LaPlatte Watershed Partnership

Phase 2 Stream Geomorphic Assessments
Lower LaPlatte River & McCabe's Brook
Shelburne and Charlotte, Vermont

June 2007

Acknowledgements

This project was possible through the Town of Shelburne Special Environmental Project funding. The LWP would like to thank the Town of Shelburne for supporting this work.

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 Kari Dolan at the VT DEC for her time and assistance with the assessment.

The LWP thanks its sister organization, the Lewis Creek Association, for assisting with the coordination and fiscal aspects of this project.

Executive Summary

The LaPlatte Watershed Partnership is a group of community members in Shelburne, Charlotte and Hinesburg focused on collecting and disseminating information about the LaPlatte River, its tributaries, and the watershed as a whole. The LaPlatte watershed includes, among others, the major tributary McCabe's Brook. This project involved collecting Phase 2 Stream Geomorphic Assessment (SGA) data on the LaPlatte River mainstem and McCabe's Brook in the towns of Shelburne and Charlotte. Phase 2 assessments were conducted in the town of Hinesburg in 2004-2005.

The LaPlatte River watershed encompasses 53 square miles, making it the largest watershed draining into Shelburne Bay. Condition of the LaPlatte River and its tributaries therefore greatly affects Shelburne Bay, the drinking water source for thousands of Chittenden County residents. This study identified stressors and stream condition for the lower LaPlatte River and McCabe's Brook. Information from this study can be used to create strategies that will protect and improve the vitality of not only the LaPlatte and McCabe's Brook, but Shelburne Bay as well.

Methods for this study followed the VT DEC Phase 2 Stream Geomorphic Assessment Protocols (the Protocols) (VT DEC, March 2006). The Protocols are listed on the River Management website at: http://www.anr.state.vt.us/dec/waterq/rivers/htm/rv_geoassesspro.htm.

Overall, the study reaches appeared to be undergoing channel adjustments related to past channel management practices and effects from agriculture and recent development. Key stressors appeared to be stormwater effects, excess erosion, agricultural practices, and stream crossings.

Stormwater runoff from impervious surfaces can lead to increased peak flows, increased erosion, and decreased water quality. Study segments all had watersheds with more than 10% urban cover and reach T1.03 had more than 20% urban cover (according to Phase 1 remote sensing data). Stormwater inputs were noted in reaches M06, T1.03, and T1.05. More stormwater inlets likely exist and may enter small tributaries before entering the main channels. Other possible signs of stormwater inputs include gullies and tributary rejuvenation, which are also sources of sediment and nutrients.

Excessive erosion, as seen in many areas, leads to sediment and nutrient loading of the system and deposition in downstream reaches. Mass failures, where large segments of high banks fall or slump into the channel, also contribute sediment to the system. This sediment carries nutrients and also can form deposits downstream, which can instigate or exacerbate channel adjustment. The Sediment Load Indicators Map in Appendix B highlights mass failures seen during this assessment.

Agriculture can be a stressor in terms of addition of nutrients to the system and in reduction of woody buffer areas. Some sections of stream had reduced woody buffer widths due to current or past agricultural practices. This can reduce channel resistance and lead to excess erosion. Stream segments with areas of reduced woody buffer are highlighted and could benefit from buffer enhancement efforts.

Some sections of stream ran through pasture areas. Allowing animals free access to the channel causes problems for stream stability and water quality. Animal waste and therefore nutrients are added directly to the water when livestock is near or in stream channels and negatively affects water quality of streams and Lake Champlain. Additionally, bank and bed trampling by livestock contributes sediment and nutrients to waterways. Programs such as CREP work with landowners to fence pasture areas away from waterways and look for alternate drinking arrangements. Tree planting can be a component of such buffer projects as well.

Bridges and culverts, if undersized, constrict channel and floodplain flows, interrupting sediment transport, and resulting in aggradation upstream, incision downstream, and may contribute to bank erosion. Undersized structures not only affect the stream channel, but also can be at risk themselves of failure in high flows or due to ice or debris jams. The report details structures most at risk of failure and includes a table of structures assessed in this study.

Segments M06 and T1.05A appeared to have undergone stream type departures, resulting in significant channel adjustment and a loss of geomorphic functionality. More exploration into causes and possible strategies for regaining stream channel equilibrium is recommended.

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). Phase 2 Stream Geomorphic Assessments (SGA) were completed first in the headwaters and upper reaches of the LaPlatte River mainstem in the Town of Hinesburg in 2004-2005. The LWP aims to collect geomorphic data throughout the LaPlatte River watershed where feasible in order to better understand stressors and adjustments in stream channel equilibrium. This study continued that effort with Phase 2 data collected for the LaPlatte mainstem and McCabe’s Brook. Concurrently, the LWP has been collecting and analyzing water quality data and aims to compare results with information from the SGAs.

Through this stream assessment, the LWP has increased its information base of channel conditions, adjustment, and evolution in the mainstem and McCabe’s brook, which can now be used to plan and complete other projects in the basin and to guide development of a Stream Corridor Plan (SCP) to assist 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. Phase 2 data can also be used to create Fluvial Erosion Hazard (FEH) Zone maps. Please see Appendix D for a description of FEH zones and delineation.

Scope

This report details work from Phase 2 SGAs of the lower LaPlatte River watershed in the towns of Shelburne and Charlotte and a tributary, McCabe’s Brook. The study area for the Phase 2 assessment (Figure 1) included the lower reaches of the LaPlatte mainstem in the towns of Shelburne and Charlotte, M03 – M11, and reaches T1.02 – T1.05 on McCabe’s Brook (landowner access could not be secured for the short and small upper reaches T1.06 and T1.07). The lowermost reaches, M01, M02, T1.01, were not assessed due to influence from Lake Champlain and because the lands are in conservation. The study area for the LaPlatte River included roughly from east of the Dorset Street crossing in Charlotte, northwest to Spear Street, then to Shelburne Falls and ending at the Route 7 Bridge just north of Shelburne Village. On McCabe’s Brook, the study area began north of the Lime Kiln Road crossing in Charlotte, past VT Teddy Bear and under Route 7, north to Harbor Road and ending north of the Shelburne town garages.

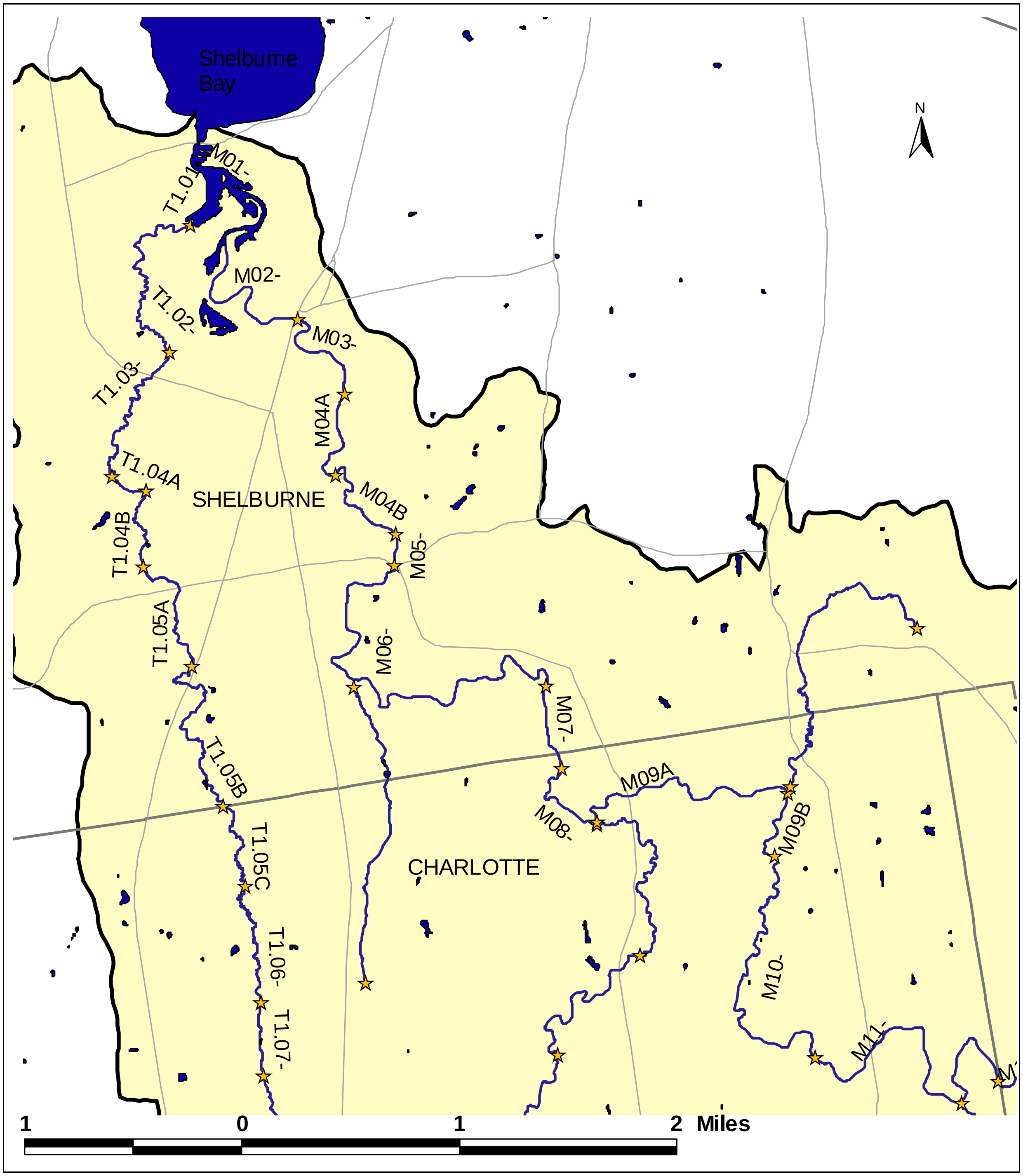

Figure 1. Study reaches in Shelburne and Charlotte with main roads and town boundaries.

The Phase 2 SGA was completed in 2006-2007 through a Special Environmental Project grant from the Town of Shelburne. 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.

A copy of the data and report will be provided to the Towns of Shelburne and Charlotte 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.

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 2) 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 agriculture and mill power. 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, changing runoff characteristics related to increased development in the watershed, and aging flow control dams and diversions in the upper watershed, there is a high likelihood of continued and increased channel adjustment. The reduction in use of land for agriculture and high real estate values has lead to development of these riparian and adjacent 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

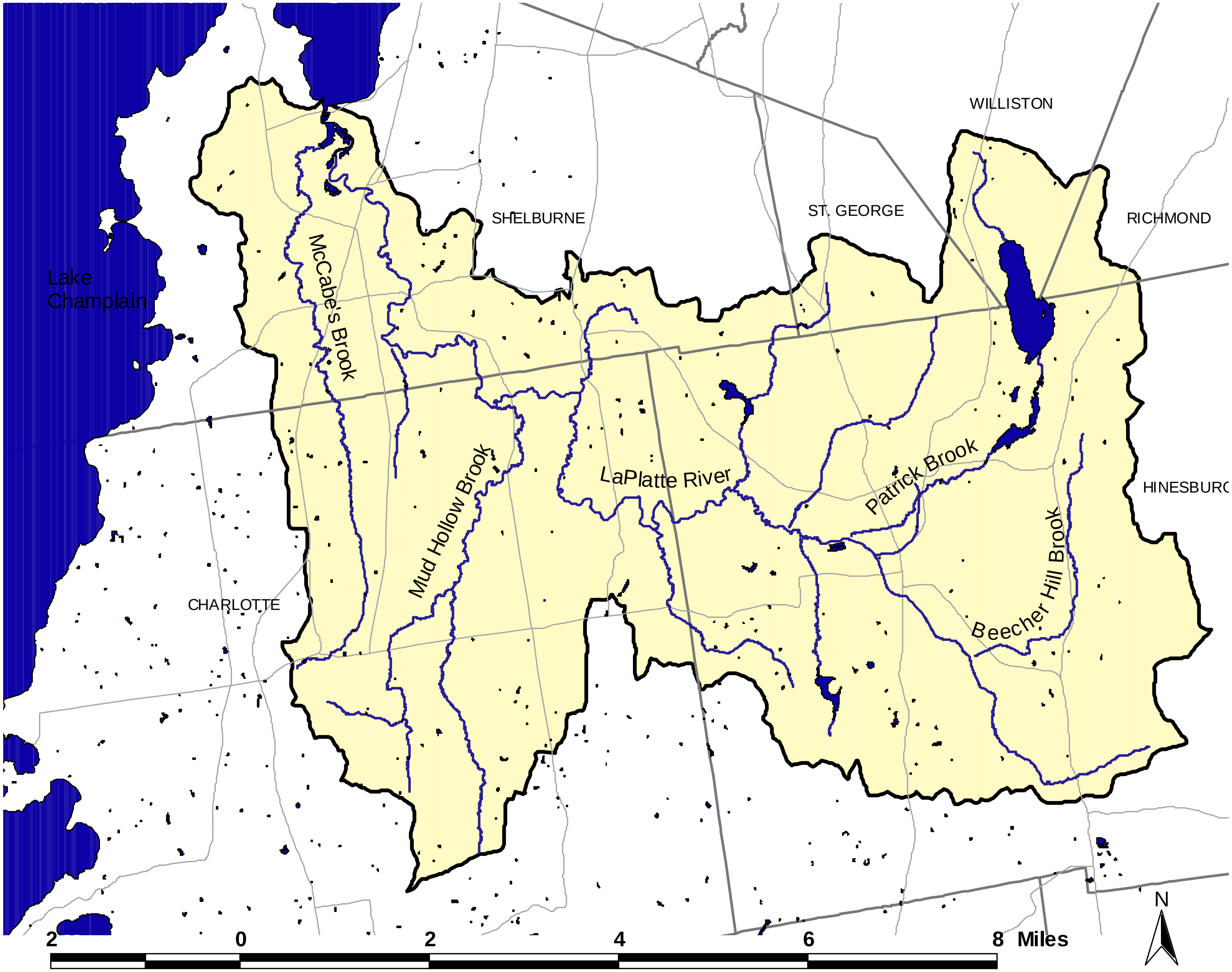

Figure 2. Map of the LaPlatte River Watershed

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]

Study Reaches

The upstream extent of this study was Reach M11 in Charlotte, in a semi-confined valley downstream of the wide, flat Hinesburg Valley. The upper study reaches, M09B-M11, were in the area of silt/clay soils. M09A had a steeper slope and began the area of mixed fine and coarse bank material. The valley widened at M08, promoting agricultural uses, but then narrowed again in M07. Downstream of Shelburne Falls (M05), the LaPlatte became a slow-moving, meandering channel in a broad valley setting with fine-grained bank material. Toward Shelburne Bay and reach M01, the channel becomes delta-like. The downstream reaches of McCabe's brook, T1.01 and T1.02, were also slow-moving meandering channels with fine bank material. This very broad valley extended up to T1.05A, which narrowed with an increase in slope and bank material became a mix of fine and coarse particles. Upstream of this, the valley became slightly wider and less steep again.

Phase 2 Methods

This project exclusively used the VT DEC Stream Geomorphic Assessment Protocols (the Protocols) (VT DEC, March 2006) 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:

- Notified landowners along study reaches before performing the assessment along their segment of river;

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

- Used the Phase 1 data, field checked reaches and types identified in Phase 1 and segmented or modify as necessary;
- Walked the length of each reach to map features and evaluate conditions;
- Photographed and mapped reaches and segments and collected GPS points;
- 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 (VT DEC, March 2006).

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 (VT DEC, March 2006).

Bridge and Culvert Assessment

Phase 2 Bridge and Culvert Assessments were also performed according to the VT ANR Protocols. Bridges and culverts crossing study reaches were assessed and field data entered into the VT ANR Data Management System. Data from these assessments can be used to guide planning for bridge and culvert maintenance or replacement. Refer to the VT ANR Protocols for more on Bridge and Culvert Assessments (VT DEC, March 2006).

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, Kari Dolan, observed assessment procedures in the field to assure the Protocols were followed appropriately. All data entered into the States DMS are reviewed as part of the quality control program.

Phase 2 Results

Table 1 presents results for each reach assessed in the Phase 2 SGA. Included in the table are the reach number, stream type, geomorphic condition category from the RGA, stage of channel evolution, stream sensitivity rating, and habitat condition category from the RHA. Please refer to Appendix A for database reports of Phase 2 SGA data.

Table 1: Summary of results of Phase 2 Stream Geomorphic Assessment

Segment & Town	Stream Type	Geomorphic Condition	Evolution Stage	Sensitivity	Habitat Condition
M03, M04A Shelburne	E5 R-D	Good	I	High	Good
M04B Shelburne	C4 R-P	Good	I	High	Good
M06 Shelburne	B4 PB*	Poor	IV	High	Fair
M07 Shelburne	B5 PB	Good	III	Moderate	Good
M08 Charlotte	C4 R-P	Fair	IV	Very High	Fair
M09A Charlotte	B4 PB	Fair	IV	High	Fair
M09B Charlotte	C5 R-P	Fair	IV	Very High	Good
M10 Charlotte	C5 R-P	Fair	IV	Very High	Fair
M11 Charlotte	B4c R-P	Good	I	Moderate	Good
T1.02 Shelburne	E5 R-D	Good	IV	High	Good
T1.03 Shelburne	E5 R-D	Fair	IV	Very High	Fair
T1.04A Shelburne**	NA	NA	NA	NA	NA
T1.04B Shelburne	C4 R-P	Fair	IV	Very High	Fair
T1.05A Shelburne	F4 R-P*	Poor	III	Extreme	Fair
T1.05B Shelburne	C5 R-P	Good	I	High	Good

* Indicates a Stream Type Departure had occurred.
** T1.04A was not assessed due to backup of water from beaver dams.

Segments M06 and T1.05A appeared to have undergone stream type departures, resulting in significant channel adjustment and a loss of geomorphic functionality.

Reaches M03, M04 M11, and M12 appeared “In Regime,” meaning not undergoing adjustment, and in good condition. These “In Regime” reaches bracketed a group of reaches (M06-M10) undergoing channel adjustments. Having these “In Regime” reaches upstream and downstream of adjusting reaches helps moderate effects of channel adjustment and helps reduce pressures upstream and downstream. Having floodplain access, they also help store sediments and nutrients headed for Lake Champlain. Therefore, protection of these reaches and their stream corridors would be important to preserve their valuable functions. A further step could be to plant woody vegetation or allow it to regenerate in areas where it is lacking.

Watershed Stressors

Impervious Surfaces

Stormwater runoff from impervious surfaces can lead to increased peak flows, increased erosion, and decreased water quality. The Hydrologic Alterations Map in Appendix B highlights changes to the natural hydrology of the area. Note that the study segments all had watersheds with more than 10% urban cover and reach T1.03 had more than 20% urban cover (according to Phase 1 remote sensing data). Stormwater inputs were noted in reaches M06, T1.03, and T1.05. More stormwater inlets likely exist and may enter small tributaries before entering the main channels. Other possible signs of stormwater inputs include gullies, noted in segments M09A, M10, M11, and T1.05B, and tributary rejuvenation, noted in segments M06, M09A, and M11. Gullies and rejuvenating tributaries are also sources of sediment and nutrients.

Erosion

Excessive erosion, as seen in segments M04B, M06, M08, M09A and B, M10, T1.03, T1.04B, and T1.05A, leads to sediment and nutrient loading of the system and deposition in downstream reaches. Mass failures, where large segments of high banks fall or slump into the channel, also contribute sediment to the system. This sediment carries nutrients and also can form deposits downstream, which can instigate or exacerbate channel adjustment. The Sediment Load Indicators Map in Appendix B highlights mass failures seen during this assessment.

Agriculture

Agriculture can be a stressor in terms of addition of nutrients to the system and in reduction of woody buffer areas. Some sections of stream had reduced woody buffer widths due to current or past agricultural practices. This can reduce channel resistance and lead to excess erosion. Stream segments with areas of reduced woody buffer were M06, a small portion of M07, most of M08, M09A, M10, and areas of M11. On McCabe’s Brook, reduced buffer was seen in the lower part of T1.03, much of T1.04, and T1.05.

Some sections of stream ran through pasture areas. Allowing animals free access to the channel causes problems for stream stability and water quality. Animal waste and therefore nutrients are added directly to the water when livestock is near or in stream channels and negatively affects water quality of streams and Lake Champlain. Additionally, bank and bed trampling by livestock contributes sediment and nutrients to waterways. Programs such as CREP work with landowners to fence pasture areas away from waterways and look for alternate drinking arrangements. Tree planting can be a component of such buffer projects as well.

Stream Crossings

Table 2 shows structures assessed during Bridge and Culvert Assessments for study reaches. Structures with signs of significant problems are discussed below. Please see Appendix C for DMS reports with the structure assessment data.

Table 2. Structure Summary Table

Reach Town	Road	Road Type	Stream	Location	Struct Type	Struct Height	Struct Span	Stream Width	% Span/ Stream Width	Floodplain Filled	Stream Approach	Comments
M02 Shelburne	Route 7	Paved	LaPlatte	Route 7 north of Shelburne Village	Bridge	24.0	273.0	50.5	541	Partially	Naturally Straight	Minor bank erosion present.
M05 Shelburne	Shelburne Falls Rd	Paved	LaPlatte	SE of the village over the Falls	Bridge	20	50	50	100	Entirely	Mild Bend	Over the falls and gorge, bedrock controlled area.
M06 Shelburne	Farm Access/ Trail	Trail	LaPlatte River	In the upstream half of the reach	Bridge	7.5	41.5	72.5	**57**	Not Significant	Mild Bend	A snowmobile/farm access bridge. Floodplain not filled for bridge. Minor scour downstream.
T1.03 Shelburne	Harbor Rd	Paved	McCabe’s Brook	Just west of town garage	Culvert	4	7.3	15.2	48	Entirely	Mild Bend	3 culverts and gravel fill stuffed into arch. (New)
T1.04B Shelburne	Trail	Gravel	McCabe's Brook	On Meach Cove Trust Property	Bridge	7.5	17.0	18.4	**92**	Entirely	Mild Bend	Sediment upstream, scour downstream. Scour around footers, high bank erosion.
T1.05A Shelburne	Rail	Railroad	McCabe's Brook	North of Bostwick Rd		12.5	11.8	22.7	**52**	Entirely	Naturally Straight	Old stone structure. Scour downstream. Scour at downstream footers. Erosion.
T1.05A Shelburne	Bostwick Rd	Paved	McCabe's Brook	Just west of Rt 7	Culvert	8.7	7.4	22.7	**33**	Entirely	Mild Bend	Large sediment deposits and widening upstream. Outflow cascades. Scour downstream. Bank erosion present.
T1.05B Shelburne	Route 7	Paved	McCabe's Brook	Rt 7 North of VT Teddy Bear	Culvert	10.0	9.8	37.0	**26**	Entirely	Mild Bend	Outflow at grade. Sediment and bank erosion upstream. Scour downstream (lg pool).
T1.05B Shelburne	Driveway	Paved	McCabe's Brook	Driveway to VT Teddy Bear	Culvert	9.8	13.5	37.0	**36**	Entirely	Mild Bend	Outflow a free fall. Scour downstream.
T1.06 Charlotte	Lime Kiln Rd	Gravel	McCabe's Brook	Approx 0.5 mi east of Rt 7	Culvert	4.0	4.0	19.6*	**20**	Entirely	Mild Bend	Outflow at grade. Fallen tree obstructing upstream end, scour downstream.
M09 Charlotte	Spear St	Paved	LaPlatte River	At the Spear St crossing.	Bridge	12.7	53.4	60.7	**88**	Entirely	Mild Bend	Sediment deposition upstream, bank erosion.
M10 Charlotte	Carpenter Rd	Paved	LaPlatte River	On Carpenter Rd, west of Dorset St.	Bridge	16.0	63.0	43.0	147	Entirely	Channelized Straight	Stream appeared straightened in this area. Bedrock present upstream.
M11 Charlotte	Dorset St	Paved at bridge only.	LaPlatte River	Dorset St just south of Carpenter Rd.	Bridge	15.0	82.0	57.0	144	Entirely	Mild Bend	Deer carcasses, trash dumped at bridge. Scour ds. Failing rip-rap and bank erosion.

* Phase 1 estimated stream width

Recent recommendations from VT River Management encourage sizing structures to 1.25-1.5 stream width (125-150%). The % Span/Stream Width column in Table 2 shows the existing structures' width as a percent of stream width. Numbers in bold type indicate structures whose span and other problems pose threats to structure failure or stream equilibrium. More details of structures at highest risk appear below, roughly in order of severity.

Both structures in segment T1.05A constrict the channel and block the floodplain. The Bostwick Road culvert has significant sediment deposits and channel widening upstream, with bed degradation downstream. This signals a break in sediment continuity where the culvert traps sediment upstream and resulting "hungry water" scours the bed and banks downstream. The floodplain is entirely blocked by the elevated and filled roadbed. Erosion and floodwater buildup could undermine the structure eventually, however more importantly from a geomorphology perspective this scenario has led to significant channel adjustments downstream including bed incision and bank erosion.

Bostwick Rd crossing in T1.05A with large sediment deposits and channel widening upstream.

Along the stream, this structure is followed closely by a railroad bridge with similar effects. Again, the floodplain is entirely filled by the rail bed and the structure constricts the channel. Extreme bed degradation including headcuts was observed downstream. Bed degradation continued into segment T1.04B. Replacement of these structures with appropriately sized structures is important to help the stream regain equilibrium. The size and age of the railroad structure, an old stone structure, complicates replacement.

Railroad crossing on T1.05A from downstream looking upstream.

The bridge in segment T1.04B also appeared to be affecting channel geomorphology. This structure constricted the channel and the road approaches completely filled the floodplain. Sediment was deposited upstream with severe bank erosion and channel migration observed downstream. Widening this structure and lowering to approaches to allow for passage of flood flows and sediment could help alleviate these problems.

Bridge in T1.04B (L) and erosion downstream (R).

The structure on Lime Kiln Road in T1.06 was significantly smaller (20%) than the channel width (as estimated in Phase 1 SGA). This structure was also obstructed at the upstream end by a fallen tree. Downstream, the high velocities produced by the culvert had scoured a large pool. This structure appears at risk of failure by washing out due to being undersized and blocked by a large tree upstream. Furthermore, sediment from the dirt road appeared to wash into the channel at this point. Resizing the culvert and removing the debris is recommended.

Lime Kiln Rd culvert with upstream obstructions (L) and scour pool downstream (R).

Two structures, closely spaced, in segment T1.05B constricted channel width. Both had scour pools at the downstream end, the one at the Route 7 bridge was particularly large. Again, entirely filled floodplains cause all flow to pass through these narrow structures, increasing velocities and scouring the bed and banks downstream. While the structures themselves appeared well built and not likely to fail in the near term, they interrupted geomorphic functions and contribute to channel adjustments.

Structures in T1.05B: Route 7 crossing (L) and VT Teddy Bear drive (R).

The Spear Street Bridge in segment M09A did slightly constrict the channel width (88%) and had sediment deposition upstream and bank erosion present. Again, the floodplain was entirely filled by the road approaches, forcing all flood flows through this structure. Bank armoring was present as well, but resizing this structure could alleviate bank pressure and reduce erosion.

In reach M06, a farm access bridge constricts the channel width. Minor scouring of the channel bed was present downstream of the structure. Reach M06 did appear to be incised, so additional pressure would be placed on the banks in higher than bankfull flows that are not high enough to reach the floodplain. This structure could be at risk of failure from erosion due to it constricting the channel, however, the floodplain did not appear to have been filled for the roadway or the approaches to the structure. Therefore flood flows that reach the floodplain could pass over the road and around the structure.

Farm access bridge in M06.

Reach Stressors

The following summaries highlight conditions for each reach or segment and the impacts likely leading to current conditions.

M03, M04A

Reach M03 (L) and spectacular cliffs along the right bank between M03 and M04A (R).

Reach M03 began at the crossing of Route 7, just north of Shelburne Village. This reach was quite short, measuring 3060 feet long. Channel slope was shallow, with deep, slowly moving water (E Ripple-Dune stream type). The stream had floodplain access, but appeared to be slightly incised from its main terrace, possibly due to increased peak flows from stormwater runoff. The channel did not appear to have been altered or straightened and the minor erosion observed could be natural or from the possible increased peak flows. Stream banks were steep and composed of a cohesive sand/clay mix. An area of spectacular cliffs on the right bank was near the reach break between M03 and M04. Bank vegetation was deciduous trees with herbaceous under story. Buffer width was greater than 100 feet on each bank, with a forested riparian corridor and Route 7 encroaching into the corridor toward the downstream end. Beaver activity was evident with a dam and pond on the floodplain. RHA condition was “Good,” although epifaunal substrate and fish cover was only “Fair” due to lack of sufficient LWD, snags, and submerged vegetation. RGA condition was “Good” and the reach appeared to be “In Regime” (Stage I). Stream sensitivity was “High.” The downstream portion of reach M04 was similar, therefore M04 was segmented and M04A (downstream segment) was assessed with reach M03.

M04B

The downstream portion of reach M04 was similar, therefore M04 was segmented and M04A (downstream segment) was assessed with reach M03.

Segment M04B, the section below Shelburne Falls, had a slightly steeper slope than M03 and M04A, and appeared to be a C4 Riffle-Pool stream type. RGA condition appeared “Good,” although minor planform adjustments were apparent with high banks on outside bends showing erosion. Two mass failures were present on high outside banks. Some bank erosion on outside bends is natural, though. Overall, the segment appeared to be “in regime” and in channel evolution stage I. Floodplain access was good. RHA condition was also “Good.” Some sediment deposition and eroding banks lowered habitat scores from “Reference.” Deciduous and mixed tree forests occupied the riparian corridor.

Bank erosion signaling planform adjustments and contributing sediment.

Mass Failure on an outside bend with trees falling into the channel to become LWD.

M06

Reach M06 began just southwest of the intersection of Spear Street and Thomas Road and ended upstream of Shelburne Falls (12,025 feet long). The reference stream type for this reach appeared to be a C4 Riffle-Pool, but due to channel incision, the reach experienced a stream type departure to a B4c Plane Bed type. Floodplain access was limited, although old channels and/or flood chutes on the upper terrace could provide additional floodplain access and relief from high flows. Incision appeared to be historical, as did channel widening. Current channel adjustments appeared to be aggradation and major planform. Bank erosion, islands, and multiple mass failures were indicators of these adjustments with significant contributions to sediment loads. Also contributing sediment were rejuvenating tributaries in the reach and gullies from stormwater inputs. Shelburne Falls at the downstream end of the reach provided grade control.

Bank erosion on an outside bend, contributing sediment (L) and one of many mass failures in M06 (R).

M07

Reach M07 was fairly short, 2158 feet long, and appeared naturally straight in a narrowly confined valley setting with little floodplain. The “reference” stream type was B5 Step-Pool, however major aggradation filled pools, leaving the stream a Plane Bed type. Overall, geomorphic condition appeared “Good” with historical widening and the current aggradation adjustments. RHA condition was “Good” with low mix of substrate types, embedded particles, incomplete riffles, and sediment deposition affecting scores. Some hay fields on the right bank encroached into the otherwise forested corridor.

M08

Right bank erosion and diagonal bar.

Reach M08 flowed through a broad valley dominated by herbaceous and shrub/sapling vegetation. The stream type appeared to be a C4 Riffle-Pool. Multiple sediment deposits (mid, point, side, and diagonal bars) were present. Many flood chutes and areas of bank erosion were observed. The reach appeared to be in “Fair” RGA condition, the major adjustment process being planform with minor aggradation (channel evolution stage IV). RHA condition was also “Fair,” being affected by the aggradation and lack of woody bank vegetation. A shooting range was in the corridor on the left bank and a hay field on the right bank.

Trash close to the channel at the shooting range. Photo taken from the top of the left bank.

M09A

Reach M09 was segmented into two segments due to varying planform and slope characteristics. Segment M09A (downstream segment) had a steeper slope and appeared to be a B4 Plane Bed stream by reference. Adjacent side slopes in the narrow valley were steep to very steep. The channel appeared to have incised from an older terrace in the past, with current adjustment processes being minor aggradation, widening, and planform. Overall stream condition appeared “Fair” and the channel in stage IV of evolution. RHA condition appeared “Fair,” affected by bank instability, infrequent riffles, sediment deposition, and lack of cover. Some crop areas encroached into the corridor on both banks with forest in the majority of the corridor. Bank vegetation was dominated by herbaceous species. Multiple sediment deposits (bars) were present. A bridge at Spear Street constricted the bankfull width, with signs of deposition upstream.


Mass Failure in M09A.


Several flood chutes were seen in M09A, signaling planform adjustment.

M09B

Segment M09B appeared to be in a slightly shallower valley, although also narrow, with a stream type of C5 Riffle-Pool. The riparian corridor was forested, with the same herbaceous bank vegetation as in M09A. This segment also appeared to have incised from an older terrace in the past, with current adjustment processes being planform with minor aggradation. Overall stream condition appeared “Fair” and the channel in stage IV of evolution. RHA condition appeared ‘Good” with bank instability and sediment deposition being the main factors affecting habitat. Some signs of beaver activity were observed in the segment.

M10

Tree Revetments

Reach M10 appeared to be a C5 Riffle-Pool stream type in a broad valley setting with steep adjacent hill slopes. Bank vegetation was herbaceous, as was the majority of the corridor vegetation with some saplings and forested areas. Many wetland areas were near the channel, which could account for some of the herbaceous vegetation. Many sediment deposition types (mid, point, side, diagonal bars) were noted in the reach along with two islands. Much bank erosion and several mass failures were present in the reach, contributing sediment. Current adjustments were major planform and minor aggradation and widening. The channel did not appear incised. Overall RGA condition was “Fair” and the channel appeared to be in stage IV of channel evolution. RHA condition appeared “Fair” with sediment deposition, embeddedness, and bank instability the main factors affecting habitat scores. Some ledges provide grade control in the reach, and one bridge constricts the flood prone width.

Ledge grade control and herbaceous bank vegetation (L), and one of several mass failures in the reach (R).

M11

Reach M11 had a fairly shallow slope for its semi-confined valley setting. The stream type appeared to be B4c Riffle-Pool. Beaver activity increased toward the upstream end of the reach, with a large dam and pond on a tributary. The riparian corridor was forested, however downstream of the bridge, cows had free access to the channel and many crossing areas and areas where banks were trampled noted. The channel did not appear incised, however tributary rejuvenation was noted, possibly due to beaver activity in the upstream areas, and land use at the downstream end. One bridge constricted the floodprone width and had scour downstream. Trash and deer carcasses were seen dumped on the banks at the bridge. Trash and old farm equipment were dumped on the right bank roughly in the middle of the reach. RGA condition appeared "Good" with only minor aggradation observed. The reach was considered "in regime." RHA condition was also "Good." Few substrates for food and cover were present. Riffles and diversity of velocity/depth patterns were infrequent.

Animal access to channel and bank trampling (L) and cows with full access to the channel (R).

T1.02

Reach T1.02 was a low gradient stream in a very broad valley setting. The stream had high sinuosity and appeared to be an E5 Ripple-Dune stream type. The riparian corridor had wetland areas and herbaceous and sapling vegetation. The outer corridor and adjacent lands were forested. Banks were fairly unstable with more slumping rather than erosion observed. Several debris jams and signs of beaver activity were seen in the reach. Two meander bend cutoffs were noted. At the downstream most end of the reach, water was backed up, likely from beaver activity in T1.01 and from lake effects. The reach appeared to have been straightened historically and the topographic map shows a significantly straighter stream line than the recent orthophotos. The reach did not appear incised, with current adjustments being planform with minor widening and aggradation. Overall, the reach appeared to be in stage IV of channel evolution and in “Good” condition. RHA condition appeared “Good.” Bank instability was the main factor affecting habitat with additional effects from sediment deposition in pools.

T1.03

Reach T1.03 was also a low gradient stream in a very broad valley with an E5 Ripple-Dune stream type. Bank and buffer vegetation was herbaceous with some shrubs and saplings and deciduous trees. One bridge constricted the bankfull width with deposition upstream and scour downstream. Much bank slumping and erosion on outside bends was noted, signaling planform adjustments The Town of Shelburne garage and sand pile encroached into the corridor at the downstream end of the reach. Evidence of beaver activity was also seen in the reach, especially toward the upstream end and into T1.04A. RGA condition appeared “Fair” with major planform and minor aggradation adjustments. The reach appeared to be in stage IV of channel adjustment. RHA condition appeared “Fair,” affected by bank instability, sediment deposition, and lack of substrates for food and cover.

Bank slumping in T1.03.

T1.04A

View of segment A with a beaver dam and lodge and backed up water.

Reach T1.04 was segmented due to beaver dams and flow back up at the downstream end. Segment T1.04A was in a very broad valley setting. The riparian corridor was forested with some shrub/sapling areas. Bank vegetation was herbaceous. No corridor encroachments were noted.

T1.04B

Bank erosion and point bar in T1.04B

Segment T1.04B began just downstream of a large, old railroad bridge. The bridge appeared to be causing increased velocities and incision downstream. Segment T1.04B had much bank erosion and signs of planform adjustment and aggradation such as flood chutes, diagonal bars, and multiple sediment deposits. Bank vegetation was herbaceous, as was corridor vegetation, with some shrubs/saplings and forested areas. One bridge constricted the bankfull width and had deposition upstream and scour downstream. The segment appeared to be slightly incised, but not entrenched. RGA condition was "Fair," with extreme planform adjustments and minor degradation, aggradation and widening. The segment appeared to be in stage IV of channel evolution. RHA condition was "Fair," again affected by bank instability, sediment deposition, exposed channel substrate, and low mix of substrates for food and cover.

Left bank erosion with closely cropped herbaceous bank vegetation offering little bank protection.

T1.05A

Reach T1.05 was segmented due to different planform and slope conditions as well as grade controls present in segment A.

Segment T1.05A began at the T1.05 reach point (south of Bostwick Rd and the railroad crossing) and ended approximately 700 feet downstream of the Route 7 crossing. Segment T1.05A had several bedrock ledges acting as grade controls, providing bed stability. The segment appeared to have incised from a former terrace, resulting in a stream type departure (C to F). Bed substrate was gravel. Current adjustment processes appeared to be widening and planform. Multiple gravel bars signaled minor aggradation.

Close to the channel was open with herbaceous vegetation and invasive honeysuckle. Further out in the corridor was more forested with deciduous trees and shrubs/saplings. Overall habitat was “Fair,” affected by sediment deposition and bank instability. Many fish and frogs were seen in the channel however.

T1.05B

Segment T1.05B had a shallower slope, smaller substrate size and in a broad valley setting. The segment appeared to be “in regime,” remaining a C Riffle-Pool stream type and in “good” condition. Minor planform and widening processes were observed, and could be related to the lack of woody bank vegetation.

Bank and buffer vegetation was herbaceous with some shrubs/saplings. Some areas of forested corridor were present in the upstream portion of the segment. RHA condition was “good” but lacking sufficient mix of substrates and large pools. A cattle watering area had been fenced out in the channel and had turned into a large pool. For water quality purposes, cattle should be fenced out of the channel and alternative watering methods used.

Some bank planting projects were apparent in the downstream half of the segment, although not all of the trees had survived. Additional plantings could be installed.

What appeared to be a small catamount was seen in the upper portion of the segment.

Next Steps

Planning for the Future

Most reaches in the LaPlatte River and McCabe's Brook assessed in this project were undergoing channel adjustments related to historical land use and channel management practices as well as current alterations to hydrology and sediment loads. Proper planning now could reduce future disturbances in order to limit costly damage to land and infrastructure in future flood events.

For example, increasing impervious surfaces in the 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.

Further Study

The LWP has secured grant funds to compile a Stream Corridor Plan (SCP) for reaches M06 through M11 in the Shelburne and Charlotte area in 2007. 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 this SCP, possible stormwater effects should be examined, especially with regard to incision in reach M06. Looking at stormwater GIS coverages for points where stormwater enters the system and more details of impervious surfaces could help in this analysis.

The LWP will also be analyzing data collected in this study in conjunction with water quality data for additional signs of stressors. The Phase 2 data from this study could help explain fluctuations in water quality seen in sampling data. Combining these 2 datasets will be a valuable tool as the LWP moves forward with corridor planning efforts.

The LWP is also interested in using the Phase 2 data from this study to create Fluvial Erosion Hazard (FEH) Zone maps using RMP tools and guidelines. FEH corridors identify approximate boundaries and intensities of erosion hazard risk for each stream segment. The FEH tools developed by the RMP use Phase 2 SGA data to assign a belt width and a sensitivity rating for each segment. FEH maps are useful planning tools to help minimize future risks and costs associated with channel encroachment.

Examining options for the McCabe's Brook area of T1.04B and T1.05A and pursuing corridor planning and possibly restoration is recommended as part of a future project.

Additional streams in Shelburne and Charlotte that drain directly into Lake Champlain have been identified for Phase 1 assessments in 2007-2008 with funding secured from the Clean & Clear program through RMP.

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.

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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
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.

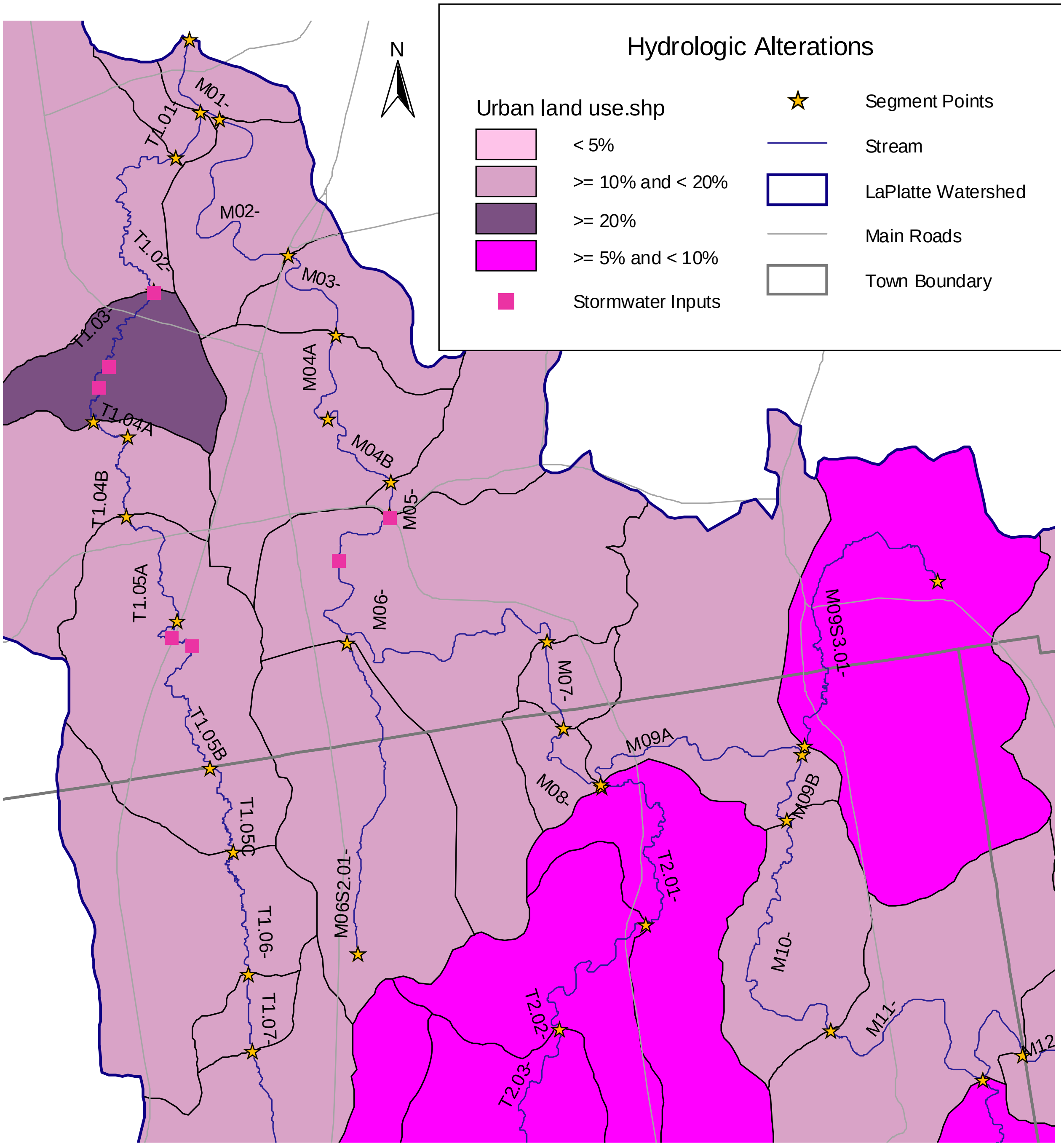
Sinuosity – The level of bends or turns in a stream, calculated by dividing the stream length by the valley length.

Thalweg – Deepest point along the length of the stream, as if the deepest point of all cross sections were connected. The thalweg of a meandering channel typically alternates from right to left bank connecting pools.

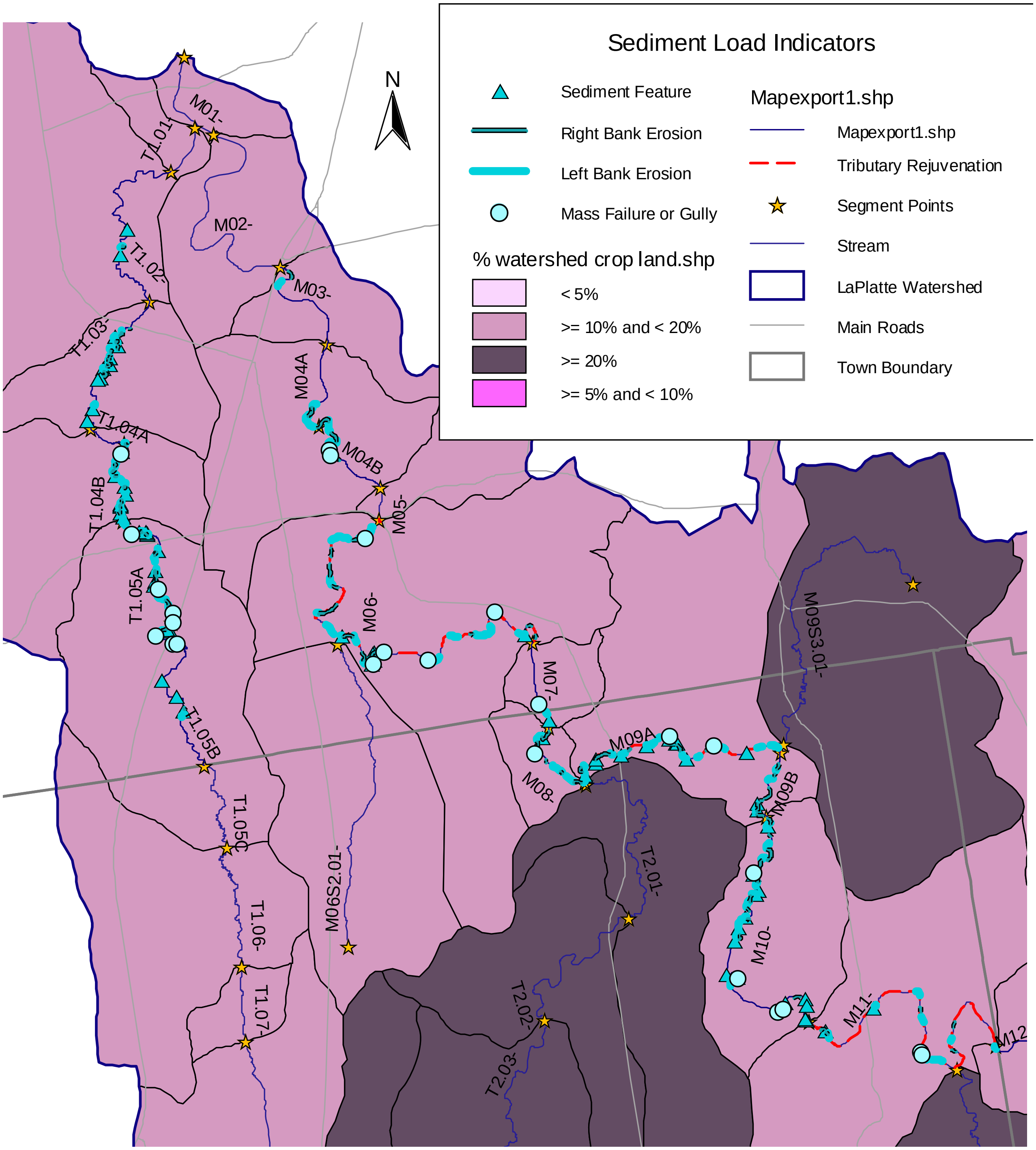
Width/depth Ratio – The ratio of channel bankfull width to the average bankfull depth. An indicator of channel widening or aggradation.

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

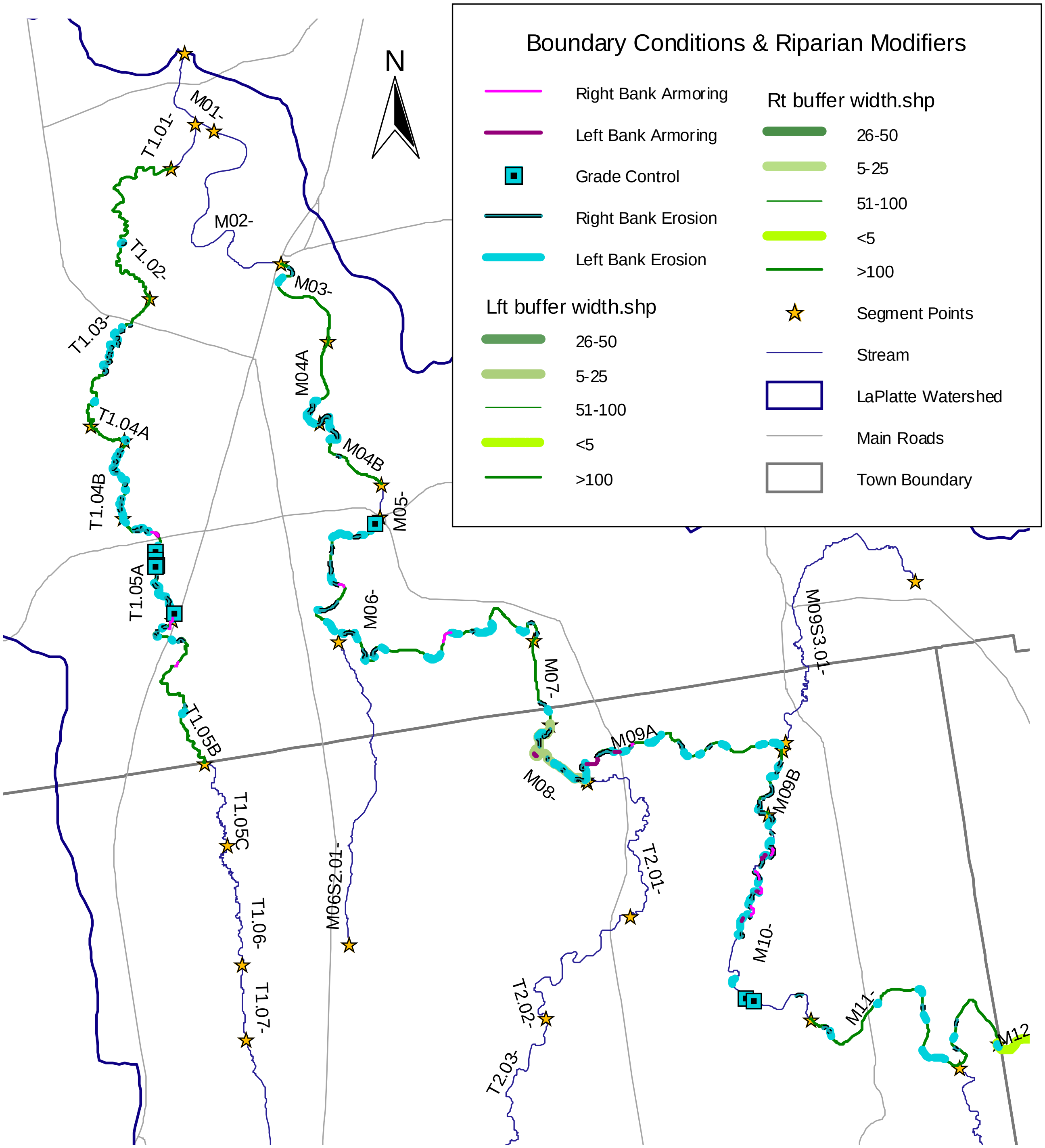
Appendix B – Mapping



The variations in maroon shading of the sub watersheds indicate the percentage of the entire watershed to that point that is urban. Stormwater inputs identified in the assessments are indicated by the pink squares. Additional stormwater inputs may exist and enter small tributaries first.

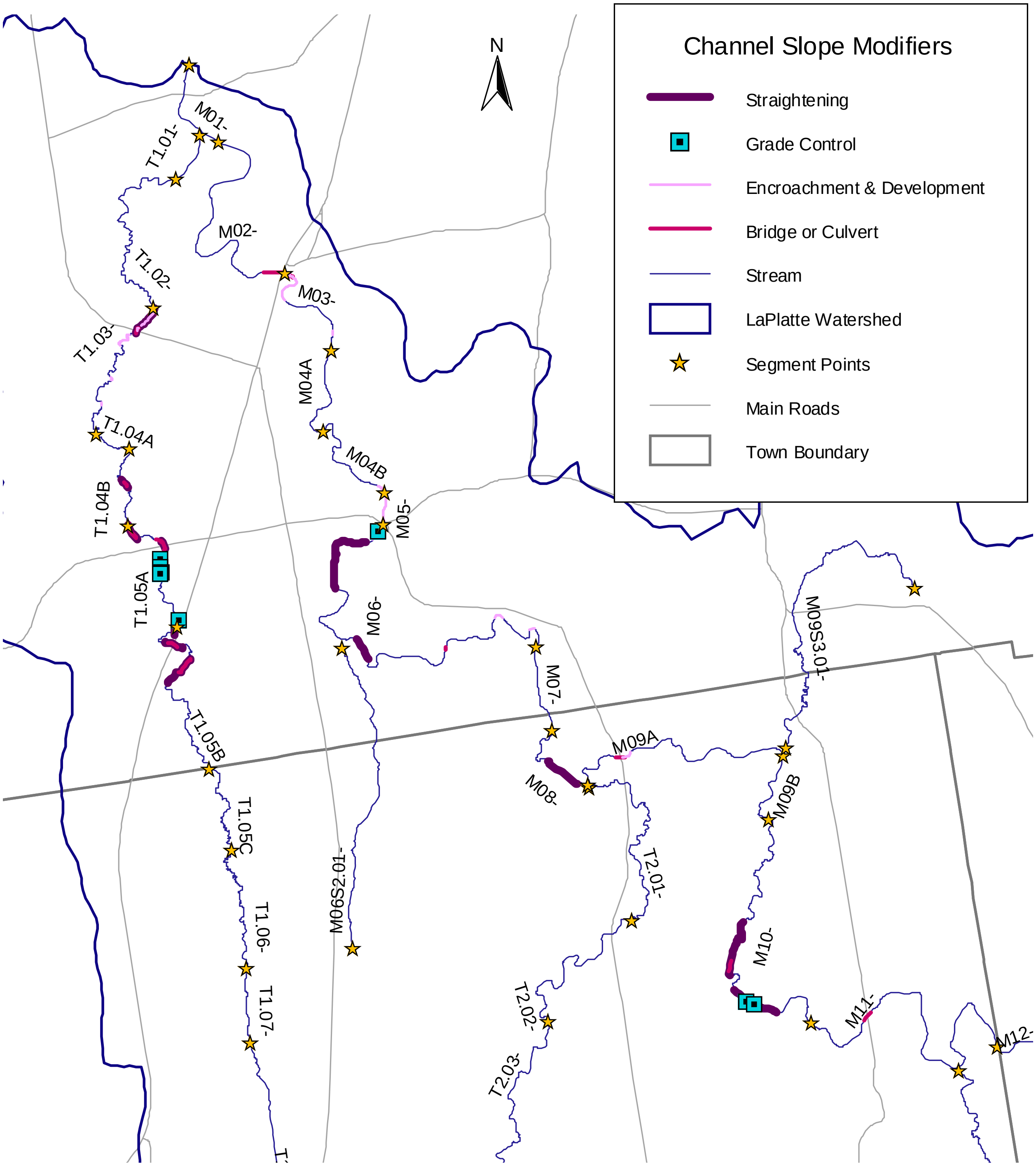


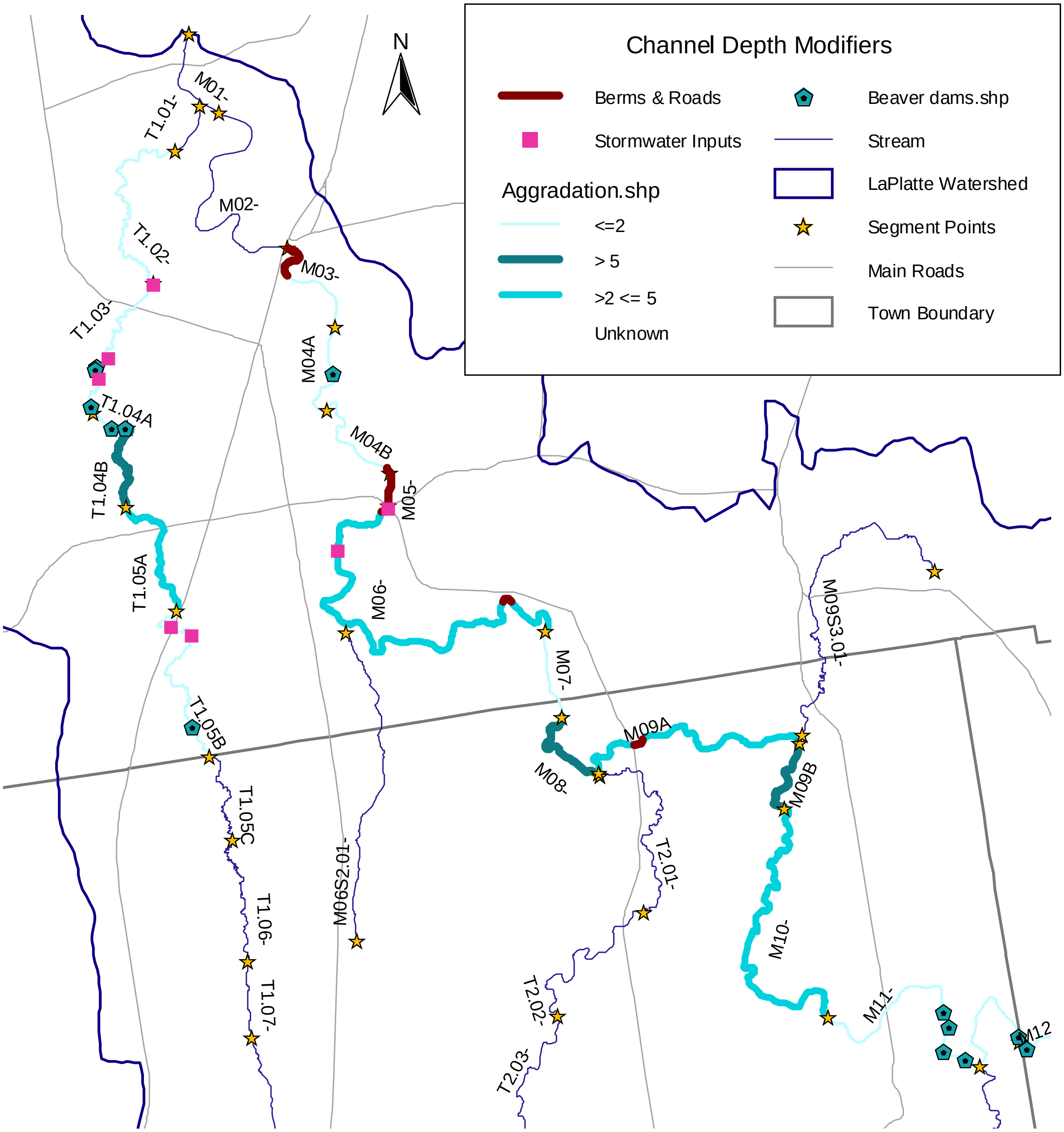
The variations in maroon shading of the sub watersheds indicate the percentage of the entire watershed to that point that is cropland. Sediment features indicated by the blue triangles include: steep riffles, flood chutes, avulsions and braiding. Streamlines with red dashes indicate segments where tributaries were rejuvenating, or incising to meet a new, lower bed elevation in the receiving stream. Rejuvenating tributaries can be significant sources of sediment.



Blue lines highlight many areas of erosion. Reach M08 had buffer width of only 5-25 feet. Grade controls, present in M05, M10, and T1.05A limit further bed incision in those areas. Relatively little bank armoring was observed and was typically in areas of road crossings. Bank armoring in M10 consisted of log revetments. Stressors in blue and green tones signify those that act to reduce channel resistance to stream power while those in red tones signify stressors increasing resistance.

The following two maps, Channel Slope Modifiers and Channel Depth Modifiers, show stressors leading to increases (red shades) or decreases (blue shades) in stream power.




Channel Depth Modifiers
Berms & Roads
Beaver dams.shp
Stormwater Inputs
Stream
Aggradation.shp
LaPlatte Watershed
<=2
Segment Points
> 5
Main Roads
>2 <= 5
Town Boundary
Unknown
N
M01-
T1.01-
M02-
T1.02-
M03-
T1.03-
M04A
T1.04A
M04B
T1.04B
M05-
T1.05A
M06-
T1.05B
M07-
M09A
M09S3.01-
M08-
M09B
T1.05C
T2.01-
M06S2.01-
T1.06-
M10-
T2.02-
T1.07-
M11-
M12
T2.03-

Appendix D: Corridor Delineations

Two corridors are identified through the SGA process:

1. Phase 1 Stream Corridor (S09 from SGAT);
2. Fluvial Erosion Hazard (FEH) corridor.

Phase 1 Stream Corridor

The Phase 1 Stream Corridor as described by the Protocols "…attempts to define a width of land on either side of the river, together called the river corridor, that will capture:

- Factors influencing runoff and erosion;
- Factors influencing flood plain function; and
- A minimum width of land within the overall valley width that may be occupied by the active stream channel, as slope and dimension remain in balance with the watershed inputs." (VT DEC Stream Geomorphic Assessment Handbook, Phase 1, Appendix E, p. E1.)

Data inputs for development of the Phase 1 Stream Corridor include valley wall delineations, stream meander centerlines, reference stream channel width, valley width, and reference stream type.(VT DEC SGA Handbook, Phase 1, Appendix E, p. E1.)

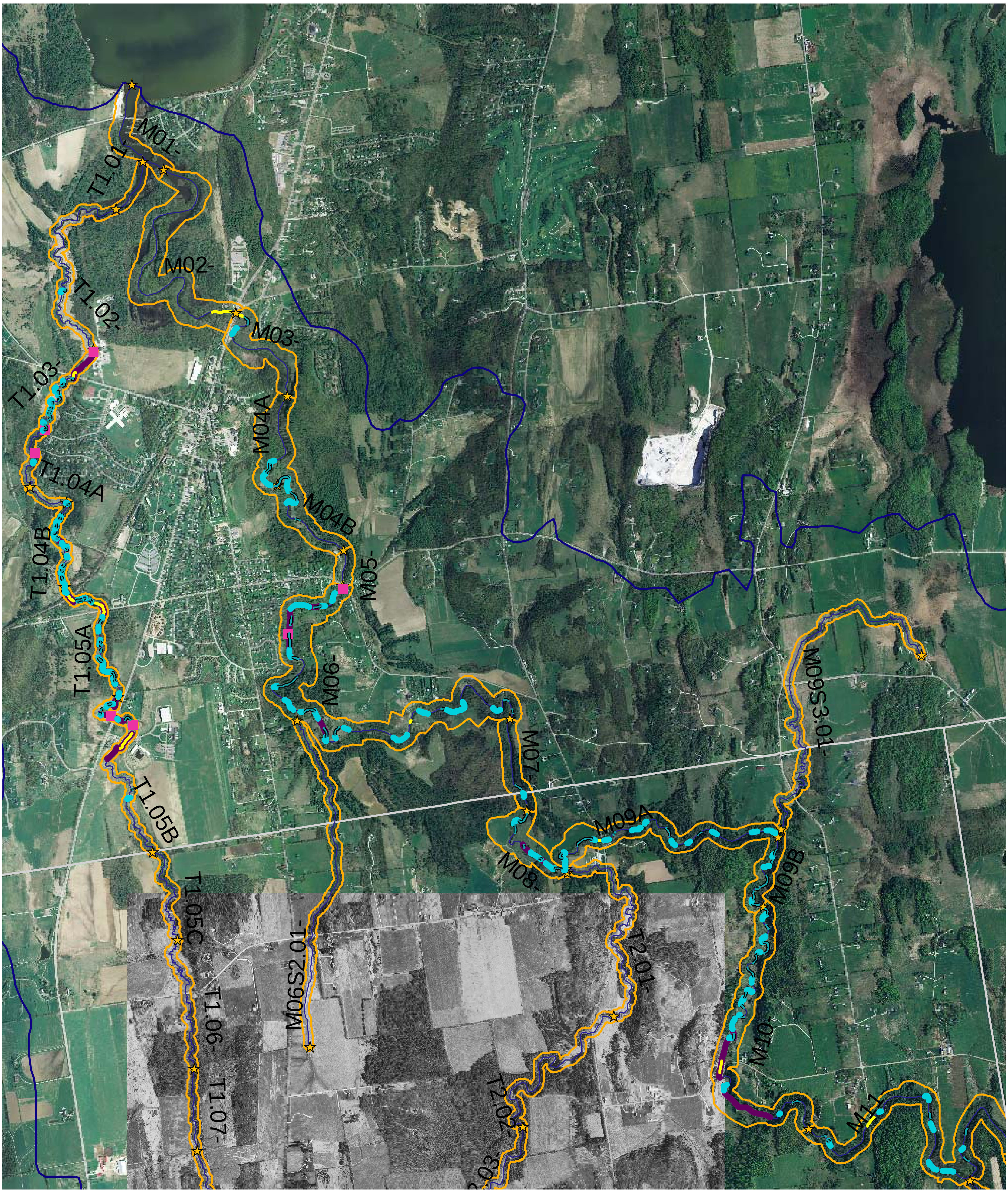
The RMP included a special note about the Phase 1 corridor: "The stream and river corridors delineated for the Phase 1 Stream Geomorphic Assessment are determined for the purposes of evaluating the possible impacts of various factors influencing runoff (i.e. land use/cover) and floodplain modifications. They are not intended to empirically show floodplains, flood prone areas, or flood hazard areas." (VT DEC Stream Geomorphic Assessment Handbook, Phase 1, Appendix E, p. E5.) Please refer to the Protocols for more on Phase 1 stream corridor delineation.
http://www.anr.state.vt.us/dec/waterq/rivers/htm/rv_geoassesspro.htm

FEH Corridor

FEH corridors identify approximate boundaries and intensities of erosion hazard risk for each stream segment. The FEH tools developed by the RMP use Phase 2 SGA data to assign a belt width and a sensitivity for each segment as follows (Color codes in the table correspond to colors used in the FEH maps to highlight the FEH corridor):

Stream Sensitivity	**Belt Widths based on Reference Channel Widths from Phase 1**
Very Low (VL)	**Equal to the reference (Phase 1) channel width.**
Low (LW)	**Equal to the reference (Phase 1) channel width.**
Moderate (MD)	**Four (4) channel widths.**
High (HI)	**Six (6) channel widths.**
Very High (VH)	**Six (6) channel widths.**
Extreme (EX)	**Six (6) channel widths.**

A detailed survey of slopes and soils including soils erodability is not performed. Therefore the FEH corridor is a best estimation of the area likely to be occupied by the active stream channel and erosion risks can extend beyond the corridor area.
Please refer to http://www.anr.state.vt.us/dec/waterq/rivers/htm/rv_floodhazard.htm for more on FEH corridors and application.



Stream Corridor and Select Impacts

☐ Stream Corridor

━ Left Bank Erosion

LaPlatte River and McCabe's Brook
in Shelburne and Charlotte