation and less channel alteration.

Habitat conditions in Beecher Hill Brook and M18 were affected by channel degradation (T5.01D) and downstream sediment deposition.

Discussion

Planning for the Future

Reaches in the Hinesburg Valley assessed in this project were undergoing channel adjustment related to historical land use and channel management practices. These reaches were highly to extremely sensitive to future disturbances. Proper planning now could reduce future disturbances in order to limit damage to land and infrastructure in future flood events.

For example, if unchecked, development in the upper watershed, especially the riparian corridor could increase storm runoff and peak stream flows (Dunne and Leopold, 1978). This could result in further stream adjustments such as bank erosion, widening, and channel migration, all contributing to sediment and nutrient loading of the LaPlatte and eventually Shelburne Bay. In planning for developments, increases in percentage of impervious surfaces created by the developments should be considered as this can greatly affect runoff amounts and therefore erosion, sedimentation, and changes in channel dimensions (widening, incision, migration). Facilities to reduce increased runoff such as detention ponds should be recommended.

Lack of riparian buffer has resulted in reduced habitat value and less stable stream banks. Recognizing an appropriate buffer width and allowing woody vegetation to return could alleviate bank erosion and improve stream and riparian habitat.

Undersized bridges and culverts, and those poorly aligned with stream channels, have resulted in erosion, aggradation, outflanking, loss or damage of infrastructure and personal property, reduced wildlife passage, backup of flood waters, reduction of floodplain function, and debris jam catchers. As bridges and culverts require replacement, sizing new structures according to bankfull and floodprone widths and placing them in proper alignment with stream channels could alleviate these problems.

Next Steps

The LWP has secured grant funds to compile a Stream Corridor Plan (SCP) for the Hinesburg area in 2006. The SCP will combine data collected in Phase 1 and 2 studies and provide a framework for management decisions for road maintenance, development, habitat improvement, and stormwater management. The SCP will aim to identify attenuation sites to reduce sediment and phosphorus from flowing to Shelburne Bay. The SCP will also identify opportunities for improving geomorphic function and habitat value. Discussions with landowners will attempt to identify timescales and level of interest for such activities.

As part of compiling the SCP for Hinesburg, development of a Fluvial Erosion Hazard Map (FEHM) is planned. Such a tool would be useful in planning further development and land use in Hinesburg.

The LaPlatte Partnership plans on continuing to work with town governments and landowners to use the information from this assessment during development review process or town plan and zoning revisions to protect the resources of the LaPlatte and reduce ongoing and future conflicts with the streams in Hinesburg. The LWP also has ongoing public education and involvement programs to increase public awareness of issues facing the LaPlatte Watershed and the Lake Champlain Basin.

The LWP will use this data to plan and select future projects that protect or restore the floodplain, the stability of the river and the riparian habitat and to educate the community at public meetings and events about being positive river stewards.

Public Education & Outreach

Data and information from this study have already been used to inform management decisions as recent storm events have highlighted instability in the watershed.

On December 6, 2005, the consultant, Lisa Godfrey, met with members of the DEC and the Hinesburg Town Administrator and Road Foreman to discuss a culvert on Hayden Hill Road that crosses a tributary of Beecher Hill Brook. While that tributary was not included in this study, the receiving waters were. The processes occurring in Beecher Hill Brook and elsewhere in the watershed were explained and related to the culvert and stream under discussion.

In December of 2005, the Town of Hinesburg used information from this study to guide an application to the WHIP program. On February 10, 2006, the consultant met with representatives from the WHIP program, the Hinesburg Town Highway Foreman, and a member of the Select Board to tour potential WHIP project sites. Information from this study was relayed to the group in discussing the undersized culverts and diversion dams affecting habitat in the watershed.

On February 15, 2006, the consultant and a member of the River Management Program met with the Hinesburg Director of Buildings and Facilities, representatives from the Basin Planning Program and the Hinesburg Community Church to discuss a potential stormwater collection pond on church property adjacent to a stream. While the stream was not included in this study, information from similar reaches and from elsewhere in the watershed was useful in the discussions.

On February 20, 2006, data and information collected in this study was presented to the Hinesburg Select Board, members of the Hinesburg Conservation Commission and the general public at the Hinesburg Town Hall. A 30-minute slide presentation was followed by questions and comments. The presentation was well received by the audience. A similar presentation to the Hinesburg Planning Commission and Conservation Commission is scheduled for April 19, 2006. Slides from this presentation are contained in Appendix D.

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Acronym List

DMS – Data Management System (Developed by the DEC)
GIS – Geographic Information System
GPS – Global Positioning System
LCA – Lewis Creek Association
LWD – Large Woody Debris
LWP – LaPlatte Watershed Partnership
RGA – Rapid Geomorphic Assessment
RHA – Rapid Habitat Assessment
RIT – Reach Indexing Tool
RMP – River Management Program
SCP – Stream Corridor Plan
SGA - Stream Geomorphic Assessment
SGAT – Stream Geomorphic Assessment Tool
VT ANR DEC – Vermont Agency of Natural Resources Department of Environmental Conservation

Glossary of Terms

Aggradation - The build up of sediment in a streambed.

Avulsion – A change in a river's course; a section of channel that has moved laterally from its bed to create another segment of channel some distance from the previous bed location.

Bankfull width - The width of the channel at a height corresponding to the level of stream flow that would overtop the natural banks in a reference stream system, occurring on average 1.5 to 2 years.

Bankfull maximum depth – The depth of the channel from the bankfull elevation to the thalweg.

Confinement – Referring to the ratio of valley width to channel width. Unconfined channels (confinement of 4 or greater) flow through broader valleys and typically have higher sinuosity and area for floodplain. Confined channels (confinement of less than 4) typically flow through narrower valleys.

Debris jam - A collection of large woody debris that has lodged in a stream channel and spans the channel from bank to bank.

Degradation or incision - Down cutting of the streambed by erosion of bed material.

Embedded – Larger bed substrate particles (gravels, cobbles, boulders) surrounded by fine sediment, reducing the oxygen in the substrata and the ability of organisms to retreat into the substrata for cover.

Entrenched - A state where a channel has lowered significantly and floodwaters can no longer overtop the banks and access the floodplain.

Flood chute - A small side channel crossing the inside of a meander bend where flood waters will bypass the main channel, taking a shorter route through the chute.

Floodprone width - The area outward from the channel that is at an elevation that could be inundated by a flood, measured in Phase 2 SGA as at an elevation of 2 times the bankfull maximum depth.

Grade control – A fixed surface on the streambed that controls the bed elevation at that point, effectively fixing the bed elevation from potential incision, typically bedrock or culverts.

Head-cut – A sharp change in slope, almost vertical, where the streambed is being eroded from downstream to upstream.

High gradient streams - Typically found in steep, narrow valleys, these streams have steep slopes and are usually fast moving with many riffles or steps and low sinuosity.

Impervious surface – A hard surface, such as concrete or a rooftop, which prevents water from infiltrating the soil.

In Regime – Referring to a stream that is in an equilibrium state, one that would be expected given the stream setting.

Large woody debris - Pieces of wood in the active channel (within the bankfull width) usually from trees falling into the channel and with minimum dimensions of 12 inches in diameter (at one end) by 6 feet long.

Low gradient streams – Typically found in wide valleys, these streams have shallow slopes and are usually slow and meandering.

Meander – A bend in a stream, or referring to the way a stream winds down its valley.

Sinuosity – The level of bends or turns in a stream, calculated by dividing the stream length by the valley length.

Width/depth Ratio – The ratio of channel bankfull width to the average bankfull depth. An indicator of channel widening or aggradation.

Windrowing - Digging material from the channel bed and piling it on the bank, creating berms.

Appendix A – Phase 1 Database Reports

Appendix B – Phase 2 Database Reports

Appendix C - Reach Summaries

The following summarizes each reach according to parameters evaluated during the assessment.

M12

Reach M12 is a low gradient stream in a very broad, unconfined valley setting. The valley narrows slightly here from upstream reaches. Adjacent valley slopes are hilly. The reach does not contain any grade controls such as falls, bedrock ledges, dams or weirs. A bridge for Leavensworth Road, 29 feet at its widest, constricts the floodprone width. The landowner reports that high water floods her land since the bridge was replaced. Bed substrate is comprised of homogeneous fine particles of sand and silt with some areas of clay noted. A count of LWD pieces yielded 36 pieces and 3 debris jams in the reach to provide food and cover for aquatic species. Two active and two old beaver dams were present in the channel affecting about 2780 feet (52%) of channel length, mostly due to the shallow slope of the channel.

Bank slopes were moderate and comprised of a non-cohesive silt/clay mix. The left bank had erosion along 7% of its length while the right bank had erosion along 13% of its length. Banks were considered 'moderately stable' and in good condition. Some riprap revetments were noted at the bridge. Bank vegetation was mostly herbaceous with some areas of deciduous trees. Riparian buffer width was 5 feet or less with some areas of 50-100 feet. Buffer vegetation was herbaceous with some deciduous trees. Riparian corridor land use was hay fields with some areas of shrub-saplings and light forest.

A Rapid Habitat Assessment (RHA) shows the overall reach habitat to be in "fair" condition. Few types of bed substrate and cover exist for fish or macroinvertebrates. Pools are large, with some submerged vegetation. Water filled the channel, leaving no exposed substrate. Some new increase in fine sediment was noted. Channel alteration appeared minimal. Channel sinuosity was "fair." Riparian buffer was rated as "poor" due to proximity of hay fields.

A Rapid Geomorphic Assessment (RGA) indicated the reach was not entrenched or incised and had floodplain access at bankfull and higher flows. Therefore flood flows can spread out over the floodplain and have less potential for erosion damage. Ripples and pools are somewhat impacted by beaver dam effects, however these parameters were difficult to evaluate due to the dune-ripple bed morphology and deep water. Some bank erosion was noted on outside meander bends, signaling minor planform adjustment. Overall, the geomorphology of reach M12 was in "good" condition, with minor planform changes but appeared to be in regime, meaning minimal change and within the range of adjustment for its stream type (E5 Dune-Ripple). The stream sensitivity to future disturbance was "high."

M13

Reach M13 is a low gradient stream running through a very broad, unconfined valley setting. Adjacent valley side slopes were moderate, or hilly. The reach did not contain any grade controls such as falls, bedrock ledges, dams or weirs. A snowmobile bridge 45 feet wide constricts the floodprone width. Bed substrate is comprised of homogeneous fine particles of sand and silt with some areas of clay noted. A count of LWD pieces yielded 26 pieces and 2 debris jams in the reach to provide food and cover for aquatic species. One old beaver dam is present in the channel affecting only about 10 feet of channel length.

Bank slopes are steep and comprised of a non-cohesive silt/clay mix. Both the right and left banks have erosion on approximately 40% of their lengths and are moderately unstable and considered in fair condition. About 450 feet of tree revetments have been placed in the channel at meander bends where the bank was migrating laterally. Bank vegetation is comprised of shrubs, saplings, and herbaceous species and is rated as fair. The right bank has a riparian buffer of over 100 feet, with some areas being less than 5 feet. This buffer is mostly comprised of deciduous trees with some shrubs and saplings. The left bank buffer is less than 5 feet with some areas being around 25-50 feet and comprised of herbaceous species with shrubs and saplings in a few areas. Land use in the riparian corridor is hayfields with some pasture area on the left bank and some scattered trees to light forest on the right bank.

A Rapid Habitat Assessment (RHA) shows the overall reach habitat to be in “fair” condition. Few types of bed substrate and cover exist for fish or macroinvertebrates. Pools are large and have uniform fine substrate and some increase in sediment deposition exists. Channel flow is considered in reference condition as little channel substrate is exposed. This reach of the LaPlatte does not appear to have been straightened. Channel sinuosity is considered fair for a low gradient stream; more bends would be expected here. The riparian buffer width for this reach is in poor condition, having lost most woody species and cover.

Cross section measurements show the reach is not entrenched, meaning that it has connection to its floodplain at 1.5 to 2 year high flows. Therefore flood flows can spread out over the floodplain and have less potential for erosion damage. Measurements show minimal incision or widening of the channel. Riffles are almost absent with the reach dominated by runs and a few large pools. This combined with homogeneous fine sediment signals minor aggradation of the reach. The high amount of bank erosion in this reach signals minor planform adjustment. Herbaceous bank vegetation and silt/clay bank composition are factors likely contributing to the planform changes in the reach. Overall, the geomorphology of reach M13 is in “good” condition and it appears to be in regime, meaning minimal change and within the range of adjustment for its stream type (E5 Dune-Ripple). Stream sensitivity to future disturbances was “high.”

M14

Reach M14 was a short reach just below a significant tributary. Similar to M13, it was a low gradient stream running through a very broad, unconfined valley setting. Adjacent valley side slopes were moderate, or hilly. The reach did not contain any grade controls such as falls, bedrock ledges, dams or weirs. Bed substrate was comprised of homogeneous fine particles of sand and silt with some areas of clay noted. No LWD pieces were present in this reach contributing to a lack of food and cover for aquatic species. A stream ford at the downstream end of the reach was built up with rocks to provide a crossing for farm equipment.

Bank slopes were typically undercut and comprised of a non-cohesive silt/clay mix. Bank erosion was present along 36% of the left bank and 28% of the right bank. Banks were moderately unstable and considered in fair condition. Bank vegetation was comprised of grasses with no woody species and was rated as fair. Both right and left banks had buffer widths of less than 5 feet. The buffer vegetation was comprised of grasses, as the riparian corridor land use was pasture.

The RHA showed the overall reach habitat to be in “fair” condition. Few types of bed substrate and cover existed for fish or macroinvertebrates. Pools were large and had uniform fine substrate and some increase in sediment deposition was observed. Channel flow was considered in reference condition as little channel substrate was exposed. This reach of the LaPlatte appeared to have evidence of past straightening, but no recent alterations were evident. Channel sinuosity was considered good. The riparian buffer width for this reach was in poor condition, having lost most woody species to pasture.

Cross section measurements showed the reach was not entrenched, meaning that it had connection to its floodplain at 1.5 to 2 year high flows. Therefore flood flows could spread out over the floodplain and have less potential for erosion damage. The reach did appear to be slightly incised signifying minor bed degradation. Measurements showed minimal widening of the channel. Riffles were almost absent with the reach dominated by runs and a few large pools. This combined with homogeneous fine sediment signaled minor aggradation of the reach. The high amount of bank erosion in this reach signaled minor planform adjustment. Herbaceous bank vegetation and silt/clay bank composition were factors likely contributing to the planform changes in the reach. Overall, the geomorphology of reach M14 was rated in “good” condition and it appeared to be in stage III of the F-stage process. Stream sensitivity to future disturbances was “high.”

M15

Reach M15 was segmented into two segments during the study to reflect the channel straightening in the upstream section.

M15 Segment A

Segment M15a was a low gradient stream running through a very broad, unconfined valley setting. Adjacent valley side slopes were moderate, or hilly. The segment did not contain any grade controls such as falls, bedrock ledges, dams or weirs. Bed substrate was comprised of homogeneous fine particles of sand and silt with some areas of clay noted. A count of LWD pieces yielded 14 pieces and 1 debris jam in the segment to provide food and cover for aquatic species.

Bank slopes were undercut and comprised of a non-cohesive silt/clay mix. Bank erosion was present along 63% of the left bank and 36% of the right bank. The left bank was unstable and in poor condition while the right bank was moderately unstable and considered in fair condition. Bank vegetation was comprised of grasses with no woody species and was rated as fair. Both right and left banks had buffer widths of less than 5 feet. The buffer vegetation was comprised of grasses, as the riparian corridor land use was pasture with some hay.

A Rapid Habitat Assessment (RHA) showed the overall segment habitat to be in “fair” condition. Some bed substrates existed that are favorable for fish and macroinvertebrates. Pools were large and had uniform fine substrate and some increase in sediment deposition existed. Channel flow was considered in reference condition as little channel substrate was exposed. This segment of the M15 appeared to have evidence of past straightening, but no recent alterations were evident. Channel sinuosity was considered good. The riparian buffer width for this segment was in poor condition, having lost most woody species to pasture.

Cross section measurements showed the segment was not entrenched, however it had incised meaning that the channel could access its floodplain at higher flood flows but not at bankfull or lower flood flows. This could lead to higher rates of erosion in the segment. Measurements showed minor widening of the channel. Riffles were almost absent with the segment dominated by runs and a few large pools. This combined with homogeneous fine sediment signaled moderate aggradation of the segment. The high amount of bank erosion in this segment signaled major planform adjustment. Herbaceous bank vegetation and silt/clay bank composition combined with upstream channel straightening were factors likely contributing to the planform changes in the segment. Overall, the geomorphology of segment M15a was in "fair" condition. The historic bed degradation and current channel adjustments suggested this segment was in stage II of the F-stage channel evolution process. The stream type was E5 Dune-Ripple. The stream was "very highly" sensitive to future disturbances.

M15 Segment B

Segment M15b is a low gradient stream running through a very broad, unconfined valley setting. Adjacent valley side slopes are gentle to moderate. The segment does not contain any grade controls such as falls, bedrock ledges, dams or weirs. Bed substrate is comprised of homogeneous fine particles of sand and silt with some areas of clay noted. A count of Large Woody Debris pieces yielded 35 pieces and 6 debris jams in the segment to provide food and cover for aquatic species. Four beaver dams are present in the segment affecting about 1500 feet of channel length.

Bank slopes are steep and comprised of a non-cohesive silt/clay mix. Bank erosion is present along 4% of the left bank and 14% of the right bank. The banks are moderately unstable and considered in fair condition. Bank vegetation is comprised herbaceous species with some deciduous trees on the left bank. Left bank vegetation is rated as in good condition while right bank vegetation is rated as fair. The left bank has a riparian buffer of 26-50 feet, with some areas being less than 5 feet. This buffer is mostly comprised of deciduous trees with some herbaceous species. The right bank buffer is less than 5 feet with some areas being around 25-50 feet and comprised of herbaceous species with deciduous trees in a few areas. Land use in the riparian corridor is fallow field with the solid waste treatment facility on the left bank.

A Rapid Habitat Assessment (RHA) shows the overall segment habitat to be in "poor" condition. Few types of bed substrate and cover exist for fish or macroinvertebrates. The majority of the pools are shallow with fine substrate and little submerged vegetation. A large increase in sediment deposition exists, filling pools. Channel flow does not fill the channel, leaving exposed substrate and is considered in fair condition. This segment of the LaPlatte appears to have been entirely straightened. Channel sinuosity is considered poor due to the extensive channel straightening. The riparian buffer width for this segment is in poor to fair condition, having lost most woody species and cover.

Cross section measurements show the segment is not entrenched, meaning that it has connection to its floodplain at 1.5 to 2 year high flows. Therefore flood flows can spread out over the floodplain and have less potential for erosion damage. Measurements show minimal incision of the channel. Erosion on both right and left banks at riffles and mid channel bars indicate minor channel widening. Minor mid channel bars, few riffles, and homogeneous fine sediment signal minor aggradation of the segment. The high amount of bank erosion in this segment, flood chutes crossing meander bends and historic channel straightening signal major planform adjustment. Herbaceous bank vegetation and silt/clay bank composition are factors also likely contributing to the planform changes in the segment. Overall, the geomorphology of segment M15b is in "fair" condition. The historic bed degradation and current channel adjustments suggest this segment is in stage III of the F-stage channel evolution process. The stream type is C5c Dune-Ripple. The stream is "very highly" sensitive to future disturbances.

M16

Reach M16 is a low gradient stream running through a very broad, unconfined valley setting. Adjacent valley side slopes are moderate on the right and steep on the left. The reach does not contain any grade controls such as falls, bedrock ledges, dams or weirs. Bed substrate is comprised of homogeneous fine particles of sand and silt with some areas of clay noted. A count of Large Woody Debris pieces yielded 57 pieces and 10 debris jams in the reach to provide food and cover for aquatic species. Seven beaver dams are present in the segment affecting about 2050 feet of channel length. A stream ford toward the upstream end of the reach provides a crossing for farm equipment. Eight stormwater inputs enter from fields and Silver Street. A culvert at the Charlotte Road constricts the channel and a bridge at Silver Street constricts the floodprone width. Upstream deposition is a problem at both constrictions.

Bank slopes are moderate and comprised of a non-cohesive silt/clay mix. Bank erosion is present along 14% of both the left and right banks. Rock riprap is present along 20 feet of both banks at a bridge. Banks are moderately stable and considered in good condition. Bank vegetation is comprised of herbaceous species with some shrubs and saplings and is rated in good condition. Both right and left banks have buffer widths of 26-50 feet with some areas less than 5 feet. The buffer vegetation is comprised of shrubs and saplings with some deciduous trees. Riparian corridor land use is pasture on the left and hay and crops on the right.

The RHA shows the overall reach habitat to be in "fair" condition. The variety of bed substrate and cover for fish or macroinvertebrates is fair. Pool variability is reference with a mix of small and large pools of varying depths. Moderate sediment deposition is present in the reach. Channel flow is good with some channel substrate exposed. This reach of the LaPlatte appears to have been entirely straightened with berms present on banks in some areas. Channel sinuosity is poor due to extensive straightening. The riparian buffer width for this reach is in fair condition, being only 26-50 feet with mostly shrubs and saplings.

Cross section measurements show the reach is not entrenched, meaning that it has connection to its floodplain at 1.5 to 2 year high flows. Therefore flood flows can spread out over the floodplain and have less potential for erosion damage. The reach does appear to be slightly incised signifying minor bed degradation. Measurements and mid channel bars signal minor widening of the channel. Filling of pools with fine sediment deposition and mid channel bars signal major aggradation of the reach. Moderate bank erosion, flood chutes crossing meander bends and historic channel straightening signal minor planform adjustment. Overall, the geomorphology of reach M16 is in “fair” condition. The major aggradation with minor widening and planform adjustments suggest this reach is in stage III of the F-stage channel evolution process. The stream type is C5 Dune-Ripple. The stream is “very highly” sensitive to future disturbances.

M17

Reach M17 is a low gradient stream running through a very broad, unconfined valley setting. Adjacent valley side slopes are moderate on the left and steep on the right. The reach does not contain any grade controls such as falls, bedrock ledges, dams or weirs. Bed substrate is comprised of sand and fine gravel. A count of LWD pieces yielded 30 pieces and 6 debris jams in the reach to provide food and cover for aquatic species. Three beaver dams are present in the reach affecting about 1100 feet of channel length. A Great Blue Heron was spotted at the downstream end of the reach. The reach runs through a pasture where animals (horses) have unlimited access to the channel and have created numerous crossings with unvegetated banks. Three stormwater inputs enter from fields. Two culverts constrict the channel with deposition upstream and scour downstream of the culverts.

Bank slopes are steep and comprised of a non-cohesive silt/clay mix. Bank erosion is present along 12% of both the left and right banks. Rock riprap is present along 10 feet of the left bank and 35 feet of the right bank at culverts and one bend. Banks are moderately unstable and considered in fair condition. Bank vegetation is comprised of shrubs and saplings with some herbaceous species and is rated in fair condition. Some areas of bank have no vegetation due to animal crossing. Both right and left banks have buffer widths of 5-25 feet with some areas less than 5 feet. The buffer vegetation is comprised of shrubs and saplings with some herbaceous species. Riparian corridor land use is pasture on the left and hay and pasture on the right.

The RHA shows the overall reach habitat to be in “fair” condition. The variety of bed substrate and cover for fish or macroinvertebrates is fair. Pools are shallow but do have some vegetation for cover. Moderate sediment deposition is present in the reach. Channel flow is poor with riffle substrate mostly exposed. This reach of the LaPlatte appears to have been entirely straightened with berms present on the left bank in some areas. Channel sinuosity is fair due to extensive straightening, although the upstream most section has some bends. The riparian buffer width for this reach is in poor condition, being only 5-25 feet with mostly shrubs and saplings.

Cross section measurements show poor entrenchment and incision ratios, signifying extreme bed degradation. Therefore the reach does not have access to the floodplain and could have higher erosion rates. Historic degradation, bank scour at riffles, and mid channel bars signal major widening of the channel. Filling of pools with fine sediment deposition and mid channel bars signal minor aggradation of the reach. Bank erosion, flood chutes crossing meander bends and historic channel straightening signal major planform adjustment. Overall, the geomorphology of reach M17 is in “poor” condition. The extreme historic degradation with major widening and planform adjustments suggest this reach is in stage III of the F-stage channel evolution process. The stream type is B5c Dune-Ripple. The stream is highly sensitive to future disturbances.

M18
Reach M18 was segmented into 2 segments to capture significant channel adjustments near the Route 116 culvert crossing.

M18 Segment A
Segment M18A was a high gradient stream in an unconfined valley setting. Adjacent hill slopes were steep and sometimes within 1 bankfull width of the channel. Three ledges acted as grade controls toward the downstream end of the segment. Bed substrate was comprised of sand and gravel particles. A count of LWD pieces yielded 53 pieces and 5 debris jams in the segment to provide food and cover for aquatic species. Two beaver dams were present in the segment affecting about 750 feet of channel length, however they had been drained by the landowner and the large pond observed previously was gone.

Bank slopes were moderate and comprised of sandy substrate. Erosion was observed along 40 feet of the left bank and 110 feet of the right bank. Bank vegetation was comprised of coniferous trees with some areas of herbaceous species. Some areas of bank had no vegetation due to animal crossing. Both right and left banks had buffer widths greater than 100 feet. Buffer vegetation was comprised of coniferous and mixed trees. Riparian corridor land use was forest with some pasture. In the areas of pasture, animals have full access to the channel resulting in many animal crossings. Many wetland areas were near the channel.

A RHA indicated habitat in this segment to be in “good” condition. Deposition of fine sediment and grazing of bank vegetation appeared to be the main factors affecting habitat condition.

A RGA indicated minor channel degradation related to recent channel avulsions. Sediment deposition and multiple mid channel, point, side, and diagonal bars and steep riffles signaled major aggradation. A high width-to-depth ratio indicated major widening of the channel. Erosion on outside bends, active flood chutes, and sediment deposition signaled major planform changes. Overall, the segment appeared to be a C4b Riffle-Pool stream type in “fair” condition in stage IIc of the D-stage channel evolution process. Stream sensitivity was “very high.”

M18 Segment B
Segment M18B was a high gradient stream in an unconfined valley. Adjacent slopes were “hilly” and sometimes continuous with the bank slope. One culvert at the Route 116 crossing acted as a grade control and also constricted the channel. Significant deposition and ponding was observed upstream of the culvert, while incision, headcuts, widening, and bank erosion were observed downstream of the culvert. Bed substrate was gravel with some cobbles and sand. A count of LWD yielded 5 pieces and 2 debris jams, one at the upstream end of the culvert.

Banks were undercut and comprised of a mix of substrates. Erosion was noted along 80 feet of the left bank and one mass failure (12 feet high) was observed. Bank and buffer vegetation was shrub-sapling with some deciduous trees. Buffer width was typically 26-50 feet with some areas of less than 5 feet. The riparian corridor was shrub-saplings with some areas of lawn for the golf course downstream of Route 116.

A RHA indicated the habitat of this segment to be in “fair” condition. Sediment deposition and bank stability were the main factors affecting habitat condition.

A RGA indicated extreme channel degradation, with headcuts observed. Minor channel aggradation was signaled by mid channel bars and an increase in fine sediment. Major widening and planform adjustments were also noted. This segment appeared to be a C4 Riffle-Pool stream type in stage II of the F-stage channel evolution process. This segment was assessed in “poor” condition and the stream sensitivity was very high.

T3.01 - Unnamed Tributary

Reach T3.01 was the lowermost reach of an unnamed tributary to the LaPlatte River. This was a low gradient reach flowing through a very broad valley. The adjacent terrace was flat. A culvert for the Charlotte Road crossing acts as a grade control and constricts the channel and floodprone width. Turtles and otter have been reported dead in the road at this crossing. Bed substrate is comprised of homogeneous fine particles of sand and silt with some areas of clay noted. No LWD pieces were observed. The channel appears to have been straightened and dredged along the length of the reach in the past, however recent alterations were not apparent.

Bank slopes were steep and bank material comprised of a silt/clay mix. Both right and left banks had erosion along 2% of their length. Bank vegetation was herbaceous with some shrub-saplings. The riparian buffer was 5-25 feet of herbaceous species with some shrub-saplings. The riparian corridor was hay.

The RHA indicated habitat in the reach to be “fair.” Few types of bed substrate and cover exist for fish or macroinvertebrates. Pools were large (few shallow) with no submerged vegetation. Moderate deposition of fine sediment on bars and in pools was observed. Water filled the channel with no exposed substrate. Channel sinuosity was low due to historical straightening. Banks were moderately stable and rated as “good.” Riparian buffer was rated as “poor” due to proximity of hay fields.

A RGA indicated minor incision of the reach, signaling minor degradation. Multiple mid-channel and point bars indicated minor channel aggradation. Flood chutes, sediment deposition and the historical channel straightening indicated planform adjustments. The RGA indicated the reach appeared in “good” condition, however this may be attributed to the relatively slow adjustments at work following historical straightening. The reach appeared to be an E5 Dune-Ripple stream type in stage III of the F-stage channel evolution process. Stream sensitivity to future disturbance was “high.”

T3.02 - Unnamed Tributary

Reach T3.02 was a low gradient stream in a very broad valley setting. Adjacent valley slopes were “hilly.” No grade controls were present in the reach. The reach was classified as a C type with Dune-Ripple bed morphology. Bed substrate was dominated by fine sand particles with some silt and clay noted. A large beaver dam and pond were located at the upstream end of the reach. A total of 3 beaver dams were present in the reach, impacting 1950 feet (34%) of channel length. Many wetland areas and seeps were noted along the reach.

Bank slopes were steep and composed of a silt/clay mix. The right bank had active erosion along 1% of its length, while no erosion was noted on the left bank. Bank vegetation consisted of herbaceous species with some shrub-saplings. Banks were moderately stable and assessed in "good" condition. Riparian buffer widths were 50-100 feet on each bank with some areas of 5-25 feet. Buffer vegetation was herbaceous with shrubs-saplings. Riparian corridor land use was pasture. Many wetland areas and seeps were noted along the reach. Historical straightening was noted along the reach.

A RHA indicates the reach habitat to be in "fair" condition. A good mix of bed substrates and cover exist for fish and macroinvertebrates. Some increase in sediment deposition exists. The majority of pools were shallow, with few deep pools. Water filled the channel, leaving no exposed substrate. Channel sinuosity was assessed as "fair," likely due to historical straightening. Riparian buffer width was "fair" at 25-50 feet, with adjacent pasture impacting riparian buffer.

A RGA indicated the reach had not incised or become degraded. Multiple mid-channel, point, and side bars, incomplete riffles, and an increase in fine sediment indicated minor aggradation and widening. Active flood chutes, erosion on outside bends, and a change in channel planform indicated major planform adjustment. Overall, the reach was assessed in "good" condition, in stage IIc of the D-stage channel evolution process with planform adjustments. Sensitivity to future disturbance was "high."

M15 S2.01 – Historical Patrick Brook

Reach M15S2.01 is what remains of Patrick Brook after the construction of the Canal. Most of Patrick Brooks flow is diverted by an assemblage of rocks into the Canal at T4.2 just downstream of Mechanicsville Road. This reach carries overflow and flow from a small tributary. This reach is classified as a high gradient stream (1.12% slope) and flows through a very broad valley. Adjacent slopes were flat on the left bank (Commerce Park) and hilly on the right bank. One culvert at the Route 116 crossing acted as a grade control and constricted the channel and floodprone width. Bed morphology was Dune-Ripple with gravel substrate. The reach appeared to have been straightened historically and flow is currently managed as mentioned above.

Bank slopes were steep and comprised of a mix of substrates. Erosion was observed along 4% of the left and right banks. Rock riprap was present along 130 feet (2%) of the left bank. Bank vegetation was comprised mostly of shrub-saplings and herbaceous species. Buffer width was less than 5 feet in most areas, with some areas of 5-25 feet. The riparian corridor land use was primarily hay fields with some commercial on the left bank at Commerce Park. Many wetland areas are near the channel, with 3 beaver dams affecting approximately 1500 feet of channel.

A RHA indicated reach habitat to be in "fair" condition. Few substrate types were observed. Gravel particles were fairly embedded and some increase in fine particles was noted. Banks were "moderately unstable" with bank vegetation limited to shrub-saplings and herbaceous species. Width of riparian vegetation was "poor."

A RGA indicated minor incision of the reach, signaling minor degradation. Multiple mid-channel, point, side and diagonal bars indicated minor channel aggradation. Flood chutes, diagonal bars and the historical channel straightening indicated major planform adjustments. The RGA indicated the reach appeared in "good" condition, however this may be attributed to the relatively slow adjustments at work following historical straightening and flow reduction. The reach appeared to be an E4 Dune-Ripple stream type in stage III of the F-stage channel evolution process. Stream sensitivity to future disturbance was "high."

T4.01 – The Canal

Reach T4.1 is a low gradient stream running through a very broad, unconfined valley setting. The entire reach has been channelized into a canal against the left valley wall and water from the historical Patrick Brook channel (M15S2.01) has been diverted into this channel upstream at T4.2. The lower section of the reach passes the Saputo Cheese Factory. Adjacent valley side slopes are gentle on the right and steep on the left. There is a store-release dam just downstream of the Route 116 crossing. The dam is about 7 feet high. Bed substrate is comprised of homogeneous fine particles of sand and silt with some areas of clay noted. A count of Large Woody Debris pieces yielded only 1 piece. A culvert and a bridge constrict the channel and a footbridge constricts the floodprone width. No problems are apparent at these constrictions.

Bank slopes were moderate and bank material comprised of a non-cohesive silt/clay mix. Bank erosion is present along 3% of the right bank. Rock riprap is present along 650 feet of the left bank and 150 feet of the right bank. Banks are moderately stable and considered in good condition. Bank vegetation is comprised of herbaceous species with some shrubs and saplings and is rated in fair condition. Both right and left banks have buffer widths of less than 5 feet. The buffer vegetation is comprised of herbaceous species with some shrubs and saplings. Riparian corridor land use is industrial and residential on the left and hay and commercial on the right.

The RHA shows the overall reach habitat to be in "poor" condition. Few types of bed substrate and cover exist for fish or macroinvertebrates. The few pools are shallow with fine substrate and little submerged vegetation. Moderate sediment deposition is present in the reach. Channel flow is reference with little channel substrate exposed. This reach of Patrick Brook appears to have been entirely straightened and channelized with berms present on 57% of the right bank and 25% of the left bank. Channel sinuosity is poor due to extensive straightening. The riparian buffer width for this reach is in poor condition, being less than 5 feet with mostly herbaceous species.

Cross section measurements show the reach is not entrenched, meaning that it has connection to its floodplain at 1.5 to 2 year high flows. Therefore flood flows can spread out over the floodplain and have less potential for erosion damage. The reach does appear to be moderately incised and channel features have been straightened and replaced by plane bed features, signifying major bed degradation. Incision, channel alteration, and mid channel bars signal minor widening of the channel. The change to plane bed features, fine sediment deposition and mid channel bars signal extreme aggradation of the reach. Deposition and historic channel straightening signal minor planform adjustment. Overall, the geomorphology of reach T4.01 is in "fair" condition. The extreme aggradation after historic degradation suggest this reach is in stage II of the F-stage channel evolution process, however continued management may limit channel evolution. The stream type is C5 Plane Bed. The stream is "very highly" sensitive to future disturbances.

T4.02 – The Canal

Reach T4.2 is a low gradient stream running through a very broad, unconfined valley setting. Adjacent valley side slopes are gentle on the right and steep on the left. Bed substrate is comprised of sand, gravels and cobbles with some areas of clay noted. A count of Large Woody Debris pieces yielded 12 pieces. A dam located along the right bank confines flow to the canal, rather than it flowing through the adjacent meadow.

Bank slopes are undercut and comprised of gravel and silt/clay mix. Bank erosion is present along 17% of the left bank and 22% of the right bank. Banks are moderately stable and considered in good condition. Bank vegetation is comprised of deciduous trees and shrubs and saplings and is rated in good condition. Both right and left banks have buffer widths of 5-25 feet with some areas up to 50 feet. The buffer vegetation is comprised of deciduous trees with some shrubs and saplings. Riparian corridor land use is residential on the left and fallow field on the right.

The RHA shows the overall reach habitat to be in "fair" condition. The variety of bed substrate and cover for fish or macroinvertebrates is fair. Pools are shallow with fine substrate and little submerged vegetation. Moderate sediment deposition is present in the reach. Channel flow is good with some channel substrate exposed. This reach of Patrick Brook appears to have been entirely straightened and channelized with berms present along 16% of both banks. Some braiding is present at the upstream end of the reach where the channel has not been maintained. Channel sinuosity is poor due to extensive straightening. The riparian buffer width for this reach is in poor condition, being less than 25 feet.

Cross section measurements show poor entrenchment and incision ratios, signifying extreme bed degradation. Therefore the reach does not have access to the floodplain and could have higher erosion rates. Historic degradation, bank scour at riffles, and mid channel bars signal major widening of the channel. Filling of pools with fine sediment deposition, plane bed features, and mid channel bars signal major aggradation of the reach. Bank erosion, flood chutes crossing meander bends, deposition, and historic channel straightening signal major planform adjustment. Overall, the geomorphology of reach T4.2 is in "poor" condition. The extreme historic degradation with major widening, aggradation and planform adjustments suggest this reach is in stage III of the F-stage channel evolution process. The stream type is F4 Plane Bed. The stream is "extremely" sensitive to future disturbances.

T4.03 – Patrick Brook

Reach T4.03 is a high gradient stream running through a narrowly confined valley setting. Adjacent valley side slopes are very steep. The upstream end of the reach begins at an old milldam, about 10 feet high. The reach passes over multiple ledges and falls and past more mill foundations. One culvert and 3 mill foundations constrict the channel in this reach. Bed substrate is comprised mostly of gravels with sand, cobbles and boulders. A count of Large Woody Debris pieces yielded 56 pieces and 5 debris jams in the reach to provide food and cover for aquatic species.

Bank slopes are moderate and comprised of a mix (cobbles, gravels, silt/clay). Bank erosion is present along 13% of the left bank and 3% of the right bank. Rock riprap is present along 25 feet of the right bank. Banks are moderately stable and considered in good condition. Bank vegetation is comprised of deciduous trees, shrubs and saplings on the left bank and invasive species on the right bank. Riparian buffers are over 100 feet, comprised of mixed trees. Land use in the riparian corridor is forest with some residential on the right bank.

A Rapid Habitat Assessment (RHA) shows the overall reach habitat to be in "good" condition. A good mix of bed substrates and cover exist for fish and macroinvertebrates. Some increase in sediment deposition exists and gravel, cobbles and boulders are only slightly embedded (surrounded by fine sediment). Channel flow is considered fair with riffle substrate mostly exposed. This reach of Patrick Brook appears to have been straightened at the downstream end. The frequency of riffles is reference, although fast, deep areas are limited. The riparian buffer width for this reach is in good to reference condition, with some loss at the downstream end of the reach.

Cross section measurements show the reach is not entrenched, meaning that it has connection to its floodplain at 1.5 to 2 year high flows. Therefore flood flows can spread out over the floodplain and have less potential for erosion damage. Measurements show minor incision of the channel. Multiple mid channel bars and an increase in sediment signal major aggradation of the reach. A very high width to depth ratio, mid channel bars, and minor incision signal extreme channel widening. Minor planform adjustment is suggested by mid channel bars, past channel avulsion, and channel constrictions. Overall, the geomorphology of reach T4.3 is in "fair" condition and it appears to be widening with aggradation, stage III of the F-stage evolution process. The stream type is C4 Riffle-Pool. The stream is "very highly" sensitive to future disturbances.

T4.04 – Patrick Brook

Reach T4.04 is a high gradient stream running through a semi-confined valley setting. Adjacent valley side slopes are very steep. The upstream end of the reach begins at a run-of-the-river dam at the Lower Pond, about 10 feet high. The reach passes over multiple ledges and falls and past another r-o-r dam at Iroquois Manufacturing. Two culverts, old abutments and bedrock outcrops constrict the channel with deposition above and scour below the constriction. Bed substrate is comprised mostly of gravels with sand, cobbles and boulders. A count of Large Woody Debris pieces yielded 41 pieces and 7 debris jams in the reach to provide food and cover for aquatic species.

Bank slopes are steep and comprised of a mix (cobbles, gravels, silt/clay). Bank erosion is present along 245 feet of the left bank and 40 feet of the right bank. Rock riprap is present along 1050 feet (26%) of the left bank and 575 feet (14%) of the right bank. Banks are moderately stable and considered in good condition. Bank vegetation is comprised of mixed trees and herbaceous species. Riparian buffers are over 100 feet, with some areas of the right bank 26-50 feet, and comprised of mixed trees. Land use in the riparian corridor is forest with some industrial on the right bank.

A Rapid Habitat Assessment (RHA) shows the overall reach habitat to be in “good” condition. A good mix of bed substrates and cover exist for fish and macroinvertebrates. Some increase in sediment deposition exists and gravel, cobbles and boulders are moderately embedded (surrounded by fine sediment). Channel flow is considered fair with riffle substrate mostly exposed. Channel alteration status is fair due to extensive riprap. The frequency of riffles is reference. The riparian buffer width for this reach is in good condition, with some loss at the upstream end of the reach.

Cross section measurements show the reach is not entrenched or incised for a confined stream. Minor degradation has occurred through reduction of sediment at dams. Multiple mid channel bars, an increase in sediment, and sediment buildup at constrictions signal minor aggradation of the reach. A very high width to depth ratio, mid channel bars, and a decrease in sediment load due to the dams signal extreme channel widening. Minor planform adjustment is suggested by mid channel bars, past channel avulsion, and channel constrictions. Overall, the geomorphology of reach T4.04 is in “fair” condition and it appears to be in stage IIc of the D-stage evolution process: widening with minor aggradation and planform adjustment. The stream type is F4b Step-Pool. The stream is “highly” sensitive to future disturbances.

T4.05 – Patrick Brook

Reach T4.05 encompasses Lower Pond with a run-of-river dam at its downstream end. This reach was not assessed due to its status as pond rather than stream channel.

T4.06 – Patrick Brook

Reach T4.06 is a high gradient stream running through an unconfined valley setting. Adjacent valley side slopes are steep. The upstream end of the reach begins below a run-of-the-river dam at Lake Iroquois, about 6 feet high. One bedrock ledge acts as a grade control in the reach. Channel constrictions include a bridge, a culvert, an old abutment, and a bedrock outcrop. Sediment deposits upstream of these constrictions. Bed substrate is comprised mostly of gravels with sand, cobbles and boulders. A count of Large Woody Debris pieces yielded 2 pieces and 1 debris jam in the reach to provide food and cover for aquatic species.

Bank slopes are steep and comprised of a mix (cobbles, gravels, silt/clay). Bank erosion is present along 25 feet of the left bank. Rock riprap is present along 110 feet (6%) of the left bank and 300 feet (16%) of the right bank. Banks are moderately stable and considered in good condition. Bank vegetation is comprised of shrubs and saplings and herbaceous species. Riparian buffers range from 5 to 100 feet, and are comprised of mixed trees. Land use in the riparian corridor is forest with some shrubs and saplings.

A Rapid Habitat Assessment (RHA) shows the overall reach habitat to be in “good” condition. A good mix of bed substrates and cover exist for fish and macroinvertebrates. Some increase in sediment deposition exists and gravel, cobbles and boulders are slightly embedded (surrounded by fine sediment). Channel flow is considered good with some channel substrate exposed. Channel alteration status is fair due to extensive riprap. The frequency of riffles is good. The riparian buffer width for this reach is in good condition.

Cross section measurements show the reach is not entrenched or incised. Minor degradation has occurred through reduction of sediment at dams. Multiple mid channel bars, an increase in sediment, and sediment buildup at constrictions signal minor aggradation of the reach. Minimal mid channel bars and a decrease in sediment load due to the dams signal minor channel widening. Minor planform adjustment is suggested by mid channel bars, the presence of flood chutes and channel constrictions. Overall, the geomorphology of reach T4.06 is in "good" condition and it appears to be in stage III of the F-stage evolution process. The stream is "highly" sensitive to future disturbances.

T5.01 Beecher Hill Brook

Reach T5.01 was included in the Phase 1 assessment as a single reach, however many segments were necessary due to different reference stream types and boundary conditions. Five segments have been identified, with 4 of them assessed in this study.

T5.01 Segment A

Segment A was identified as the segment between the confluence with the mainstem LaPlatte River at reach M16 and just below the first culvert on Beecher Hill Road. Segment A is a low gradient stream in an unconfined valley. Adjacent terrace slopes are flat. Berms were noted along 875 feet (34%) of the segment length on both banks. Route 116 and Gillman Road had reduced the valley width. One double culvert at the Route 116 crossing acts as a grade control and constricts the channel. Deposition was noted both above and below the culvert with one side of the double culvert being blocked by sediment at base flow. A count of LWD yielded 15 pieces.

Bank slopes were moderate and comprised of sand particles. Erosion was noted along 70 feet (3%) of the left bank and 35 feet (1.4%) of the right bank. Rock riprap was noted along 200 feet (8%) of both banks. Bank and buffer vegetation was shrub-saplings with some herbaceous species. The riparian corridor had crop and pasture along the left bank and hay on the right bank.

A RHA indicated habitat in the segment to be in "fair" condition. Pools lacked submerged vegetation and variety in size. Moderate deposition of fine sediment was observed. Channel straightening reduced sinuosity and resulted in a "poor" rating for this parameter. Width of riparian vegetation was also rated as "poor" (less than 25 feet).

A RGA indicated minor degradation signaled by reduced riffles and historical straightening. Major aggradation was observed by pool and bar deposits and deposition at the culvert. Minor planform changes were noted as bank erosion on outside bends, minor flood chutes, and bar formation. The RGA indicated the reach appeared in "good" condition, however this may be attributed to the relatively slow adjustments at work following historical straightening and/or continued management of the channel. The reach appeared to be an E5 Dune-Ripple stream type in stage IIc of the D-stage channel evolution process. Stream sensitivity to future disturbance was "high."

T5.01 Segment B

Segment B was the portion of the reach from just downstream of the Beecher Hill Road culvert to the base of the ledges and mill footings. This segment was a high gradient stream in an unconfined valley. Adjacent hill slopes were steep on the left and hilly on the right. One culvert in the reach acted as a grade control and constricted the channel. Significant sediment deposition was observed upstream of the culvert. A count of LWD yielded 7 pieces.

Bank slopes were undercut and comprised of mixed substrate and sand. Erosion was noted along 200 feet (15%) of the left bank and 65 feet (5%) of the right bank. Bank vegetation was mostly herbaceous with some shrub-saplings. The buffer width was less than 5 feet with some areas of more than 100 feet. The riparian corridor was pasture, with animals having full access to the channel and some forest.

A RHA indicated habitat in this segment to be in “fair” condition. Sediment deposition and embeddedness of larger particles affected habitat condition. Bank stability and bank vegetative protection were also rated as “fair.”

A RGA indicated little to no channel degradation. Minor aggradation was most significant just upstream of the culvert where large bars were observed. Major planform changes were signaled by erosion on outside bends, flood chutes, and deposition features. This segment appeared to be an E4 Riffle-Pool stream type in “fair” condition and in stage IIc of the D-stage channel evolution process. Stream sensitivity was “very high.”

T5.01 Segment C
Segment C was a bedrock controlled area with ledges and falls. This segment was a high gradient, confined stream. Adjacent slopes were extremely steep. Three ledges and a waterfall control the gradient and limit channel movement. Old mill footings and dam remains constrict the channel. Three pieces of LWD were counted in this segment.

Bank slopes were steep and comprised of boulders, cobbles and sand. Bank and buffer vegetation was mixed trees. Buffer widths were greater than 100 feet on the left bank while the right bank had buffer widths of 51-100 feet with some areas of 26-50 feet. The riparian corridor was forest with some residential area on the right bank.

A RHA indicated the segment to be in “good” condition. Sediment deposition and embeddedness of large particles affected habitat condition. Beecher Hill Road infringed on the right bank riparian buffer width.

A RGA indicated the segment was in “good” condition and in regime. Minor aggradation and widening were observed and likely flood related from upstream channel enlargement. This segment appeared to be a B3 Step-Pool stream type with a “moderate” sensitivity to future disturbance.

T5.01 Segment D
Segment D was a high gradient stream in an unconfined valley. Adjacent slopes are very steep. Berms were noted along 1175 feet (38%) of the left bank and 300 feet (10%) of the right bank. Roads were along 300 feet (10%) of the right bank corridor. One culvert acted as a grade control at the upstream end of the segment. This culvert and one bridge mid segment constricted the channel. A count of LWD yielded 18 pieces.

Bank slopes were steep and comprised of boulders, cobbles and sand. Erosion was noted along 1710 feet (55%) of the left bank and 645 feet (21%) of the right bank. Rock riprap was noted along 125 feet (4%) of the left bank and 100 feet (3%) of the right bank. Bank and buffer vegetation was mostly deciduous trees with some shrub-saplings. Buffer width was 51-100 feet with some areas less than 5 feet on the left bank and 5-25 feet with some areas greater than 100 feet on the right bank. The riparian corridor was forest with some commercial areas on both the right and left banks.

A RHA indicated habitat in this segment to be in “fair” condition. Stream alteration, sediment deposition, embeddedness, and bank stability and vegetation all affected habitat.

A RGA indicated extreme channel degradation with headcuts, incision, channel alteration, and stream type departure from B Step-Pool to F Plane Bed. This degradation appeared to be related to straightening and berm construction. Scour and erosion along both banks indicated widening. This segment appeared to be in “poor” condition and in stage II of the F-stage channel evolution process. Stream sensitivity was “extreme.”

Appendix D – Presentation Slides