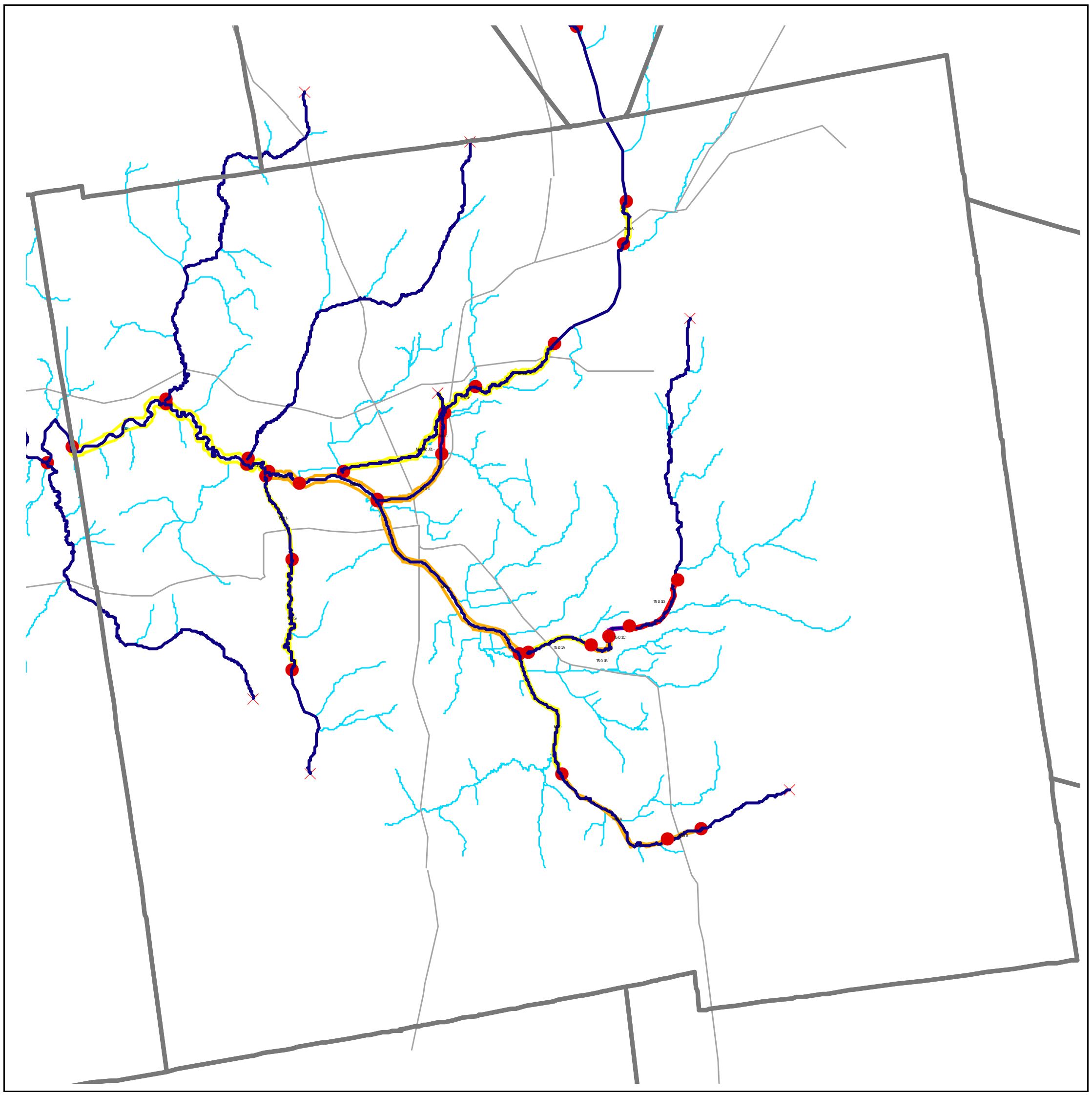
Stream Corridor Plan
LaPlatte River and Tributaries
Town of Hinesburg, Vermont



Prepared by the LaPlatte Watershed Partnership

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The LWP thanks Pam Brangan at the Chittenden County Regional Planning Commission for producing the Stressor and Departure maps for this Corridor Plan.

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

Executive Summary

The Stream Corridor Plan was developed based on previously completed geomorphic assessments on the main stem of the LaPlatte River and selected tributaries in a geographically discreet area of Hinesburg. Phase 1 and 2 geomorphic assessments had been completed for the LaPlatte and the tributaries within the proposed Hinesburg growth center areas and identified geomorphically sensitive reaches of the LaPlatte River, Patrick Brook, and Beecher Hill Brook that would benefit from river corridor protection and restoration initiatives. The Stream Corridor Plan (SCP) serves to inform both landowners and town officials of the assessment results and allows for the development of river corridor protection projects. Building on previous work by the Hinesburg Conservation Commission, US Partners for Wildlife, and Natural Resources Conservation Service, and the LaPlatte Watershed Partnership this plan creates a framework to identify and prioritize projects that will have the long term benefit for landowners, the town and water quality of the LaPlatte and Lake Champlain.

The multiple uses of the SCP include:

Support for the Planning Commission's effort to create a framework for regulations as part of the Village Growth plan that recognizes the importance of "Managing the conflict between people's land use expectations and river dynamics should be based on an examination of alternative and cost-benefit analyses, in both the short and long term, to both private and public interests.[1]" And provides the opportunity to be proactive and to avoid further conflicts as development occurs. Both a Fluvial Erosion Hazard Map and a Surface Water Resource Overlay map were developed as part of the SCP.

Use by the town Select Board and highway department in evaluating infrastructure improvements and guides process to assure that public investments are economically and ecologically sustainable. Use as a tool for improving structures at stream crossings based on geomorphic assessment data.

Facilitation and communication of a science based approach to resolving conflicts between streams and landowners.

The SCP was developed through analysis of geomorphic assessment data, landowner contacts and communication with town boards. Stream reaches evaluated in this study present a variety of management options. All of the reaches have been actively managed at some point in the past, or continue to be managed, for varying reasons. Management alternatives for each reach were analyzed and can be classified under one of the following categories: Active Management, Conservation, Passive Geomorphic Restoration, and Active Geomorphic Restoration.

Potential restoration and protection projects were analyzed following the RMP Corridor Planning Guide (VT ANR River Management Program 2 January 2007) and step-wise procedure to identify projects that would be compatible with geomorphic adjustments and managing the stream toward equilibrium conditions. Types of projects include: Protecting River Corridors, Planting Stream Buffers, Stabilizing Stream Banks, Arresting Head Cuts and Nick Points, Removing Berms, Removing or Replacing Structures, Restoring Incised Reaches, and Restoring Aggraded Reaches.

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[1] Vermont DEC River Management Program. Alternatives for River Corridor Management. Position Paper. April 18, 2003. P1.

Of the potential projects identified in the Corridor Planning process, the LWP has identified the Beecher Hill Brook T5.01 B Corridor Protection and T5.01D restoration projects as important and feasible for immediate action. The LWP will be applying for funding to develop and implement these projects.

The LWP will also be working to develop funding proposals for additional projects in the coming years. Projects seen as priorities and feasible include M15B-1 on Town land upstream of the sewage treatment plant and projects on M15S2.01 related to restoration of the historical Patrick Brook.

The LWP will also continue to work with the Town of Hinesburg to implement strategies for protecting the LaPlatte River and tributaries with the goal of reducing future conflicts and costs.

Introduction

The LWP has undertaken a stream corridor planning process by exploring potential stream corridor restoration and protection projects that were geomorphically compatible with the current channel condition and adjustments. The goals of the Stream Corridor Plan (SCP) were to develop projects with the goal of increasing the capacity for stream corridor capture and storage of sediment and nutrients in the watershed in order to reduce sediment and nutrient loading of Lake Champlain. Previous studies including Phase 1 and Phase 2 Stream Geomorphic Assessments (SGA) provided an information basis for the identification of corridor planning activities.

Funding for the development of the Corridor Plan was through a Category 2 Clean and Clear Grant from the VT Department of Environmental Conservation (DEC) River Management Program (RMP). The RMP aims to reduce long-term costs, damage, and risk and increase safety by identifying streams in adjustment and working to address stressors and move streams toward equilibrium conditions. The RMP has promoted the Corridor Planning Process to help achieve these goals.

Background

Setting

The LaPlatte River Watershed (Figure 1) 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."[2]

The LaPlatte River Watershed 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.

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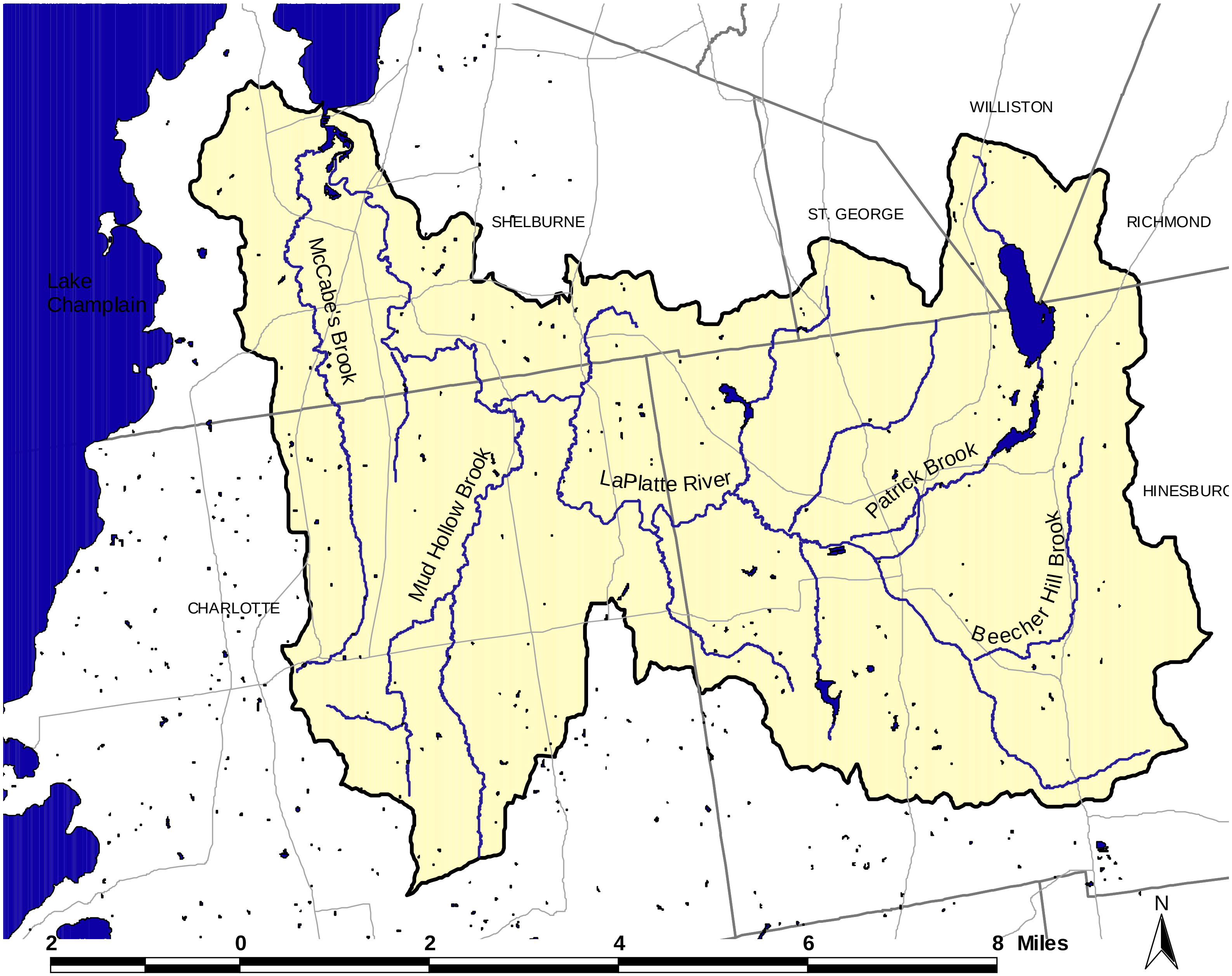
[2] Stewart, David P., 1973 Geology For Environmental Planning in the Burlington-Middlebury Region, Vermont

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.



LaPlatte River Watershed

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 are alluvial deposits of a sand, clay and silt mix. Some clay is present along lower banks, adding bank stability. Bank vegetation is 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 have 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, has significantly reduced stream function and adjacent wetland area.

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 are typically high gradient, confined reaches while the lower reaches (T4.01 and T4.02) are low gradient, unconfined reaches. Patrick Brook reaches are sources and transporters of sediment. A few low gradient meadow areas provide places for sediment attenuation. Patrick Brook has numerous grade controls in the form of bedrock ledges and falls and dams. Soils in the hill reaches are dense till and glacial outwash. Adjacent land use is forest, residential, and one industry, with evidence of old mill activity.

Human Related Impacts on Stream Habitat and Geomorphology

Development results in higher peak storm runoff rates, lower water retention for summer base flows, less buffer for filtering sediment, nutrients and chemicals. Increases in development bring increases in stream crossings, requiring bridges and culverts, which constrict channel flows and/or floodplain flows. Stream crossing structures are summarized in Table 3.

Reaches/segments M15B through M17 and T5.01A have been straightened (channelized) in order to maximize tillable land. Channelization refers to alterations in a river channel including: widening and deepening, straightening, levee construction, bank stabilization, and vegetation clearing (Brookes, 1988). As summarized by Brookes (1988) channel straightening leads to increased channel slope, resulting in increased velocities, bed and bank erosion, increased sediment loads, increased flooding, downstream sedimentation, and decreased water quality.

Hortle and Lake (1983) studied the distribution and abundance of fish in channelized and unchannelized sections of the Bunyip River, Victoria. Number of fish species, total biomass of fish, and total numbers of fish were significantly higher in unchannelized sections than in channelized sections. Hortle and Lake (1983) found that effects of channelization were loss of fish habitat (woody debris, bank vegetation, pools) and a change in channel form from relatively shallow and wide with low velocities to narrow and deep with higher velocities.

Meandering of a channel creates complex habitats such as pools, undercut banks, gravel point bars, and supplies LWD. Creation of these complex habitats is limited or eliminated when the channel is stabilized. When a channel meanders, pools form on the outside of the bends and point bars form on the inside (Kondolf, 1996). As the channel erodes the outside bank, it also creates an overhanging bank that fish and other species use for cover. Straightening channels, as seen in the Hinesburg Valley reaches and lower Beecher Hill Brook, eliminates channel meandering and thereby important instream habitat.

Recent research has demonstrated the importance of Large Woody Debris (LWD) for instream habitat such as for fish habitat creation, shaping pools and bars, providing cover, and acting as substrate for microorganisms and invertebrates (Cederholm et al., 1997; Connolly and Hall, 1999; Crispin et al., 1993). Lack of woody riparian vegetation, as seen in the Hinesburg Valley reaches and lower reaches of Patrick Brook and Beecher Hill Brook, translates to a lack of habitat-enhancing LWD in the channel; if there are no trees on the banks, they cannot fall into the channel as LWD.

Corridor Planning Goals and Objectives

Stream restoration and protection projects and efforts are most successful when they are planned with consideration for the reach and watershed stressors and physical processes causing the channel instability and adjustments (VT DEC, September 2005; April 2003).

The goals of the Stream Corridor Plan (SCP) were to develop projects with the goal of increasing the capacity for stream corridor capture and storage of sediment and nutrients in the watershed in order to reduce sediment and nutrient loading of Lake Champlain.

Overall River Management Program goals for stream corridor planning are:

- To define and achieve water resource goals and objectives,
- To assess the degree of stream departure from equilibrium and the condition of instream and riparian habitat,
- To identify potential restoration and protection projects that would support stream dynamic equilibrium conditions and reduce potential future conflicts between human investments and stream channels and their associated expenses.

LWP/Hinesburg Goals

- To allow for resources to be protected and private and public investments to be made that are economically and ecologically sustainable as individual parcels are subdivided and developed within the growth center area.
- To engage decision makers, landowners and other citizens who can be guided by a better understanding of riparian systems before additional public and private investment are made within the designated village growth area.
- To provide officials and landowners the information and a framework to implement strategies that can result when the community understands and values the river as a system and recognizes the importance and opportunity in avoiding future conflicts between human

investments and river dynamics and in resolving current conflicts in the most economical and ecologically sustainable manner.

Stream Corridor Planning Tasks

The LWP undertook the following tasks in the process of developing the LaPlatte River Watershed Corridor Plan in Hinesburg: 1) Analyze Geomorphic Assessment Data; 2) Define the stream corridor; 3) Identify potential restoration and protection projects that meet the above goals; and 4) Contact and meet with landowners to discuss goals and opportunities.

Analysis of Geomorphic Data

Data collected during Phase 1 and Phase 2 Stream Geomorphic Assessments were analyzed according to the Protocols (VT DEC, March 2006). Table 1 briefly summarizes Phase 2 data for each segment. Included in the table are the reach number, existing stream type, habitat condition category from the RHA, geomorphic condition category from the RGA, stream sensitivity rating, channel evolution stage, and overall stream condition. 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.

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

Reach Number	Existing Stream Type	RHA Condition	RGA Condition	Stream Sensitivity	Channel Evolution Stage	Stream Condition
						Banks
M15S2.01	E4 D-R	Fair	Good	High	III F	Eroding Banks
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

* Denotes a Stream Type Departure

Outreach

Landowner Contact

Riparian landowners along study streams were mailed an informative latter describing the corridor planning process. Follow-up by telephone allowed for interested landowners to schedule a meeting with members of LWP (James Donnegan, Lisa Godfrey, and/or Andrea Morgante). Packets of information including a map, reach condition details, and ANR publications were prepared for each landowner and discussed at the meetings. Meetings were held with 24 of the riparian landowners.

Hinesburg Town Boards

Presentations were given for the Select Board, Conservation Commission, and Planning Commission at the beginning and toward the end of the planning process. A meeting was held with town officials as part of the landowner meetings to discuss possibilities on town-owned parcels. A Planning Commission meeting was attended to discuss the Water Resources Overlay District concept for the village area.

Corridor Delineations

Two corridors have been identified for the LaPlatte River and tributaries 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 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:

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.**

Color codes in the table correspond to colors used in the FEH maps to highlight the FEH corridor.

Development of the FEH corridor for the LaPlatte River and tributaries in Hinesburg followed RMP guidelines using the SGAT program. Valley wall delineations had been field checked and updated by the RMP. A detailed survey of slopes and soils including soils erodability was 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.

Project Identification

A step-wise procedure (VT ANR River Management Program 2 January 2007) has been developed by RMP to identify projects that would be compatible with geomorphic adjustments and managing the stream toward equilibrium conditions. Please refer to the RMP Corridor Planning Guide at: http://www.anr.state.vt.us/dec/waterq/rivers/htm/rv_restoration.htm for more detailed information.

Types of projects include:
- Protecting River Corridors
- Planting Stream Buffers
- Stabilizing Stream Banks
- Arresting Head Cuts and Nick Points
- Removing Berms
- Removing or Replacing Structures
- Restoring Incised Reaches
- Restoring Aggraded Reaches

Corridor protection and conservation is an effective tool for stream restoration. Protecting stream corridors helps avoid future conflicts between streams and human investments while allowing streams room to establish their desired dynamic equilibrium. Vegetated buffers, whether planted or allowed to reestablish, protect water quality, stabilize banks, and provide riparian habitat. Protecting the river corridor and allowing the stream to recreate its own equilibrium geometry can be more cost effective long-term than attempting to impose a calculated stream geometry in the short-term. Analyzing the desired time frame for results can help determine if a “passive” approach to channel restoration is feasible, or if a more “active” approach for more immediate results is desired.

A “passive” approach can be sought through perpetual corridor easements, which include the purchase of channel and riparian vegetation management rights within the river corridor. Costs of such easements have yet to be established and a holder of such an easement would need to be identified. Goals of such easements are:
- To allow the system to move toward dynamic equilibrium.
- To improve water quality.
- To improve instream and riparian habitat.

By allowing the stream more room to perform its geomorphic functions, the risks of disastrous channel avulsions and extreme flood damage are reduced, therefore reducing property loss and damage in the long-term. A corridor protection easement would define the protected area, define the allowed uses in that area, and dictate the river course management options.

An “active” approach to stream restoration typically involves designing and constructing desired equilibrium conditions for the stream channel. Examples of “active” restoration projects include constructed meander bends, constructed or lowered floodplain areas, bank stabilization measures, constructed grade controls, or constructed habitat structures.

Depending on project goals and desired timelines to achieve equilibrium conditions, “passive,” “active,” or a combination of both approaches may be employed.

Stressor, Departure, and Sensitivity Analysis

Chittenden County Regional Planning Commission (CCRPC) generated a series of Stressor and Departure Maps (Appendix A) with guidance from RMP, following protocols in Step 5 of the RMP Corridor Planning Guide. The maps help visualize the types of stressors acting on the stream channel over a watershed scale, allowing upstream and downstream effects to be seen across the watershed. The maps were used along with Table 2 to identify potential restoration and protection projects included in Table 3.

Following outlines developed by the River Management Program, Table 2 was developed to list river segment stressors by segment.

Table 2: LaPlatte River Segment Stressor Table

	Watershed Input Stressors		**Reach Modification Stressors**	
River Segment (Evolution Stage)	Hydrologic	Sediment Load	Stream Power **Bold**=increase Plain=decrease	Boundary Resistance **Bold**=increase Plain=decrease
M12 (I)				Reduced riparian vegetation
M13 (I)		Minor Aggradation (from local planform)		Reduced riparian vegetation
M14 (III)		Minor Aggradation (from local planform)		Reduced riparian vegetation
M15 Segment A (II)	Ditching	Historical Degradation; Aggradation		Reduced riparian vegetation
M15 Segment B (III)	Ditching	Historical Degradation; Aggradation	**Straightening, Dredging**	Reduced riparian vegetation
M16 (III)	Ditching	Major Aggradation	**Straightening, Dredging, Berms**	Reduced riparian vegetation
M17 (III)	Ditching	Degradation, Widening, Planform adjustments producing sediment.	**Straightening, Dredging, Berms**	Reduced riparian vegetation
M18 Segment A (II C)	Historical Deforestation	Aggradation, Planform, Widening		**Grade Control**
M18 Segment B (II)	Historical Deforestation	Degradation, Widening, Planform	**Rt 116 Culvert downstream,** decrease with aggradation upstream	
T3.01 (III)	Ditching	Minor Aggradation (from local planform)	**Straightening**	Reduced riparian vegetation

T3.02 (II C)				
M15S2.01 (III)	Diversion to "The Canal"	Minor Aggradation (from local planform)	**Straightening, Berms**	**Rip-rap** Reduced riparian vegetation
T4.01 "The Canal" (II)		Aggradation	**Straightening, Berms**	**Rip-rap** Reduced riparian vegetation
T4.02 "The Canal" (III)		Aggradation	**Straightening, Berms**	Reduced riparian vegetation
T4.03 (III)	Historical Deforestation - may have caused some channel enlargement.	Aggradation	**Straightening (at ds end), Falls**	**Grade Controls**
T4.04 (II C)	Historical Deforestation - may have caused some channel enlargement.	Minor Aggradation (from local planform)	**Falls**	**Grade Controls, Rip-rap**
T4.06 (III)		Minor Aggradation (from local planform)	**Berms**	**Grade Controls, Rip-rap**
T5.01 Segment A (II C)	Ditching	Aggradation	**Straightening**	**Minor Rip-rap,** Reduced riparian vegetation
T5.01 Segment B (II C)		Aggradation	Culvert constriction, Aggradation	Reduced riparian vegetation
T5.01 Segment C (I)		Aggradation	**Falls**	**Grade Controls**
T5.01 Segment D (II)	Deforestation/Development Historical deforestation may have caused some channel enlargement.	Historical Degradation; Widening	**Straightening, Berms, Culvert**	**Minor Rip-rap,** Reduced riparian vegetation

Planning and Management Strategies

Current research in fluvial geomorphology promotes a process-based approach, focusing on restoring the ecological functions, which can then create the habitats in a self-maintaining cycle (Ward et al. 2001). Addressing limiting factors and restoring natural processes that create and maintain habitats and geomorphic functions is important.

Stream reaches evaluated in this study present a variety of management options. Most of the reaches have been actively managed at some point in the past, or continue to be managed, for varying reasons. The steep upper reaches of Patrick Brook and steep Beecher Hill Brook segments were used for mill operations, evidenced by numerous stone abutments and dams. Here, the persistence of dams continues to reduce sediment loads in downstream reaches.

The lower reaches of Patrick Brook, Beecher Hill Brook, and the mainstem in this assessment have been managed for maximizing agricultural land. Loss of sinuosity and riparian vegetation has prompted planform adjustment, aggradation and widening.

Management alternatives for each reach were analyzed and can be classified under one of the following categories: Active Management, Conservation, Passive Geomorphic Restoration, and Active Geomorphic Restoration.

Active management implies that whatever the current management practices are of a particular reach, they are expected to continue in the short term due to the presence of infrastructure. (i.e. dams will be maintained, dredging will continue, straightening, berms, and riprap will be maintained, roads and buildings will be protected). Under current management practices, these reaches are likely to persist in their respective conditions and stages of channel evolution (the channel evolution process cannot occur if management activities act to keep the channel in its current state). As funding sources for flood-related repairs become more limited, continued active management becomes more costly to towns.

Conservation is an option to consider when stream processes that create and maintain habitats are mostly intact and the stream is in a state of dynamic equilibrium. Such areas of stream would benefit from protection. Some reaches may be candidates for conservation due to their relatively good instream and riparian habitat quality. Such reaches are shown in the assessment to be in reference or good condition and may be undergoing minor adjustment. Conservation can also be used as a tool for passive restoration.

Passive restoration removes the factors adversely impacting a reach, such as a dam or continued dredging, and allows the channel to progress to dynamic equilibrium where it regains balance with respect to flow and sediment load. Truly passive restoration, where no actions are taken to change conditions, is an option for some reaches. Other reaches may benefit from varying degrees of actions that could be taken to speed the process. In these reaches, a passive restoration approach could include establishment of a riparian buffer, allowing woody vegetation to colonize the riparian buffer, move land uses such as mowing or grazing outside the buffer, move berms, or reduce sediment inputs.

Clay layers exposed in the bed and banks of Hinesburg valley segments and reaches have slowed channel adjustment. This should be considered when deciding between passive and active restoration activities, as passive results may not be seen in the near term (20-30 years).

Active restoration implies physical alteration of the channel and/or floodplain to a geometry or state that has been calculated to be sustainable by the channel to improve stream and/or habitat condition. Active restoration can also include such projects as habitat restoration projects, and biotechnical bank stabilization (such as installation of root wads, brush revetments, or bank planting).

Current Management

Reaches T4.01, T4.02, T4.04 are being actively managed. T4.01 is a canal with a dam and berms on both banks. T4.02 is similarly confined with berms and a dam preventing flow into an abandoned channel. No significant diversion structure (only stones and the beginning of the ditch) was apparent in the area where T4.02 “The Canal” begins and diverts water from M15S2.01.

A historical study of "The Canal" and ownership revealed "The Canal" was constructed sometime in the early 1800's and rights to convey water and repair and maintain the ditch or canal went with the property, which is now owned by Saputo Cheese. Language referring to "The Canal" disappeared in the most recent deeds." In the recent past (40 years) the volunteer fire department has performed periodic maintenance to assure adequate flow to allow the filling of the tanker truck. The Hinesburg select board agreed that it would be beneficial to have the LaPlatte Watershed Partnership communicate with Saputo Cheese to investigate ownership issues. A letter was written and sent to the general manager of Saputo in Hinesburg but all correspondence regarding any legal issues is forwarded to the Montreal office and no reply has been received. A copy of the letter is attached in Appendix B.

Management of reaches T4.01 and T4.02 is likely to continue in the short term due to the presence of infrastructure and the desire to keep water in “The Canal.” Therefore, water is likely to continue to be diverted from reach M15S2.01 (historical Patrick Brook) and into T4.01 and T4.02. Under current management practices, these reaches are likely to persist in their respective conditions and stages of channel evolution (the channel evolution process cannot occur if management activities act to keep the flow and channels in their current state). Potential restoration activities for M15S2.01 (historical Patrick Brook) should consider current infrastructure limitations and management needs of “The Canal.”

Reach T4.04 had 2 large dams, which are currently maintained and likely to continue under management in the near term.

Conservation

Reaches T4.03 and T4.04 are candidates for conservation due to their relatively good instream and riparian habitat quality. Both reaches are experiencing extreme widening and a reduction of sediment load due to upstream dams and are highly sensitive to future disturbances. An increase in runoff due to roads or development could compound these problems.

Habitat in reach T4.06 is in good condition and the reach appears to be in regime, so may be a candidate for conservation. However, development in the area is constricting flow with rock walls, a culvert and a bridge.

Segment M18A has a naturally vegetated riparian buffer and “Good” habitat. RGA condition was “Fair” although the channel was not incised. Condition appeared to be affected by upstream sediment sources (M18B) and would be a good candidate for conservation to preserve the buffer and habitat. Conserving this segment would also allow for continued buffering of affects from segment M18B.

Restoration

Sustainable is defined as “to keep up or keep going, as an action or process” (Flexner, 1988 p. 1324). In the case of the LaPlatte River, the term sustainable is used to mean taking restoration actions that will result in habitat improvements that are self-perpetuating. This implies restoring the fluvial processes that create habitats in the LaPlatte.

Truly passive restoration, where no actions are taken to change conditions, is an option for the Hinesburg Valley reaches, with varying degrees of actions that could be taken to speed the process if desired. Reaches M12, M13, M14 and segment M15a retain some channel sinuosity, but lack riparian vegetation and its associated benefits. In these reaches, a passive restoration approach could include allowing woody vegetation to colonize the riparian buffer, and move land uses such as mowing or grazing outside the buffer. Planting trees in the buffer (as has been done in some areas along M13) could speed the colonization of woody species. Planting is recommended to include woody species toward the outside of the corridor, away from eroding banks. Shrubby species such as willows can be planted nearer the banks.

Reaches M16, M17, and M18 have been straightened and are lacking channel the sinuosity and adjacent wetlands that would be expected. M16 and M17 are incised and have limited floodplain access. Passive restoration here would again involve allowing the riparian buffer to return to woody vegetation, and allow the channel to erode its banks and regain sinuosity. Results could take time, depending on flow and sediment conditions and may include sediment inputs. Varying degrees of actions (with varying levels of expense) that could be taken to speed the process include planting trees, opening berms, installing LWD, or recreating a lower floodplain and meander bends.

Potential Project Opportunities

Watershed-Level Opportunities

Stream Crossings

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. Many bridges and culverts in the LaPlatte River watershed are currently undersized and causing various problems such as deposition, excessive erosion, wildlife passage problems, etc. As such structures come up for replacement, resizing them to accommodate the flow and sediment loads of the streams and placing them in proper alignment with stream channels is recommended. The River Management program has begun recommending sizing structures at 1.25-1.5 times the bankfull width. Streams undergoing significant adjustments may require larger structures than streams in an equilibrium state. Towns can adopt bridge and culvert standards for appropriate crossing width. Adopting such standards can help with pre-disaster mitigation planning and with receiving state incentives (Appendix C) by taking a proactive approach.

A new F&W document for appropriately sized crossings is due out in spring 2007 and can provide additional guidance on structure sizing.

Table 3 shows structures assessed during Bridge and Culvert Assessments in Hinesburg. Structures with signs of significant problems include: Route 116 on M18B, Beecher Hill Road at T5.01B, Route 116 at T5.01A, Leavensworth Road on M12, Mechanicsville Road on T4.03, North Road at T5.01D, and Charlotte Road at T3.01. Summaries of condition and details about these structures and potential projects are included in the potential projects list. Please see Appendix D for DMS reports with the structure assessment data.

Table 3: Hinesburg Structures

Reach	**Road**	**Road Type**	**Stream**	**Location**	**Struct Type**	**Struct Height**	**Struct Span**	**Stream Width**	**% Span/ Stream Width**	**Floodplain Filled**	**Stream Approach**	**Comments**
M12	Leavensworth Rd	Gravel	LaPlatte	Just south of O'Neil Rd	Bridge	6.3	**29**	**34.5**	84	Partially	Sharp Bend	Landowner reports fields flood, road flooding problem for residents.
M15S2.01	Route 116	Paved	Patrick Bk		Culvert	4	**7**	**10**	70 (23 if no diversion)	Entirely	Mild Bend	Outflow at grade. Estimated width if flow not diverted = 31ft. Explore replacement if diversion removed.
M16	Charlotte Rd	Paved	LaPlatte		Culvert	9.5	**18**	**22**	82	Partially	Channelized Straight	Outflow at grade.
M16	Silver St	Paved	LaPlatte		Bridge	7.9	**30**	**22**	136	Entirely	Channelized Straight	Rust and deterioration on structure
M17	Gilman Rd	Gravel	LaPlatte	Gilman Road N of Birdie Ln.	Culvert	4	**4**	**13**	31	Entirely	Mild Bend	Road banks washing out – sediment. Outflow at grade.
M17	West of Gilman Rd	Dirt	LaPlatte	Bissonette Farm access	Culvert	5.9	**7.2**	**13**	55	Not Significant	Channelized Straight	Dirt dumped on upstream banks, so unknown if armoring is underneath. Outflow at grade.
M18B	Route 116	Paved	LaPlatte	Just south of old Rt 116	Culvert	3.1	**2.8**	**15.4**	18	Entirely	Mild Bend	Significant Agg us and Deg ds with headcut and incision. Outflow a free fall.
T3.01	Charlotte Rd	Paved			Culvert	3	**3**	**10.2**	29	Entirely	Channelized Straight	Outflow a free fall.
T4.01	Route 116	Paved	The Canal	Canal by the Cheese Factory	Bridge	5.5	**16**	**20.6**	78	Not Significant	Channelized Straight	Dam just downstream.
T4.01	Commerce St	Paved	The Canal	By the Post Office.	Culvert	5	**6.5**	**20.6**	32	Not Significant	Channelized Straight	Outflow at grade.
T4.03	Mechanicsville Rd	Paved	Patrick Bk	Near the cemetery.	Culvert	5	**9**	**22**	41	Entirely	Channelized Straight	Outflow at grade.
T4.04	Partridge Hill	Gravel	Patrick Bk		Culvert	4	**6**	**25.5**	24	Partially	Mild Bend	Recently replaced. Outflow at grade.
T4.04	Richmond Rd	Paved	Patrick Bk	Near Iroquois Mfg.	Culvert	8	**8**	**25.5**	31	Entirely	Mild Bend	Outflow a free fall.
T4.06	Pond Brook Rd	Gravel	Patrick Bk		Bridge	3	**12**	**14**	86	Entirely	Mild Bend	Structure replaced in 2005.
T5.01A	Route 116	Paved	Beecher Hill Bk		Culvert	6.5	**22**	**11.2**	196	Entirely	Channelized Straight	Right side plugged by sediment. Outflow at grade.
T5.01B	Beecher Hill Rd	Gravel	Beecher Hill Bk		Culvert	10	**8.8**	**15.2**	58	Entirely	Mild Bend	Outflow a cascade, natural break in slope. Bridge recommended.
T5.01D	Beecher Hill Rd	Paved	Beecher Hill Bk		Bridge	6	**13**	**22.4**	58	Partially	Mild Bend	
T5.01D	North Rd	Paved	Beecher Hill Bk	North of Beecher Hill	Culvert	8.1	**7.9**	**22.4**	35	Entirely	Naturally Straight	Outflow a cascade.

Planning and Zoning

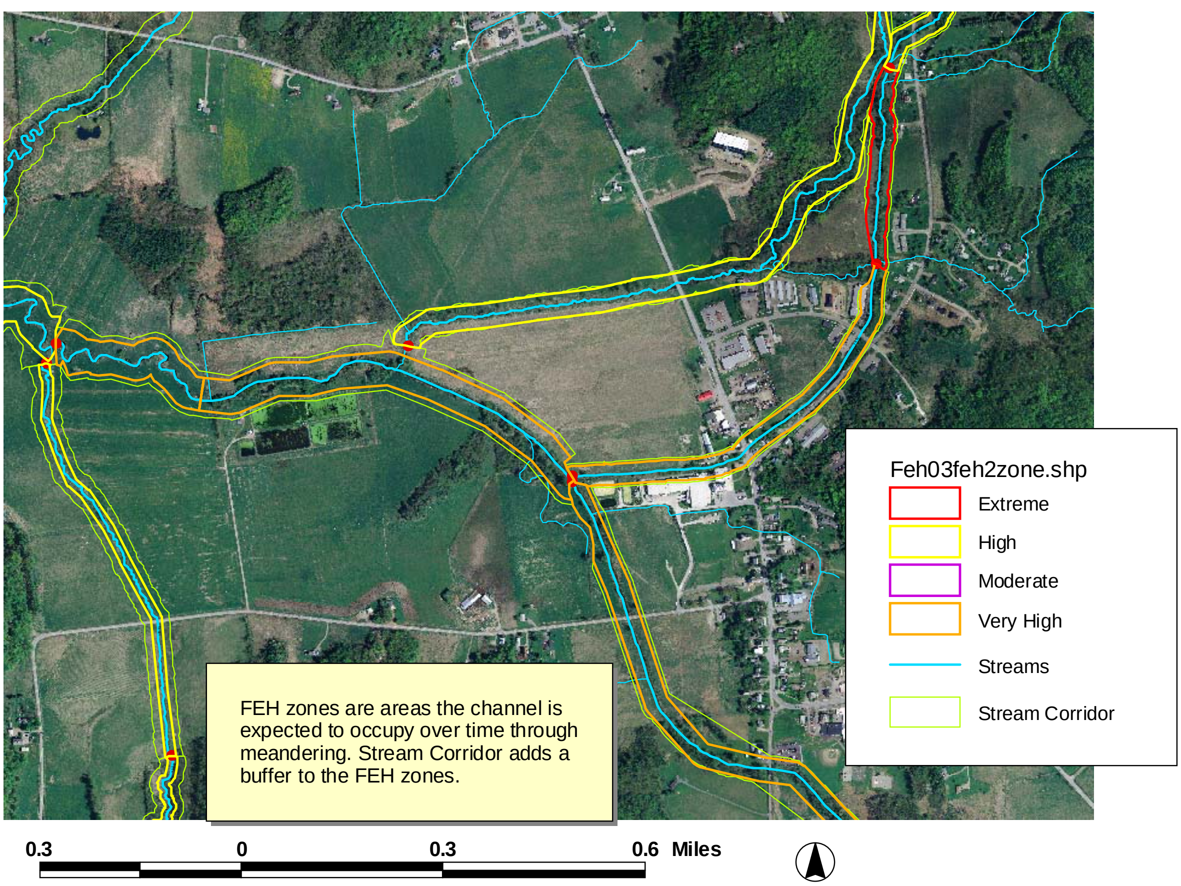
Protecting the corridor to prevent future investments from being placed in potential erosion hazard areas is very important, even if additional restoration activities are needed. If those restoration activities are not feasible, at least protecting the corridor can prevent erosion related losses and the need for future channel management activities.

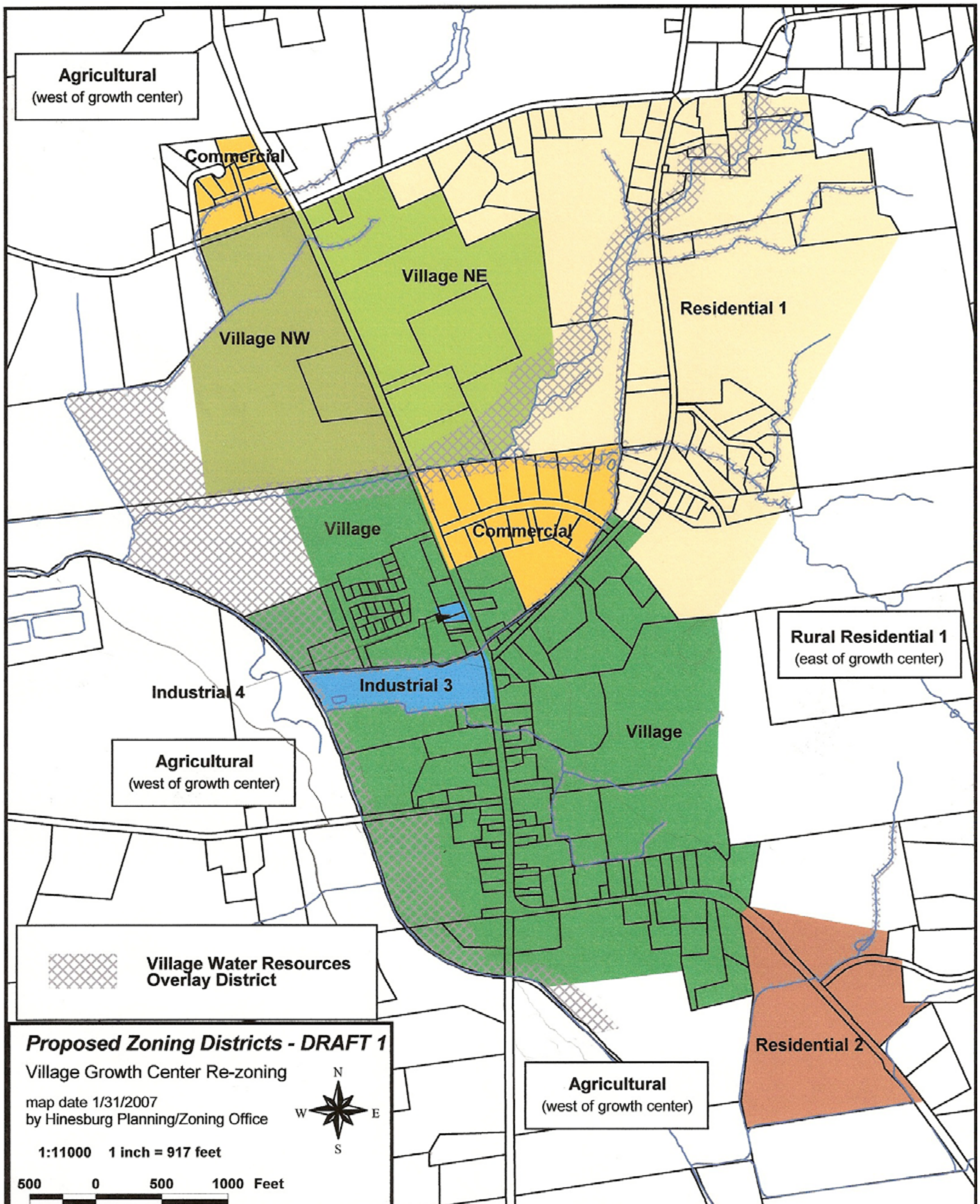
Towns can reduce future costs and increase public safety by limiting stream corridor encroachment. Using the stream corridor or the FEH corridor, towns can create zoning overlay districts or setbacks. These districts or setbacks can help protect the stream corridors and help move streams toward equilibrium conditions by limiting future encroachment into the corridors. By keeping future development out of areas with high erosion potential, towns can reduce future costs associated with protecting these developments from erosion. In Hinesburg, the Planning Commission is examining implementing a Water Resources Overlay District or zoning setbacks to accomplish these goals.

Water Resources Overlay District

A proposed Water Resources Overlay District was developed using the FEH map. The FEH zone was created by SGAT program using Phase 1 and 2 data. It is an approximate definition of the area adjacent to the active channel most likely to experience erosion in the near term. It is not a definitive outline of areas at risk of erosion. Risks of erosion and flood loss do exist outside the FEH zone. The FEH zone is not the same as the FEMA flood inundation area. The RMP considers this the minimum planning area for streams. It is intended as a planning tool to guide development in order to reduce potential future losses and risks and associated costs to society.

Fluvial Erosion Hazard Zones and Buffer Areas for Hinesburg Village





Draft Village Water Resources Overlay District under consideration by the Planning Commission.

The proposed Village Overlay District only addresses stream corridor areas within the new village boundaries. While this is a strong first step, expanding the overlay district throughout the Town of Hinesburg, and indeed throughout the watershed, is highly recommended. This can help protect the streams and riparian areas and allow for the continued adjustment and eventual establishment of equilibrium conditions. Hinesburg is lucky in that relatively little investments have been placed in the stream corridors, and where they do exist, problems are evident (e.g. erosion toward the sewage treatment plant lagoons, erosion and riprap behind Commerce Park, residences with rip-rapped banks, etc.). Avoiding future conflicts between the streams and investments by utilizing zoning to prevent encroachment will reduce future costs and risks and increase safety for Hinesburg residents as well as those downstream.

Stormwater

Runoff from roads, driveways, and road washouts during storms also appeared to be a source of increased sediment and increased runoff in the streams. 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.


Sand and gravel from roads and driveways washing into the channel.

With increasing development, more driveways and roads are funneling sediment and runoff to streams more quickly. Although the percentage of impervious surfaces is relatively low (Phase 1 data), ditches, roads, and driveways in the upper watershed gravel soils funnel water and sediment to streams. As Hinesburg develops, managing for stormwater will become increasingly important. Currently, developments must meet state standards for stormwater, but smaller developments and existing development also contribute. Managing stormwater for Hinesburg Village on a village-wide scale may make sense.

Sediment from roads and driveways can be addressed with improved ditches, limiting future driveway lengths in sensitive areas, and other methods. The Better Back Roads program would be helpful.

Leavensworth Road and bridge at M12 with large sediment deposit on the right where the road ditch meets the channel.

Site-Level Opportunities

The projects outlined in Table 4 meet the criteria for geomorphically compatible projects as outlined in Step 6: Preliminary Project Identification (VT ANR River Management Program 2 January 2007) as potential projects that could lead the channel to a dynamic geomorphic equilibrium.

Table 4: LaPlatte River Corridor Planning Project and Strategy Summary Table, Hinesburg

Project #, Condition, Evolution Stage	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Land Use Conversion	Potential Partners w/ LWP/LCA
M12-1, Good I	Stream in regime and did not appear to have been straightened in the past. Corridor undeveloped and woody vegetation lacking in some areas.	Protect stream corridor to allow for flow and sediment attenuation and to improve water and habitat quality. Also to avoid encroachment into the corridor and future expense of protecting those investments.	High priority to alleviate pressures from upstream. Technically very feasible. An entity needed to hold easement.	Habitat benefits, recreation, hunting, clean water.	Cost of corridor acquisition or easement acquisition. Or dev. & mgmt. rights	Corridor land use was hay and some fallow field. Fairly wet area. Landowner did not want to meet with LWP during this process.	RMP, HLT, NRCS, LIP
M12 – 2 Good I	Stream in regime and did not appear to have been straightened in the past. Corridor undeveloped and woody vegetation lacking in some areas.	Plant Stream Buffers. Plant perennial woody vegetation away from active erosion sites to protect banks and improve habitat and water quality. Use native grasses and shrubs in the near-bank areas.	High priority for habitat and water quality and for long-term bank stability. Feasible with volunteer labor for tree planting.	Habitat benefits, recreation, hunting, clean water.	Low, cost of plant material and volunteers to plant.	Corridor land use was hay and some fallow field. Fairly wet area. Landowner did not want to meet with LWP during this process.	RMP, Schools
M12 – 3 Good I	An undersized bridge is in the reach at Leavensworth Rd. Flooding problems have been identified here by the landowner, who has noticed increased flooding of her fields. The bridge and road were apparently designed to have flood flows run over the road. Development past the river on Leavensworth Road now makes road closure	Replace Structure. An alternative is to improve the road access from Charlotte Rd, so homes would have a second means of access, reducing the need to improve the road and possibility at this structure. With corridor protection, field flooding may not be an issue.	Low priority to replace the structure, as it appears to function from a geomorphic standpoint. Improving passage for residents is another issue, which could be solved by	Improved passage of flood flows and traffic on the road. Reduce road closures.	Expensive to replace the bridge, especially to one sized to pass flood flows. Possibly the same or less cost to improve the road to the south, with	NA	RMP, Hinesburg town and road commission

Project #, Condition, Evolution Stage	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Land Use Conversion	Potential Partners w/ LWP/LCA
	inconvenient.		improving the road access to the south as mentioned.		less stream impact.		
M13-1 Good I	Stream in regime and did not appear to have been straightened in the past. Corridor undeveloped and woody vegetation lacking in some areas, especially along the left bank. Some bank planting noted at time of assessment.	Protect stream corridor to allow for flow and sediment attenuation and to improve water and habitat quality. Also to avoid encroachment into the corridor and future expense of protecting those investments.	High priority to alleviate pressures from upstream. Technically very feasible. An entity needed to hold easement.	Habitat benefits, recreation, hunting, clean water.	Cost of corridor acquisition or easement acquisition. Or dev. & mgmt. rights	Corridor land use was hay and some fallow field. Some wooded areas.	RMP, HLT, LIP, NRCS
M13 – 2 Good I	Stream in regime and did not appear to have been straightened in the past. Corridor undeveloped and woody vegetation lacking in some areas, especially along the left bank. Some bank planting noted at time of assessment.	Plant Stream Buffers. Plant perennial woody vegetation away from active erosion sites to protect banks and improve habitat and water quality. Use native grasses and shrubs in the near-bank areas.	High priority for habitat and water quality and for long-term bank stability. Feasible with volunteer labor for tree planting.	Habitat benefits, recreation, hunting, clean water.	Low, cost of plant material and volunteers to plant.	Corridor land use was hay and some fallow field. Fairly wet area. Landowner did not want to meet with LWP during this process.	RMP, Schools
M14 – 1 Good III	The river corridor was undeveloped. Channel adjustments were minor planform and aggradation and an incision ratio of 1.3. Woody riparian vegetation was lacking.	Protect River Corridor. The channel may adjust to equilibrium conditions in the near term (20-30 yrs) or longer, depending on ongoing channel management and adjustments upstream. So protecting the corridor here is recommended to provide for passive geomorphic restoration of floodplain and meanders. Active restoration	High priority to allow for passive restoration and to prevent encroachment. Technically very feasible. An entity needed to hold easement.	Habitat benefits, recreation, hunting, clean water. If flow and sediment attenuation could occur in this area, stress and pressure on downstream	Cost of corridor acquisition or easement acquisition. Or dev. & mgmt. rights	Corridor land use was hay.	RMP, HLT, NRCS, LIP

Project #, Condition, Evolution Stage	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Land Use Conversion	Potential Partners w/ LWP/LCA
		could be employed if more immediate results are desired.		reaches could be reduced.			
M15 A – 1 Fair II	The channel appeared incised (incision ratio of 1.7), likely due to historical channel management activities. No permanent constraints exist within the corridor. Current corridor land use was pasture, although the landowner was working to fence the pasture and plant a small buffer (35 feet I believe) Upstream reaches have been significantly straightened, so stream power would be higher, but no alterations appeared to inhibit active geomorphic restoration of floodplain or meanders here. The stream is not likely to quickly equilibrate due to clay in the bed and banks, limiting movement.	Restore Incised Reach through active restoration of floodplain and meander geometry with respect to the current channel bed elevation. Protect the river corridor and plant perennial native vegetation as part of the overall restoration plan to ensure long-term viability.	High priority due to lack of encroachment. Excavating a lower floodplain has been done and is feasible.	Improved habitat and water quality. If flow and sediment attenuation could occur in this area, stress and pressure on downstream reaches could be reduced.	Relatively high to excavate a new floodplain area. Additional costs in corridor easements or acquisition.	Pasture and hay in the corridor. Landowner on the left bank has fenced a 35-foot buffer and intended to plant trees.	RMP
M15 A – 2* Fair II		Protect River Corridor as part of the overall strategy to restore the incised reach (see above).					RMP, HLT, LIP, NRCS
M15 A – 3* Fair		Plant Stream Buffers as part of the overall strategy to restore the incised reach (see					Schools

Project #, Condition, Evolution Stage	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Land Use Conversion	Potential Partners w/ LWP/LCA
II		above).					
M15 B – 1 Fair III	The channel was straightened and incised, resulting in greater stream power and increased sediment transport capacity. No recently abandoned channels were observed to capture as a restoration tool. The river corridor is undeveloped except for the STP on the left bank. If the channel were not actively managed, it may adjust to equilibrium conditions, although the 20-30 year "near-term" time line may not be realistic due to the clay present in the bed and banks. Current beaver activity could help by trapping sediment.	Restore Incised Reach Possible area to recreate floodplain through active restoration. Active restoration may be preferable to a passive approach here due to the proximity of the Sewage Treatment Plant. The channel appeared to be adjusting and protection of the corridor could allow for passive geomorphic restoration, although an active approach near the STP might be preferable to provide protection to that investment. Protecting the river corridor and planting stream buffers should be part of an overall restoration plan.	High priority due to lack of encroachment (except for the STP). Also a high priority to reduce pressure on the banks by the STP to avoid lagoon berm failure. Excavating a lower floodplain has been done and is feasible.	Improved habitat and water quality. If flow and sediment attenuation could occur in this area, stress and pressure on downstream reaches could be reduced.	Relatively high to excavate a new floodplain area. Additional costs in corridor easements or acquisition.	The Town of Hinesburg has plans to install riprap to stabilize the bank by the STP. They are willing to explore options in this area.	RMP, Town of Hinesburg
M15 B – 2* Fair III		Protect River Corridor as part of the overall strategy to restore the incised reach (see above).					RMP, HLT, Town of Hinesburg, LIP
M15 B – 3* Fair III		Plant Stream Buffers as part of the overall strategy to restore the incised reach (see above).					
M16 – 1 Fair III	The river corridor is largely undeveloped, however the channel is not	Remove Berms. If berms were removed, this reach might quickly equilibrate,	High priority as the berms are the main reason the	Improved habitat and water quality,	Cost of excavating the berms,	Some field area may experience more frequent	RMP, Town of Hinesburg

Project #, Condition, Evolution Stage	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Land Use Conversion	Potential Partners w/ LWP/LCA
	likely to adjust to equilibrium conditions in the near term due to the presence of berms and clay soils. Buffer width was 25-50 feet with some areas of about 5 feet or less. Bank erosion and lateral movement were observed. Berms were present in areas along both banks, limiting floodplain access.	although clay soils may limit movement somewhat. Protecting the river corridor and pursuing a passive restoration approach here could allow for floodplain and meander redevelopment over the long-term, although sediment from the berms would enter the system if not removed.	reach is incised. Unsure if land uses within the corridor would be threatened by more frequent flooding, so recommend to investigate with landowners and on flood stages. Analyze mature trees and habitat that may be impacted if berms were removed.	less pressure on downstream reaches.	corridor protection easements, replanting vegetation.	flooding. Corridor protection may account for this area. School lower parking lot? Near structure, so stream likely fixed in this location.	
M16 – 2 Fair III	Culvert at Charlotte Road did not appear to have problems, but does back up water during high flows. The bridge at Silver Street constricted floodprone width, but not bankfull width.	Replace Structures. Replace structures with appropriately sized structures as they come up for replacement.	Low Priority due to low level of erosion hazard associated with these structures (no major problems).	Improved continuity, less pressure on the reach and downstream reaches.	High cost to replace these large structures.	NA	Town of Hinesburg, AOT, VTRANS
M16 - 3	(See M16-1)	Restore Incised Reach through Corridor Protection and berm removal (See M16-1)	(See M16-1)	(See M16-1)	(See M16-1)	(See M16-1)	(See M16-1)
M17-1 Poor III	Incised with some berms. The river corridor is undeveloped but the channel has been straightened and likely dredged deeper. 2 crossings, one for Gilman	Protect the river corridor to allow for passive restoration. . If the channel were not actively managed, it may adjust to equilibrium conditions, although the 20-30 year "near-term" time	High priority. Funding has been secured and projects are underway	Water quality, reduced erosion (long-term), recreation, habitat improvement.	Land purchase of corridor.	Land has been in farming (hay and pasture) on the right bank and the left bank in the upper reach. Landowner is	RMP, Wetlands Division, Hinesburg Land Trust (HLT), VLT, TPL.

Project #, Condition, Evolution Stage	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Land Use Conversion	Potential Partners w/ LWP/LCA
	Rd, one for a farm access that need to be maintained. Pasture areas give animals open access to the channel.	line may not be realistic due to the clay present in the bed and banks, which has limited movement. However sediment supply is high, so protecting the river corridor and pursuing a passive restoration approach here could allow for floodplain and meander redevelopment over the long-term, without the cost of active restoration. Project is currently underway with an active restoration project of adjacent wetlands in the planning stages. **Also T5.01A downstream portion**				under contract to sell this area for conservation.	
M17 – 2* Poor III	Very thin buffer before hay and pasture areas. Some areas with only herbaceous vegetation.	Plant Stream Buffers. This will also help to stabilize stream banks over the long term.	Plant stream buffers where not likely to be eroded away before becoming established.	Habitat and water quality improvement, recreation benefits.			Wetlands Division, Hinesburg Land Trust (HLT), VLT, TPL.
M17 – 3 Poor III	Replace the culvert for the farm access, as no developments are likely to be endangered by changes in bed elevation, sediment deposition, or bank erosion. Replace the culvert at Gilman Road. Significant sediment does not appear to be present	Replace Structures. Farm access structure is an old tank. Bed incision and impending bank erosion/failure may warrant a bridge to span the banks and allow for floodplain recreation and channel meandering. Gilman Rd area has	High reach priority.	Replacement of Gilman Rd culvert with a larger structure would reduce erosion pressures on downstream properties.	WHIP funding not available for these.	NA	Town of Hinesburg

Project #, Condition, Evolution Stage	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Land Use Conversion	Potential Partners w/ LWP/LCA
	upstream, and the culvert appears to be exacerbating bank erosion downstream.	floodplain access and could use a larger culvert.					
M18A-1 Fair IIc	No development in the corridor. Pasture areas have had open access to the channel. A large beaver pond has been drained.	Protect the river corridor to allow for passive restoration. Project is currently underway.	High priority. Funding has been secured and projects are underway	Water quality, reduced erosion (long-term), recreation, habitat improvement.	Cost of corridor purchase.	Land has been used for pasture. Landowner is under contract to sell this area for conservation.	RMP, Wetlands Division, Hinesburg Land Trust, VLT, TPL.
M18B-1* Poor II	An undersized culvert at the Route 116 crossing constricts the channel and has caused significant sediment discontinuity. Deposition upstream has almost plugged the culvert entrance. Downstream, "hungry water" has resulted in erosion and head cutting.	Replace Structure. Ideally, resizing the structure to accommodate flow and sediment loads. VTRANS is booked for projects. In the short-term, arresting head cuts might be an option, although the head cuts end at the culvert.	High priority. Replacing the culvert would require VTRANS, as the structure belongs to them. Feasibility would be difficult due to the nature of the road and crossing.	Reduced pressure and erosion on downstream properties, reduced aggradation on upstream property.	High as the road is a highway and replacement would be difficult.	NA	VTRANS
M18 B – 2* Poor II	See above.	Potential Restoration/Protection Project. Analyze any additional bed stabilization measures necessary in conjunction with culvert replacement.	High priority if culvert replacement feasible to protect upstream and downstream areas from excessive erosion or instability.				RMP
M15S2.01-1 Good	The channel is significantly straightened and slightly incised (1.25).	Protect River Corridor. It is likely that this reach would adjust to equilibrium	Very High priority.	Water quality, habitat improvement,	Cost of easements or land	Other than Commerce Park, the corridor is	Town of Hinesburg, RMP, HLT,

Project #, Condition, Evolution Stage	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Land Use Conversion	Potential Partners w/ LWP/LCA
III	No recently abandoned channel was observed for use as a restoration tool. Buildings only exist in the left corridor along Commerce Park. Current flow diversion into "The Canal" would inhibit the active geomorphic restoration of floodplain and meanders here.	conditions in the near term if conditions were constant. However with uncertainty in the stream flow and in how "The Canal" will be managed in the future, it is recommended that the stream corridor be protected to prevent further investments from encroaching on the area the stream needs to regain equilibrium. This could be achieved through a proposed village Water Resources Overlay District.		reduced future losses from flood and erosion hazards.	purchase in the corridor.	wet and difficult to use. Downstream of Rt 116 the corridor is hay.	LIP
M15S2.01 – 2* Good III	See above.	Potential Restoration/Protection Project. Analyze feasibility of restoring flow and any additional watershed scale stressors, also plant a stream buffer as part of the overall project.	Restoring flow to this reach will require finding alternative ways to fill "The Canal" (such as stormwater). Also, the Rt 116 culvert would need to be replaced to accommodate the higher flows.	Habitat improvement, recreation, water quality improvement.			RMP, Town of Hinesburg, AOT, VTRANS
M15S2.01 – 3 Good III	A culvert constricts the channel at Route 116, with scour at the downstream end. No upstream sediment deposition was observed.	Replacing Structure with one of appropriate size is recommended. This could be done as the structure comes up for replacement, or if flows are restored to this	Lower priority due to little erosion hazard associated with the structure. Difficult due to		High.	NA	Town of Hinesburg, VTRANS, AOT

Project #, Condition, Evolution Stage	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Land Use Conversion	Potential Partners w/ LWP/LCA
		reach.	need for VRANS involvement.				
T3.01 – 1 Good III	The river corridor is undeveloped and likely to adjust to equilibrium, although due to clay soils, may be in the long-term rather than the near-term. The landowner was working to fence the pasture and plant a 35-foot buffer (spring of 2007 planting).	Protect the stream corridor to allow for adjustment to equilibrium.	Lower priority as this is a smaller tributary, not playing a significant flow or sediment attenuation role in the watershed.	Water quality, habitat improvement, reduced future losses from flood and erosion hazards.	Cost of easements or land purchase in the corridor.	Pasture and hay in the corridor. Right bank landowner committed to a 35-foot buffer.	RMP, HLT, LIP, NRCS
T3.01 – 2 Good IIc	A culvert at Charlotte Road constricts the channel with sediment deposition upstream and scour downstream.	Replace Structure Sediment deposition is not likely to create a significant channel adjustment if it moved downstream, so replacing the structure with one of appropriate size is recommended.	Higher priority due to the aggradation upstream and degradation downstream. Feasible as this is a town road.	Improved wildlife passage.	Moderate as this is a small crossing.	NA	Town of Hinesburg, AOT
T3.02 – 1 Good IIc	Corridor is undeveloped, used for pasture. A large beaver dam and pond were located at the upstream end of the reach and beaver activity was observed in the reach. Bank vegetation consisted of herbaceous species with some shrub-saplings.	Protect River Corridor. Channel is likely to adjust to equilibrium conditions if the corridor is protected and livestock fenced out of the channel.	Low priority due to little threat from encroachment in this area. Recommend fencing cattle from the channel.	Habitat protection, improved water quality from fencing out cattle.	Cost of easement or corridor purchase.	Pasture in the corridor.	RMP, HLT, LIP, NRCS
T3.02 – 2	See above.	Plant Stream Buffers.	Low priority.	Habitat	Cost of	Pasture in the	Schools

Project #, Condition, Evolution Stage	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Land Use Conversion	Potential Partners w/ LWP/LCA
Good IIc		Plant stream buffers in areas where grazing and trampling have disturbed buffer, or allow vegetation to regenerate through corridor protection.		improvement. Beaver activity may prove incompatible with planting.	plant material, volunteers to plant.	corridor.	
T4.01 – 1 Fair II		Managed as "The Canal"					
T4.02 – 1 Poor III		Managed as "The Canal"					
T4.03 – 1 Fair III	River corridor is undeveloped and stream impacted by historical mill operations and dams as well as deforestation. This reach is under adjustment and may regain equilibrium in the near term if watershed stressors are not increased, such as further development with driveways and road ditches.	Protect River Corridor	Low priority as this area is wooded and difficult for development within the corridor.	Habitat protection, reduced future losses from flood and erosion hazards.	Cost of easement or corridor purchase.	Corridor land appeared naturally vegetated with some lawn areas.	RMP, HLT
T4.03 – 2 Fair III	A double culvert constricts the channel at Mechanicsville Road, with deposition upstream and a scour pool below. Old mill footings and partial dams also constrict the channel in this reach. While these are historic relics, they	Replace Culvert with one of appropriate size as it is up for replacement. Remove Old mill dams and abutments. It is recommended that the Town of Hinesburg examine what course of action they want to	Higher priority for culvert replacement due to aggradation upstream and scour downstream. Removal of old mill structures	Reduced pressure on upstream and downstream properties. Removal of old mill structures may have a	Fairly high as the Mechanicsville Rd crossing is relatively large. Access to the old mill	NA	Town of Hinesburg, AOT

Project #, Condition, Evolution Stage	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Land Use Conversion	Potential Partners w/ LWP/LCA
	reduce geomorphic functions.	pursue with these historical structures.	could result in changes to the sediment regime that may need to be addressed.	negative social impact due to nostalgia for these structures.	structures is limited and may increase costs.		
T4.04 – 1 Fair IIc	A R-O-R dam at Iroquois Manufacturing reduces sediment supply to the reach. The company uses the pond, so the dam is likely to remain. Other old milldams constrict the channel, which has begun to migrate around them, producing sediment.	Remove/Replace Structures Replace the culverts with appropriately sized structures as they are up for replacement. As with historical structures in T4.03, it is recommended that the Town of Hinesburg examine what course of action they want to pursue with these structures. Protect the river corridor to allow for channel adjustment and to prevent investments from being placed in the corridor.	Lower priority for culvert replacement, as the upstream culvert is just above the Iroquois Mfg. Pond and dam and the lower one has been replaced and improved recently. Removal of old mill structures could result in changes to the sediment regime that may need to be addressed.	Reduced pressure on upstream and downstream properties. Removal of old mill structures may have a negative social impact due to nostalgia for these structures.	Access to the old mill structures is limited and may increase costs.	NA	Town of Hinesburg
T4.04 – 2 Fair IIc	Riparian buffers are over 100 feet, with some areas of the right bank 26-50 feet, comprised of mixed trees. Land use in the riparian corridor is forest with some industrial on the right bank. Minor degradation has occurred through reduction of	Protect the river corridor to allow for channel adjustment and to prevent investments from being placed in the corridor. Remove riprap if at all possible.	Lower priority due to mostly wooded corridor and lower threat of encroachment.	Improved water quality and habitat value. Reduced future losses from flood and erosion hazards.	Cost of easement or corridor purchase.	Corridor land appeared naturally vegetated with some disturbed areas, some industrial.	RMP, HLT, LIP

Project #, Condition, Evolution Stage	**Site Description Including Stressors and Constraints**	**Project or Strategy Description**	**Technical Feasibility and Priority**	**Other Social Benefits**	**Costs**	**Land Use Conversion**	**Potential Partners w/ LWP/LCA**
	sediment at dams. Current adjustments appear to be widening with minor aggradation and planform.						
T4.06 – 1 Good III	A dam is located in the reach and appeared to be non-functioning. Riprap and rock walls confine the channel toward the upstream end.	Remove Dam, A grade control structure may be necessary to prevent the channel from head cutting. Analysis of whether any of the riprap could be removed is recommended.	Higher priority as the dam appeared to be non functioning.	Improved habitat and sediment continuity.	Relatively low as this was a small rock dam.	NA	RMP
T5.01 A – 1 Good IIc	River corridor is undeveloped, except for a house on the right bank near Route 116. The channel has been windrowed downstream of Route 116, with slight sediment buildup along the tops of the banks.	Protect River Corridor. Sediment supply is high and the channel is likely to adjust to equilibrium conditions, although it has been moved over to increase field area. Windrowing could be removed, or opened up in areas to allow more frequent floodplain access.	High priority. Funding has been secured for downstream of Rt 116 and projects are underway	Water quality, reduced erosion (long-term), Recreation, habitat improvement.	Land purchase of corridor.	Land has been in farming (hay and pasture downstream, corn and other crops upstream). Downstream landowner is under contract to sell this area for conservation.	RMP, Wetlands Division, Hinesburg Land Trust (HLT), VLT, TPL.
T5.01 A – 2 Good IIc	The double culvert at Route 116 constricts the channel. Route 116 also acts as a dam here.	Replace culvert with structure of appropriate size when up for replacement. Bank stabilization and gravel extraction activities have happened at the culvert to protect the nearby house.	High priority. Replacing the culvert would require VTRANS, as the structure belongs to them. Feasibility would be difficult due to the nature of the road and crossing.	Reduced pressure and erosion on downstream properties, reduced aggradation on upstream property.	High as the road is a highway and replacement would be difficult.	NA	VTRANS
T5.01 A –	Almost no woody	Planting buffer vegetation	Downstream of Rt	Improved	Low	Farm fields	HLT, RMP,

Project #, Condition, Evolution Stage	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Land Use Conversion	Potential Partners w/ LWP/LCA
3 Good IIc	vegetation or buffer in this reach.	away from where the channel is likely to actively migrate can help with long-term bank stability and habitat value. Plant trees toward the outer edges of the corridor.	116 is being sold for conservation, funding is in place. Upstream of Rt 116 has farm fields on both banks, so less feasible without easements or corridor purchase.	habitat and water quality.		upstream of Rt 116. Downstream already in the process of conversion to wetland and riparian corridor.	VLT, TPL
T5.01 B - 1 Fair IIc	Sediment attenuation area. Stressors: increased sediment load from upstream erosion, horses had free access to the channel, banks trampled, floodplain dumping. Constraints: undersized culvert at Beecher Hill Rd crossing, current land use is pasture	Preserve corridor and exclude livestock through easements. The corridor is undeveloped and the channel is likely to adjust to equilibrium on its own. Halt dumping/filling in the corridor.	High priority as this is a valuable attenuation area.	Improved habitat and water quality. Sediment and flow attenuation to reduce pressures downstream.	Cost of easement for the corridor area.	Pasture animals would need to be fenced out of the channel	RMP, HLT, LIP
T5.01 B – 2 Fair IIc	Some bank and riparian areas lack woody vegetation.	Plant Stream Buffers (away from migration), or allow regeneration.	Low priority.	Improved habitat and water quality.	Low	Pasture would need to be fenced out of the corridor.	Schools
T5.01 B – 3 Fair IIc	A culvert constricts the channel in this segment at Beecher Hill Road. Sediment upstream could deposit downstream near the left bank barns and house.	Replace Structures Further analysis is needed to ensure that downstream investments are not impacted by replacement of this structure with one of appropriate size.	High reach priority. Difficult due to potential impacts on downstream investments.	Sediment continuity, habitat improvement.	Relatively high due to size of structure needed and difficult working location.	NA	Town of Hinesburg, WHIP, AOT
T5.01 C –	This area had multiple	Protect River Corridor to	Low priority as	Protection of	Cost of	Not a big factor.	RMP, HLT,

Project #, Condition, Evolution Stage	Site Description Including Stressors and Constraints	Project or Strategy Description	Technical Feasibility and Priority	Other Social Benefits	Costs	Land Use Conversion	Potential Partners w/ LWP/LCA
1 Good I	ledges and a waterfall.	avoid future encroachment.	lower potential for encroachment due to steepness of slopes.	habitat and riparian corridor.	easement or corridor purchase.		LIP
T5.01 D – 1 Poor II	A head cut was observed downstream of Beecher Hill Rd.	Arrest Head Cut by constructing weirs.	High priority due to potential loss of remaining floodplain in this area.	Sediment Reduction, Reduce pressure on downstream landowners	Cost of constructing weirs.	No land use conversion, although adjacent landowners will need to be involved.	RMP
T5.01 D – 2 Poor II	A berm confines the channel on the left bank, cutting off 50-100 feet of floodplain. Old channels exist. Berm was likely constructed at the time North Road was built. The stream has eroded about half of the berm as it attempts to widen. Constraints: The North Road, the berm has trees, making removal more difficult.	Restore Incised Reach: Remove Berm, Capture Abandoned Channel. Analyze active vs. passive approach, Study watershed scale stressors Remove Berm, arrest downstream head cut, possibly recapture abandoned channel. Rip-rap may be necessary along the North Road to prevent erosion of the road bed. Move the town sand pile out of the corridor as far as possible. Move garage building as a long-term strategy.	High priority due to the significant portion of belt width that would become available to the channel. The berm is vegetated with trees, so their removal may cause some habitat impacts. North Rd may require some protection (riprap) from erosion.	Sediment Reduction, Reduce pressure on downstream landowners, improved habitat and water quality.	Berm removal, Arrest head cut, Rip-rap to protect North Rd is possible ($80-90/linear foot for RR)	Move Town garage sand pile out of corridor. Move garage building as a long-term strategy	Town of Hinesburg, RMP,
T5.01 D – 3 Poor	A bridge constricts the channel at Beecher Hill Road. A culvert	Replace Structures with appropriately sized structures. Replacement of	High priority for North Rd culvert, lower priority for	Reduced pressure on downstream	Fairly high. Unsure about	NA	Town of Hinesburg, AOT,

Project #, Condition, Evolution Stage	**Site Description Including Stressors and Constraints**	**Project or Strategy Description**	**Technical Feasibility and Priority**	**Other Social Benefits**	**Costs**	**Land Use Conversion**	**Potential Partners w/ LWP/LCA**
II	constricts the channel and has a significant downstream drop at the North Road. Grade controls upstream provide stability to this area.	the culvert on North Rd with one of appropriate size and orientation is recommended as a high priority to reduce erosion at the site in conjunction with berm removal.	Beecher Hill Rd bridge. Replacing the culvert at North Rd may be difficult due to slopes and orientation.	reaches, improved habitat.	WHIP eligibility.		USDA

* Denotes projects that cannot be completed independent of other projects or restoration activities.

Potential Project Details

The following list of potential projects details those outlined in Table 4 and are in order of reach and project number. Prioritization of projects was based on listed criteria identified in the RMP Chapter 6 Step-wise procedure (VT ANR River Management Program 2 January 2007). Additional priority was given to projects with known interested landowners or with high development pressure.

Reach: M12
1 - Protect River Corridor
2 - Plant Stream Buffer
3 - Remove/Replace Structure

The river corridor was largely undeveloped and the channel appeared in regime, so protecting the corridor along the reach is recommended and a high priority to alleviate pressures from upstream. Also, perennial vegetation was lacking in some parts of the buffer, so planting the stream buffer with native woody vegetation is recommended. This can also act to stabilize the stream banks. Additional bank stabilization not recommended because bank erosion is minor and not endangering buildings.

An undersized bridge is in the reach at Leavensworth Rd. Flooding problems have been identified here by the landowner, who has noticed increased flooding of fields. The bridge and road were apparently designed to have flood flows run over the road, so even though the bridge constricts the bankfull width, pressure is low because of the opportunity for flood flows to access the floodplain and flow over the road. Development past the river on Leavensworth Road now makes road closure due to flooding inconvenient. A series of culverts under the road and adjacent to the bridge to pass flood flows has been proposed. If the culverts are put in and the road therefore raised, more pressure would likely be placed on the bridge (which brings problems there) because the floodplain would be constricted as well.

The channel here appears to be "in regime" or in a reference/equilibrium condition. So more channel migration than would be associated with a low gradient, meandering stream would not be expected. That is, the stream channel will migrate across the valley over time, but it is not currently undergoing adjustments, which would signal excessive channel movement. Installing culverts and creating more constrictions could send the stream out of balance and the channel could begin adjustment. That would be unfortunate since this is one of the few areas “in regime.” Additionally, with the added constrictions at the culverts, one would anticipate to see more water backed up in that area, which would make the landowner unhappy since she has complained of her field flooding more frequently since the new bridge was installed. A hydraulic study might be necessary here to determine level of flooding and how raising the road and installing culverts in the floodplain might affect flows.

An alternative would be to improve the road from the Charlotte Rd access so it is passable in all seasons. Under this scenario, when the road floods, the residents and emergency equipment would have another means of access.

Another alternative would be to replace the structure to an appropriate size (1.5 times BFW). No significant sediment deposition upstream of bridge. Replacement of the bridge may aid adjacent land use as flooding of the fields could be reduced.

Reach: M13
1 - Protect River Corridor
2 - Plant Stream Buffers

The river corridor was largely undeveloped and channel in regime, so protecting the corridor for the reach is recommended and a high priority to alleviate pressures from upstream. Perennial riparian vegetation was lacking in areas, especially on the left bank. Planting the stream buffer with native woody vegetation is recommended, some planting was observed at the time of assessment.

Bank erosion was observed with moderate changes in channel planform. Planting buffer vegetation can also act to stabilize the stream banks. Additional bank stabilization is not recommended because bank erosion is minor and not endangering buildings.

Reach: M14
1 - Protect River Corridor

The river corridor is undeveloped at this time. The channel appeared to be in stage III of the F-stage evolution process, with minor planform and aggradation observed and an incision ratio of 1.3. If the channel were not actively managed in the near term, it may adjust to equilibrium conditions, depending on ongoing channel management and adjustments upstream. So protecting the corridor along the reach is recommended to provide for passive geomorphic restoration of floodplain and meanders, although continued adjustment and/or changes in watershed stressors may require ongoing monitoring of conditions and adjustment here.

Perennial woody riparian vegetation was lacking, so planting the stream buffer with native woody vegetation is recommended, although planting away from actively migrating or unstable banks and toward the outer edges of the corridor is advised. This can also act to stabilize the stream banks. Additional bank stabilization not recommended because bank erosion is minor and not endangering buildings.

Reach: M15A
1 - Restore Incised Reach
2 - Protect River Corridor
3 - Plant Stream Buffers

The channel appeared incised (incision ratio of 1.7), likely due to historical channel management activities and possibly some historical watershed deforestation (although the lesser of the stressors), resulting in greater stream power and sediment transport capacity (active bed degradation not observed). No recently abandoned channels were observed to capture as a restoration tool. No permanent constraints exist within the corridor of this segment, although the Hinesburg Sewage Treatment Plant is within the corridor of the upstream segment, M15B. Current corridor land use was pasture, although the landowner was working to fence the pasture and plant a small buffer (35 feet) In terms of flow and sediment load alterations, upstream reaches have been significantly straightened, so stream power would be higher, but no alterations appeared to inhibit active geomorphic restoration of floodplain or meanders here.

The stream is not likely to quickly equilibrate as significant clay in the bed and banks has limited channel movement. Therefore, if adjacent landowners are willing, an active restoration of floodplain with respect to the current channel bed elevation is recommended. Protect the river corridor and plant perennial native vegetation as part of the overall restoration plan to ensure long-term viability.

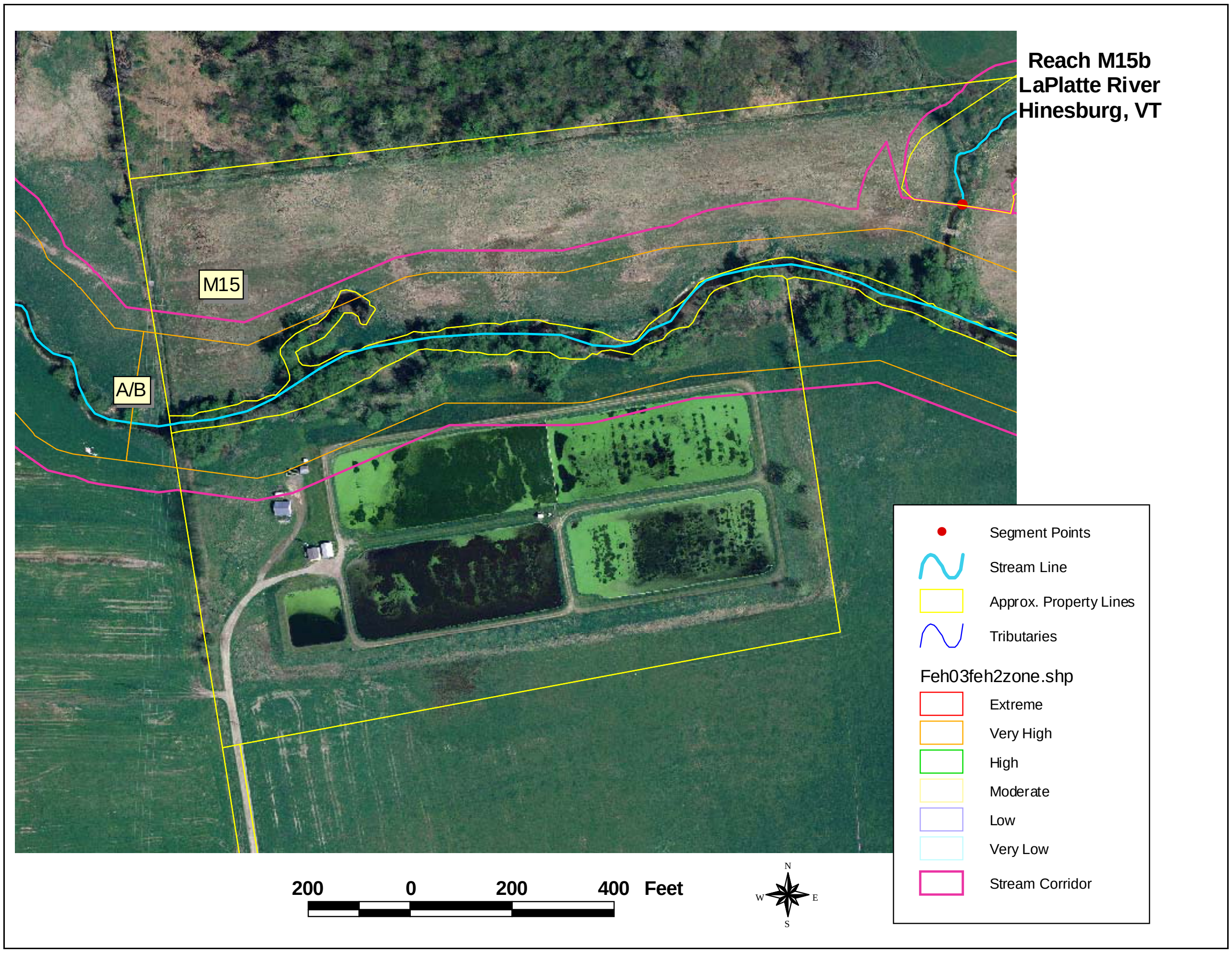
Protecting the river corridor along the reach could provide for passive restoration to equilibrium channel and floodplain dimensions in the long-term if an active approach were not feasible or desired.

Reach: M15B
1 - Restore Incised Reach
2 - Protect River Corridor
3 - Plant Stream Buffers

The river corridor is undeveloped except for the Hinesburg Sewage Treatment Plant (STP) on the left bank. If the channel were not actively managed, it may adjust to equilibrium conditions, although the 20-30 year "near-term" time line may not be realistic due to the clay present in the bed and banks, which has limited movement. Therefore, protecting the river corridor and planting stream buffers should be part of an overall restoration plan. Current beaver activity could help by trapping sediment.

The channel was straightened and incised, resulting in greater stream power and increased sediment transport capacity. No recently abandoned channels were observed to capture as a restoration tool. The Hinesburg Sewage Treatment Plant is a permanent constraint within the corridor on the left bank. The LWP has been working with the Town of Hinesburg to plan future Plant expansions out of the stream corridor. Other than that, adjacent land use appeared to be fallow field and flow and sediment load alterations do not appear to be significant enough to inhibit the active geomorphic restoration of floodplain and meanders.

Active restoration such as lowering of the floodplain may be preferable to a passive approach here due to the proximity of the Sewage Treatment Plant. The channel appeared to be adjusting and protection of the corridor could allow for passive geomorphic restoration, although an active approach near the STP might be preferable to provide protection and relief to that investment. Restoring the segment through a combination passive/active approach is a possibility as well.



Downstream area of M15B with the STP on the left bank. The STP encroaches into both the FEH corridor and the Stream Corridor. The stream has begun to meander here and is migrating toward the berm of the lagoon.

Reach: M16
1 - Remove Berm
2 - Restore Incised Reach through Corridor Protection
3 - Replace Structures

The river corridor is largely undeveloped, however the channel is not likely to adjust to equilibrium conditions in the near term due to the presence of berms and clay soils. Buffer width was 25-50 feet with some areas of about 5 feet or less. Bank erosion and lateral movement were observed. Since the channel was not at or near equilibrium conditions, it is recommended to protect the river corridor and plant perennial native vegetation as part of the overall restoration plan to ensure long-term viability.

Replace structures with appropriately sized structures as they come up for replacement. The culvert at Charlotte Road did not appear to have problems, but does back up water during high flows. The bridge at Silver Street constricted floodprone width, but not bankfull width.
Reach is straightened (incision 1.17) resulting in an increase in stream power. No recently abandoned channels were observed to capture as a restoration tool. Very little development (300 feet) exists within the corridor. Current corridor land use was pasture and hay with some crop, although the area adjacent to the stream appears wet much of the year and might be of limited use for agriculture. The parking lot for the Hinesburg Community School, lagoons at the cheese factory, and one house encroached into the corridor. Berms were present in areas along both banks, limiting floodplain access.

If berms were removed, this reach might quickly equilibrate, although clay soils may limit movement somewhat. Protecting the river corridor and pursuing a passive restoration approach here could allow for floodplain and meander redevelopment over the long-term. Unsure if developments or land uses within the corridor would be threatened by more frequent flooding, so recommend to remove berms but do more investigation first with landowners and on flood stages. Also, check for mature trees that would be impacted along with habitat if berms were removed.

Reach: M17
1 - Restore Incised Reach through Corridor Protection
2 - Plant Stream Buffers
3 - Replace Structures


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.

Reach M17, entrenched and now widening and aggrading.

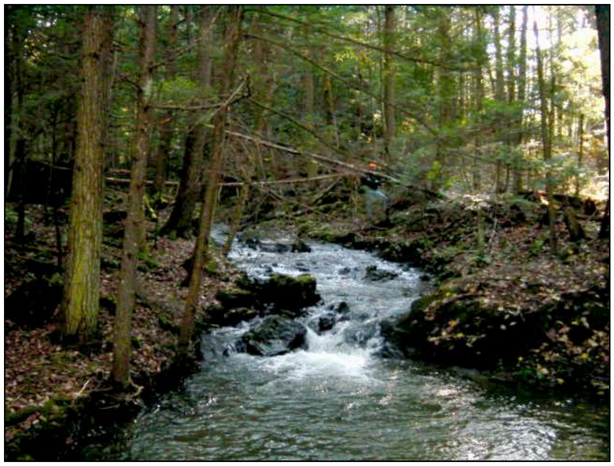
The river corridor is undeveloped but the channel has been straightened and likely dredged deeper. If the channel were not actively managed, it may adjust to equilibrium conditions, although the 20-30 year "near-term" time line may not be realistic due to the clay present in the bed and banks, which has limited movement. However sediment supply is high, so protecting the river corridor and pursuing a passive restoration approach here could allow for floodplain and meander redevelopment over the long-term, without the cost of active restoration. Berms present in the reach are not the main reason the channel is incised.

Plant stream buffers where not likely to be eroded away before becoming established. This will also help to stabilize stream banks over the long term.

Replace the culvert for the farm access, as no developments are likely to be endangered by changes in bed elevation, sediment deposition, or bank erosion. Replace the culvert at Gilman Road. Significant sediment does not appear to be present upstream, and the culvert appears to be exacerbating bank erosion downstream. Replacement of this culvert with a larger structure would reduce erosion pressures on downstream properties.

This reach is part of the LaPlatte Headwaters Initiative on Bissonette Farm, a conservation project involving 628 acres. Funding has been secured through a variety of sources, including the Vermont Clean & Clear program, to purchase 300 acres and over 5 miles of river and tributaries associated with this reach as well as the upstream most portion of M16, most of M18A, and part of M18B. The area will be the focus of both active and passive restoration strategies with funding for wetlands restoration coming from the Natural Resource Conservation Service. The town will own the land with a conservation easement held by Vermont Land Trust. A management plan will insure that this reach and the surrounding land is managed to achieve geomorphic equilibrium conditions.

Reach: M18A
1 - Protect River Corridor

Ledge grade control toward downstream end

The river corridor is undeveloped and the channel is likely to adjust to equilibrium conditions in time. So protecting the river corridor is recommended. The segment appeared to be aggrading, but not due to significantly increased sediment supply or decreased peak flows. The stream has access to floodplain, but sediment is being generated in the upstream reach. Protecting the river corridor and addressing upstream issues is recommended.

Moose track to the right of boot. Moose seen in the area as well as bear, deer, turkey, coyote, fox, and others.

This segment is part of the LaPlatte Headwaters Conservation initiative. Funding has been secured to purchase the stream corridor and protect it along the majority of this segment, excluding the downstream 815 feet and the upstream 450 feet.

Reach: M18B
1 - Replace Structures
2 - Potential Restoration/Protection Project

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).

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

The river corridor is largely undeveloped except for one house on the left bank, but the channel is not likely to adjust to equilibrium due to the undersized culvert at Route 116. The streambed was actively eroding with active head cuts observed. The stream was deeply incised (1.9). The culvert should be replaced with protection provided to the house on the left bank if necessary. Sediment from upstream of the culvert would erode and enter the system, however that could aid adjustments underway downstream by slightly raising bed elevation and/or inducing meanders (such as in reach M17). If sediment introduction is undesirable from a water quality standpoint, structures could be placed to partially retain the sediment and encourage floodplain restoration or the sediment could be removed.

The stream is significantly incised, resulting from an undersized culvert trapping sediment upstream. This is a potential restoration/protection project that depends on the ability to replace the Route 116 culvert.

Reach: M15S2.01
1 - Protect River Corridor
2 - Replace Structures
3 - Potential Restoration/Protection Project

The river corridor is largely undeveloped except for the left bank along Commerce Park. Diversion of water from this reach into “The Canal” has altered flow historically. In recent years, a failing dam behind Nestech has allowed more water to return to this reach. It is likely that this reach would adjust to equilibrium conditions in the near term if conditions were constant. However with uncertainty in the stream flow and in how “The Canal” will be managed in the future, it is recommended that the stream corridor be protected to prevent further investments from encroaching on the area the stream needs to regain equilibrium. Additionally, restoring flow to this reach and finding alternative ways to fill “The Canal” (such as stormwater) are recommended further actions as Potential Restoration/Protection Projects (to also include planting a stream buffer).

A culvert constricts the channel at Route 116, with scour at the downstream end. No upstream sediment deposition was observed. Replacing the structure with one of appropriate size is recommended, especially if flow is restored to this reach from the Canal diversion.

The channel is significantly straightened and slightly incised (1.25). No recently abandoned channel was observed for use as a restoration tool. Buildings only exist in the left corridor. Current flow alterations as discussed above would inhibit the active geomorphic restoration of floodplain and meanders here. Landowners are being contacted to discuss willingness for corridor protection and passive restoration. If landowners are willing, restore the incised reach through corridor protection.

Reach: T3.01
1 - Protect River Corridor
2 - Replace Structure

The river corridor is undeveloped and likely to adjust to equilibrium, although due to clay soils, may be in the long-term rather than the near-term. Protect the stream corridor to allow for adjustment to equilibrium. The landowner was working to fence the pasture and plant a 35-foot buffer (spring of 2007 planting).

Channel and valley view. Note straightening and lack of woody riparian vegetation.

A culvert at Charlotte Road constricts the channel with sediment deposition upstream and scour downstream and a high incidence of road-killed wildlife. Sediment deposition is not likely to create a significant channel adjustment if it moves downstream, so replacing the structure with one of appropriate size is recommended.

Reach: T3.02
1 - Protect River Corridor
2 - Plant Stream Buffers

The river corridor is undeveloped and used for pasture. A large beaver dam and pond were located at the upstream end of the reach and beaver activity was observed in the reach. 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. The channel is likely to adjust to equilibrium conditions if the corridor is protected and livestock fenced out of the channel. Plant stream buffers in areas where grazing and trampling have disturbed buffer, or allow vegetation to regenerate through corridor protection.

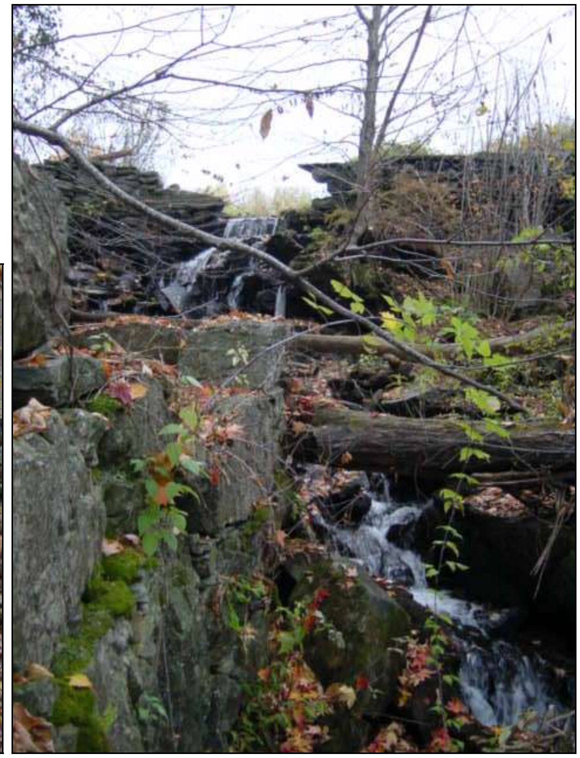
Reach: T4.01
Managed as “The Canal.”

Reach: T4.02
Managed as “The Canal.”

The LWP has begun communication with Saputo Cheese, the owner of “The Canal” in order to explore possible options for this area and the historical Patrick Brook to the north.

Reach: T4.03
1 - Protect River Corridor
2 - Replace/Remove Structures


Reach view with old abutment.


Old Mill dam near town cemetery.

River corridor is undeveloped and stream impacted by historical mill operations and dams as well as deforestation. This reach is under adjustment and may regain equilibrium in the near term if watershed stressors are not increased, such as further development with driveways and road ditches. So protecting the corridor is recommended, although a low priority as this area is wooded and difficult for development within the corridor. Minimal bank erosion was observed.

A double culvert constricts the channel at Mechanicsville Road, with deposition upstream and a scour pool below. Replacing this structure with one of appropriate size is recommended. Old mill footings and partial dams also constrict the channel in this reach. While these are historic relics, they reduce geomorphic functions. It is recommended that the Town of Hinesburg examine what course of action they want to pursue with these structures.

Reach: T4.04
1 - Protect River Corridor
2 – Remove/Replace Structures


Old mill dam upstream and downstream photos.

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. Two culverts constrict the channel. Minor degradation has occurred through reduction of sediment at dams. Current adjustments appear to be widening with minor aggradation and planform.

A R-O-R dam at Iroquois Manufacturing reduces sediment supply to the reach. The company uses the pond, so the dam is likely to remain. Other old milldams constrict the channel, which has begun to migrate around them, producing sediment. As with those in T4.03, it is recommended that the Town of Hinesburg examine what course of action they want to pursue with these structures. Protect the river corridor to allow for channel adjustment and to prevent investments from being placed in the corridor.

Reach: T4.06
1 - Remove Dam

A dam was located in the reach and appeared to be non-functioning. Removal of this dam is recommended. A grade control structure may be necessary to prevent the channel from head cutting. Riprap and rock walls confine the channel toward the upstream end. Analysis of whether any of this could be removed without endangering infrastructure and homes is recommended.

Reach: T5.01A
1 - Protect River Corridor
2 - Replace Structure
3 - Plant Stream Buffers

The river corridor is undeveloped, except for a house on the right bank near Route 116. Sediment supply is high and the channel is likely to adjust to equilibrium conditions, although it has been moved over to increase field area. Protecting the river corridor is recommended. The channel has been windrowed downstream of Route 116, with slight sediment buildup along the tops of the banks. This could be removed, or opened up in areas to allow more frequent floodplain access. Planting buffer vegetation away from where the channel is likely to actively migrate can help with long-term bank stability and habitat value.

The double culvert at Route 116 constricts the channel and should be replaced with one of appropriate size. Route 116 also acts as a dam here. Sediment deposition has been a problem upstream of this culvert and has been cleaned out with riprap placed on the right bank.

Reach: T5.01B
1 - Protect River Corridor
2 - Replace Structure
3 - Plant Stream Buffers

Attenuation area with floodplain connectivity.

The corridor is undeveloped and the channel is likely to adjust to equilibrium on its own, so protecting the stream corridor is recommended. This is also a valuable attenuation zone to buffer against upstream impacts. Planting stream buffer away from actively migrating banks is recommended.

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.

A culvert constricts the channel in this segment at Beecher Hill Road. Sediment upstream could deposit downstream near the left bank barns and house. Further analysis is needed to ensure that these investments are not impacted by replacement of this structure with one of appropriate size.

Reach: T5.01C
1 - Protect River Corridor


Milldam to left, falls to right.

This area had multiple ledges and a waterfall and a wooded corridor. Protect the corridor to avoid future encroachment.

The channel may have had a longer travel path with less of a drop over to the left in the photo before the milldam was constructed.

Reach: T5.01D
1 - Arrest Head Cut
2 - Restore Incised Reach
3 - Remove Berm
4 - Capture abandoned Channel
5 - Replace Structure

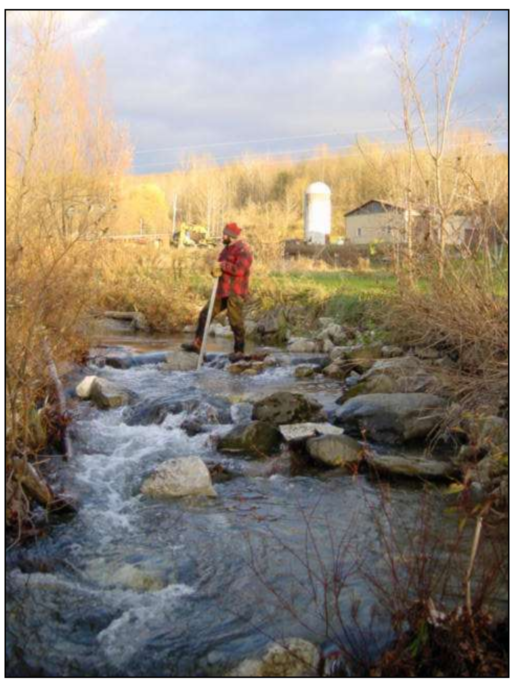
Segment T5.01D had been straightened, moved, and bermed historically, likely in conjunction with construction of North Road. Following the channel alteration, the stream had no access to floodplain and appears to have severely widened and incised. Continued incision and widening (channel enlargement)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

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.

Significant channel enlargement following straightening and berming.


Channel enlargement further downstream leaving investments in danger.

A head cut was identified downstream of the Beecher Hill Road bridge near North Road. This area has some floodplain access, so constructing a weir to arrest the head cut is recommended.


Headcut downstream of Beecher Hill Rd.

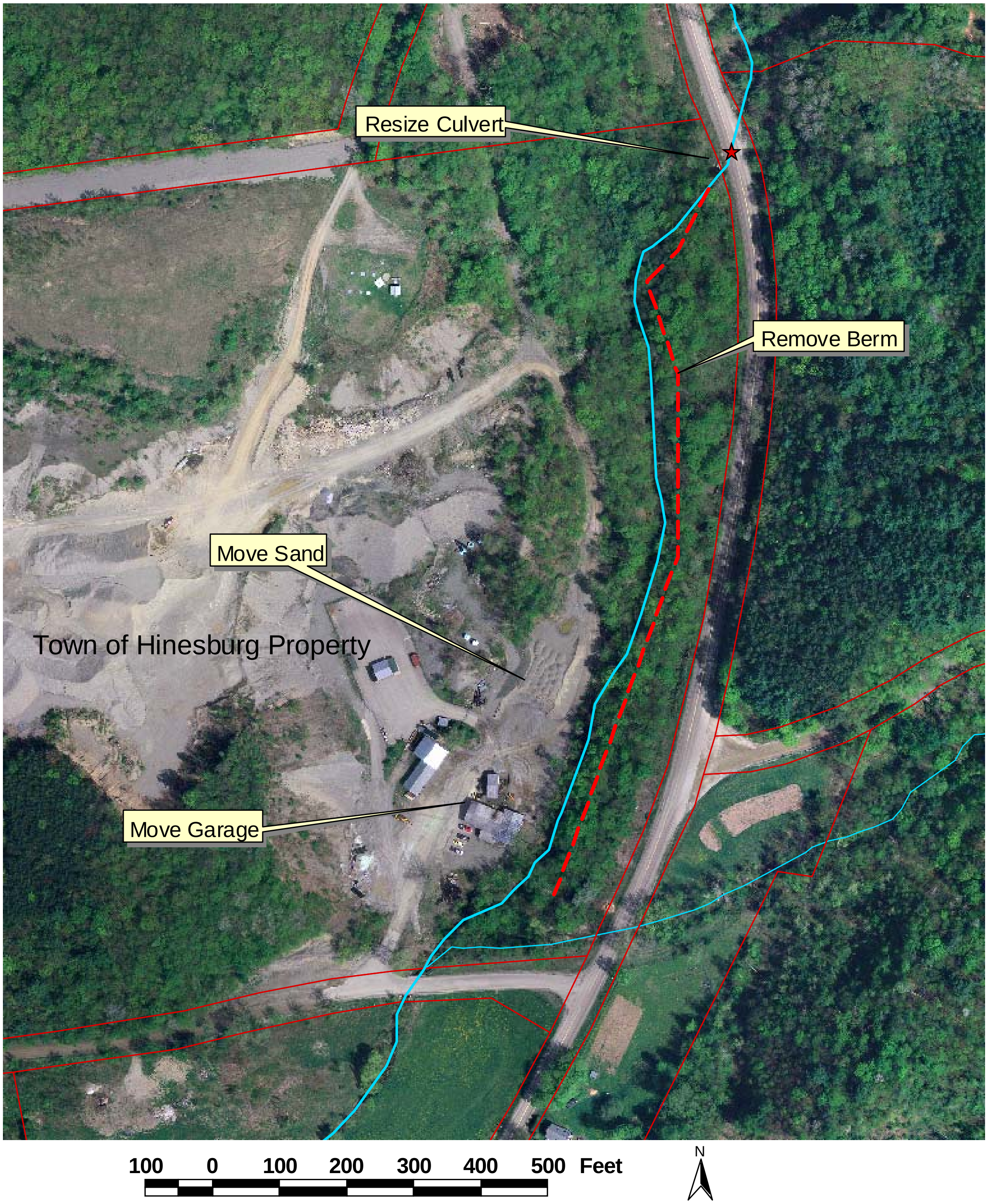
Berms confine the channel upstream of Beecher Hill Road, preventing floodplain access. Removal of the berms is recommended, with consideration for protection of North Road and the Town Highway Garage.

A bridge constricts the channel at Beecher Hill Road. Replacement with one of appropriate size is recommended. A culvert constricts the channel and has a significant downstream drop at the North Road. Grade controls upstream provide stability to this area. Replacement with one of appropriate size and orientation is recommended as a high priority to reduce erosion at the site. The segment is incised due to the berms. Parts of an abandoned channel exist that could be used for restoration. This should be examined in planning for restoration of the incised segment. The restoration may need to include bed forms and floodplain features in equilibrium with the higher stream power due to the North Road occupying some floodplain area.

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

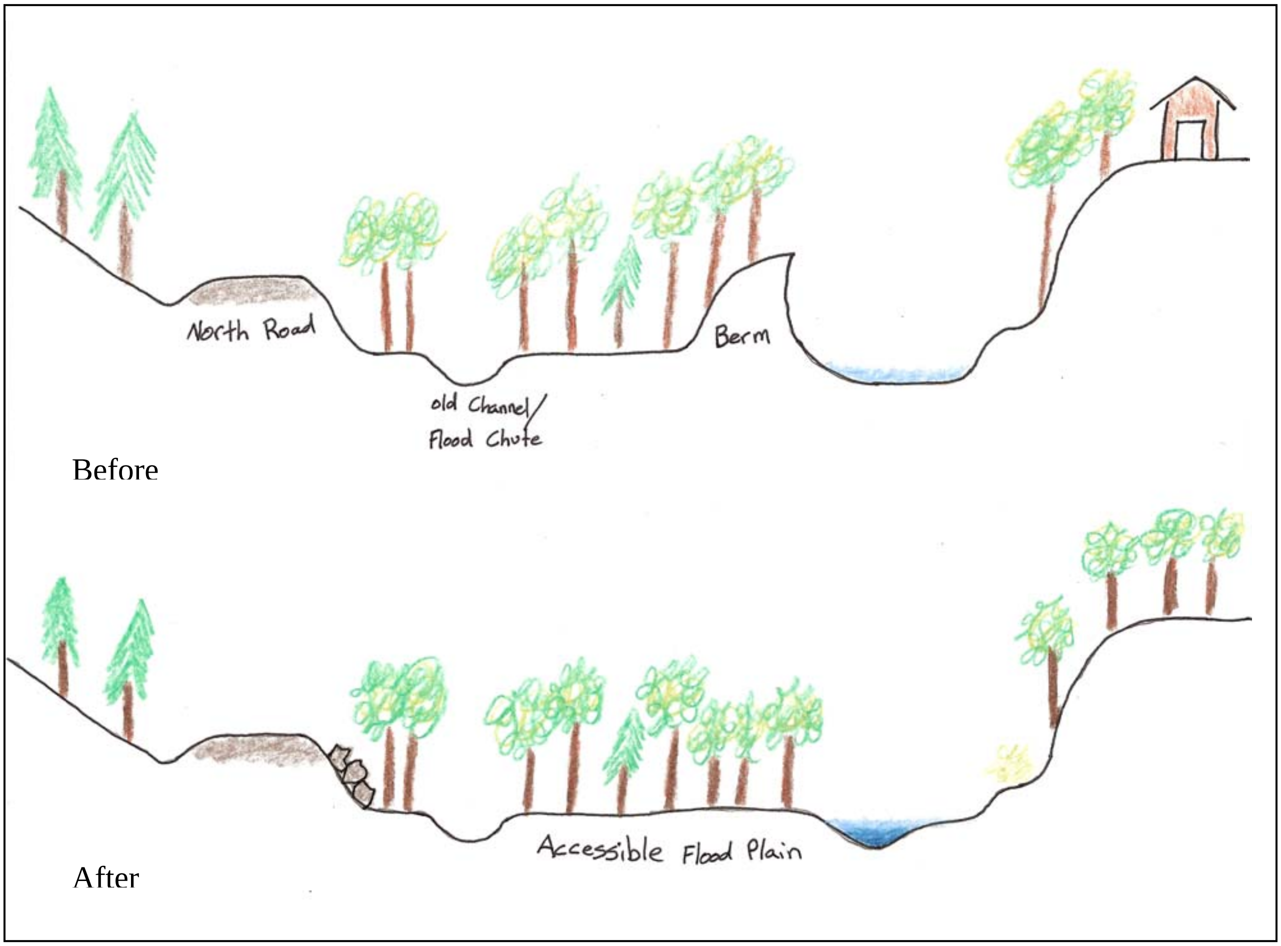
Culvert at North Rd views: upstream end and downstream end.

Town Garage Site T5.01D



Town Garage site map showing berm highlighted in red, North Rd to the east, Beecher Hill Rd to the south, the town garage and sand pile, and the location of the undersized culvert.

Concept project components include:
Conserve corridor
Move Town Garage and sand pile
Remove berm
Resize culvert upstream
Stabilize North Rd if and where necessary
Recapture old channels



Conceptual cross sections to illustrate berm removal and relocation of garage and sand pile.

Next Steps

Of the potential projects identified in the Corridor Planning process, the LWP has identified the Beecher Hill Brook T5.01 B and T5.01D projects as important and feasible for immediate action. The LWP will be applying for funding to develop and implement these projects.

The LWP will also be working to develop funding proposals for additional projects in the coming years. Projects seen as priorities and feasible include M15B-1 on Town land upstream of the sewage treatment plant and projects on M15S2.01 related to restoration of the historical Patrick Brook.

The LWP will also continue to work with the Town of Hinesburg to implement strategies for protecting the LaPlatte River and tributaries with the goal of reducing future conflicts and costs.

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Acronym List

CCRPC – Chittenden County Regional Planning Commission
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 (see below).

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.