Phase II Geomorphic Assessment of the LaPlatte River: Hinesburg Reaches

Vermont Watershed Grant 2004

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Introduction

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

This report details work from a Phase II Stream Geomorphic Assessment of the Upper LaPlatte River in Hinesburg and its tributary Patrick Brook, which was completed in the Summer and Fall of 2004 through a Vermont Watershed Grant. The Phase II study utilized data collected from a Phase I study, which delineated the 53 square mile watershed, identified 48 distinct reaches, and collected remote sensing data such as slopes, stream type, land use, riparian buffers, soils, and channel modifications.

The LaPlatte is the largest watershed feeding Shelburne Bay, 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 development are resulting in channel degradation and adjustment and extreme loss of instream and riparian habitat. Given the extensive channel management history, aging flow control dams and diversions, and changing runoff characteristics related to increased development in the watershed, there is a high likelihood of continued and increased channel adjustment. The past use of land for agriculture is leading 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.

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

The LWP also educated community members on stream geomorphic processes through meetings, press releases and involvement in fieldwork. A copy of the data and report is provided to each of the towns and the LWP will work to help towns understand how the information is congruent with their Town Plans and how it can be used in planning and in development review to protect the resources of the LaPlatte. Hinesburg will be making substantial changes to zoning and subdivision regulations and it is LWP's hope that this information will help guide that process for riparian areas and help protect natural, cultural, and recreational values.

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

Background

Setting

The LaPlatte River Watershed encompasses 53 square miles, mainly in the towns of Shelburne, Charlotte, and Hinesburg, with small sections in Williston, Richmond, and St. George. The LaPlatte is the largest watershed feeding directly into Shelburne Bay.

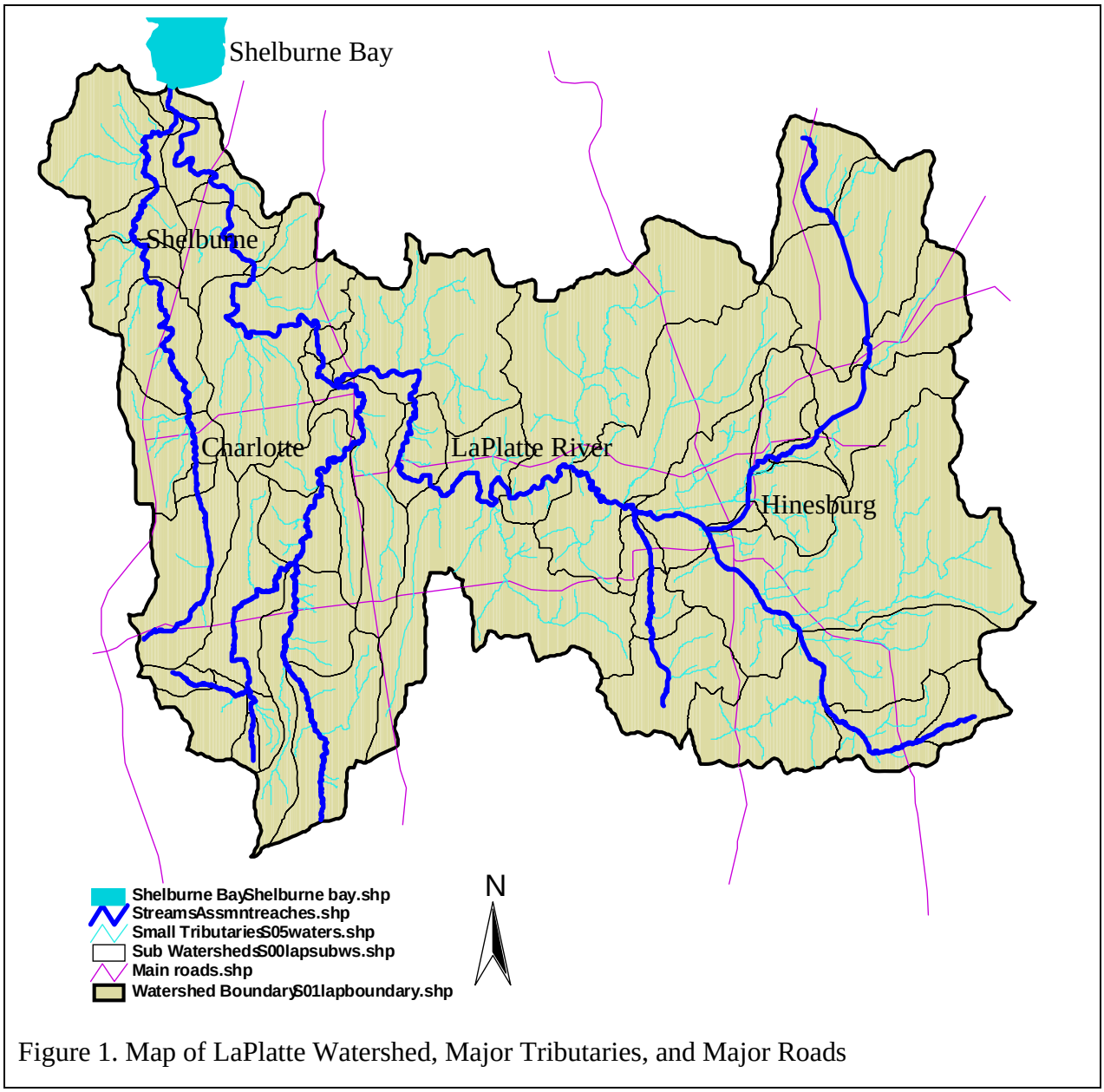

Figure 1. Map of LaPlatte Watershed, Major Tributaries, and Major Roads

The study area for this assessment includes the valley reaches of the LaPlatte mainstem in the town of Hinesburg and the reaches of Patrick Brook below Lake Iroquois (except the reach encompassing Lower Pond, T4.5). The watershed size at the downstream most assessment reach, M13, is 23 square miles. The Patrick Brook watershed is 7 square miles and enters the LaPlatte mainstem at reach M15.

Phase II Assessment Methods

A Phase II Stream Geomorphic Assessment was completed on 10 reaches of the LaPlatte mainstem and its tributary Patrick Brook. This project exclusively used the VT DEC Stream Geomorphic Assessment Protocols (the Protocols) (VTANR, April 2003) to perform the Phase II Assessment and utilized data and information collected in the Phase I Assessment.

The following summarizes tasks involved in the Phase II Assessment according to the Protocols:

· Contact volunteers and coordinate fieldwork days for those interested.
· Obtain permission from landowners along study reaches before performing the assessment along their segment of river.
· Train volunteers as necessary.
· Using the Phase I data, field check reaches and types identified in Phase I and segment or modify as necessary.
· Walk the length of each reach to map features and evaluate conditions.
· Collect physical data for reaches or segments including location, elevation, reach length, drainage area, flood/disturbance history, bankfull elevation.
· Photograph and sketch reaches and segments.
· Identify natural and artificial features of the channel and adjacent valley (watershed zone, channel constraints, floodplain terrace, valley slope, habitat barriers).
· Using a measuring tape and rod, measure channel dimensions, bankfull and flood elevations and depths, width-to-depth ratio, entrenchment ratio, riffle-step distribution, substrate size and verify stream typing.
· Evaluate stream banks, buffer strips, and riparian corridor.
· Document flow modifiers such as impoundments, springs, wetlands, drainage ditches, constrictions, and condition of the upper watershed.
· Identify evidence of channel bed and planform changes.
· Perform a Rapid Habitat Assessment (RHA) using the RHA field form developed by VT ANR.
· Perform a Rapid Geomorphic Assessment (RGA) using the RGA field form developed by VT ANR.
· Enter all data into ANR Stream Geomorphic Assessment database.

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

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

The RGA is useful in evaluating current stream processes, departures from a reference condition, and stages of channel evolution for a given reach. Two separate RGA forms are used in the Phase II Assessment, one for unconfined streams and one for confined streams. Parameters evaluated in the RGA are summarized as follows:

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

Once the RGA is completed and a condition category selected, a stage of channel evolution is selected. One of 2 channel evolution models is used; either the F-stage model or the D-stage model. In the F-stage model, a channel undergoes degradation first, due to a disturbance. This degradation is typically followed by channel widening, then aggradation and planform adjustments, before then regaining stability with regard to its water and sediment loads. In the D-stage model, aggradation, widening, and planform changes are the main adjustment processes, with degradation being limited, sometimes by bed material or grade controls.

Parameters for the RGA and RHA were scored and assigned to the correlating condition category as follows:

Condition	Score
Reference (in regime)	0.85-1.0

Good (minor adjustment)	0.65-0.84
Fair (moderate adjustment)	0.35-0.64
Poor (extreme adjustment or departure from reference stream type)	0.00-0.34

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

Phase II Assessment Results

Hinesburg Valley Reaches

This section of the LaPlatte River mainstem, from reach M13 to M17 drains 23 square miles. The LaPlatte through these reaches is a low gradient, unconfined stream. 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 and silt mix. Some clay is present along lower banks, which can add 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 and Beecher Hill Brook, enter the mainstem along these reaches. Adjacent wetlands have typically been converted to agricultural land through ditching and dredging of side channels.

RHA conditions of the valley reaches are evaluated in fair condition except for segment M15b, which is in poor condition. Lack of diverse substrates for instream habitat, channel straightening, and lack of riparian buffer are the major factors contributing to these low scores. Segment M15b also suffers from exposed channel substrates, sediment deposition, and moderately unstable banks.

RGA conditions of the valley reaches vary. M13 and M14 appear in good condition and in regime for their stream type, that is, they do not appear to be undergoing adjustment due to disturbance. Reaches M15 and M16 appear in fair condition and undergoing stage IIc of the D-stage channel evolution process. They are undergoing planform, widening, and aggradation adjustments. Reach M17 is in poor condition, it is incised and entrenched and now widening and migrating laterally. These reaches are moderately to highly sensitive to future disturbance.

Reaches M16 and M17 have undersized bridges and culverts. These reaches pass through 3 culverts that are narrower than bankfull width, meaning that they constrict the 1.5 to 2-year high flow. M16 passes through 2 bridges that are narrower than the floodprone width and therefore constrict higher flood flows.

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

M13

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

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

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

Cross section measurements show the reach is not entrenched, meaning that it has connection to its floodplain at 1.5 to 2 year high flows. Therefore flood flows can spread out over the floodplain and cause less erosion damage. Measurements show minimal incision or widening of the channel. Riffles are almost absent with the reach dominated by runs and a few large pools. This combined with homogeneous fine sediment signals minor aggradation of the reach. The high amount of bank erosion in this reach signals minor planform adjustment. Herbaceous bank vegetation and silt/clay bank composition are factors likely contributing to the planform changes in the reach. Overall, the geomorphology of reach M13 is in good condition and it appears to be in regime, meaning minimal change and within the range of adjustment for its stream type (C5c Dune-Ripple). The stream is moderately sensitive to future disturbances.

M14

Reach M14 is a short reach just below a significant tributary. Similar to M13, it is a low gradient stream running through a very broad, unconfined valley setting. Adjacent valley side slopes are moderate, or hilly. The reach does not contain any grade controls such as falls, bedrock ledges, dams or weirs. Bed substrate is comprised of homogeneous fine particles of sand and silt with some areas of clay noted. No Large Woody Debris pieces are present in this reach contributing to

a lack of food and cover for aquatic species. A stream ford at the downstream end of the reach is built up with rocks to provide a crossing for farm equipment.

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

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

Cross section measurements show the reach is not entrenched, meaning that it has connection to its floodplain at 1.5 to 2 year high flows. Therefore flood flows can spread out over the floodplain and cause less erosion damage. The reach does appear to be slightly incised signifying minor bed degradation. Measurements show minimal widening of the channel. Riffles are almost absent with the reach dominated by runs and a few large pools. This combined with homogeneous fine sediment signals minor aggradation of the reach. The high amount of bank erosion in this reach signals minor planform adjustment. Herbaceous bank vegetation and silt/clay bank composition are factors likely contributing to the planform changes in the reach. Overall, the geomorphology of reach M14 is in good condition and it appears to be in regime, meaning minimal change and within the range of adjustment for its stream type (E5 Dune-Ripple). The stream is moderately sensitive to future disturbances.

M15

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

M15 Segment a

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

Bank slopes are undercut and comprised of a non-cohesive silt/clay mix. Bank erosion is present along 63% of the left bank and 36% of the right bank. The left bank is unstable and in poor condition while the right bank is moderately unstable and considered in fair condition. Bank vegetation is comprised of grasses with no woody species and is rated as fair. Both right and left

banks have buffer widths of less than 5 feet. The buffer vegetation is comprised of grasses, as the riparian corridor land use is pasture with some hay.

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

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

M15 segment b

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

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

A Rapid Habitat Assessment (RHA) shows the overall segment habitat to be in poor condition. Few types of bed substrate and cover exist for fish or macroinvertebrates. The majority of the pools are shallow with fine substrate and little submerged vegetation. A large increase in

sediment deposition exists, filling pools. Channel flow does not fill the channel, leaving exposed substrate and is considered in fair condition. This segment of the LaPlatte appears to have been entirely straightened. Channel sinuosity is considered poor due to the extensive channel straightening. The riparian buffer width for this segment is in poor to fair condition, having lost most woody species and cover.

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

M16

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

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

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

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

M17

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

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

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

Cross section measurements show poor entrenchment and incision ratios, signifying extreme bed degradation. Therefore the reach does not have access to the floodplain and could have higher erosion rates. Historic degradation, bank scour at riffles, and mid channel bars signal major widening of the channel. Filling of pools with fine sediment deposition and mid channel bars signal minor aggradation of the reach. Bank erosion, flood chutes crossing meander bends and

historic channel straightening signal major planform adjustment. Overall, the geomorphology of reach M17 is in poor condition. The extreme historic degradation with major widening and planform adjustments suggest this reach is in stage III of the F-stage channel evolution process. The stream type is B5c Dune-Ripple. The stream is highly sensitive to future disturbances.

Patrick Brook Reaches

Patrick Brook 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. Upper reaches of Patrick Brook are typically high gradient, confined reaches while the lower reaches (T4,1 and T4.2) are low gradient, unconfined reaches. Patrick Brook reaches are sources and transporters of sediment. A few low gradient meadow areas provide places for sediment collection. Patrick Brook has numerous grade controls in the form of bedrock ledges and falls and dams.

Patrick brook soils are lacustrine and alluvium downstream (T4.1 and T4.2), changing to dense till and glacial outwash in the upper reaches. Adjacent land use is forest, residential, and one industry, with evidence of old mill activity. Through the village, floodplain encroachment, or elimination of floodplain through berming, significantly reduces stream function and adjacent wetlands. Nine tributaries enter the stream in these reaches.

RHA conditions of Patrick Brook vary. Habitat in reach T4.1 is in poor condition due to extensive channel alteration and loss of riparian buffer. Variety in channel substrates and pools is also lacking. T4.2 is in fair condition with some variety of substrates and pools, but limited riparian vegetation and extensive channel alteration. Habitat in upstream reaches (T4.3, T4.4, and T4.6) is in good condition.

RGA conditions of Patrick Brook are similarly varied. Lower reaches (T4.1 and T4.2) are in fair and poor condition respectively due to extensive channel alteration. Reaches T4.3 and T4.4 are in fair condition and appear to be undergoing extreme widening with some aggradation. Reach T4.6 is in good condition and appears to be in regime with only minor planform, aggradation and widening.

Reach T4.1 passes through one culvert and one bridge that constrict the bankfull width, and one bridge that constrict the floodprone width. One undersized culvert and 3 old mill abutments and dams constrict the bankfull width of T4.3. The bankfull width of T4.4 is constricted by 2 culverts, several old mill abutments and bedrock outcrops. One bridge, one culvert, and a bedrock outcrop constrict the bankfull width of T4.6 and another bridge constricts the floodprone width.

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

T4.1

Reach T4.1 is a low gradient stream running through a very broad, unconfined valley setting. The entire reach has been channelized into a canal against the left valley wall. The lower section of the reach passes the Saputo Cheese Factory. Adjacent valley side slopes are gentle on the right

and steep on the left. There is a store-release dam just downstream of the Route 116 crossing. The dam is about 7 feet high. Bed substrate is comprised of homogeneous fine particles of sand and silt with some areas of clay noted. A count of Large Woody Debris pieces yielded only 1 piece. A culvert and a bridge constrict the channel and a footbridge constricts the floodprone width. No problems are apparent at these constrictions.

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

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

Cross section measurements show the reach is not entrenched, meaning that it has connection to its floodplain at 1.5 to 2 year high flows. Therefore flood flows can spread out over the floodplain and cause less erosion damage. The reach does appear to be moderately incised and channel features have been straightened and replaced by plane bed features, signifying major bed degradation. Incision, channel alteration, and mid channel bars signal minor widening of the channel. The change to plane bed features, fine sediment deposition and mid channel bars signal extreme aggradation of the reach. Deposition and historic channel straightening signal minor planform adjustment. Overall, the geomorphology of reach T4.1 is in fair condition. The extreme aggradation after historic degradation suggest this reach is in stage III of the F-stage channel evolution process. The stream type is C5 Plane Bed. The stream is highly sensitive to future disturbances.

T4.2

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

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

shrubs and saplings. Riparian corridor land use is residential on the left and fallow field on the right.

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

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

T4.3

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

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

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

width for this reach is in good to reference condition, with some loss at the downstream end of the reach.

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

T4.4

Reach T4.4 is a high gradient stream running through a semi-confined valley setting. Adjacent valley side slopes are very steep. The upstream end of the reach begins at a run-of-the-river dam at the Lower Pond, about 10 feet high. The reach passes over multiple ledges and falls and past another r-o-r dam at Iroquois Manufacturing. Two culverts, old abutments and bedrock outcrops constrict the channel with deposition above and scour below the constriction. Bed substrate is comprised mostly of gravels with sand, cobbles and boulders. A count of Large Woody Debris pieces yielded 41 pieces and 7 debris jams in the reach to provide food and cover for aquatic species.

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

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

Cross section measurements show the reach is not entrenched or incised for a confined stream. Minor degradation has occurred through reduction of sediment at dams. Multiple mid channel bars, an increase in sediment, and sediment buildup at constrictions signal minor aggradation of the reach. A very high width to depth ratio, mid channel bars, and a decrease in sediment load due to the dams signal extreme channel widening. Minor planform adjustment is suggested by mid channel bars, past channel avulsion, and channel constrictions. Overall, the geomorphology of reach T4.4 is in fair condition and it appears to be widening with minor aggradation and

planform adjustment. The stream type is F4b Step-Pool. The stream is highly sensitive to future disturbances.

T4.5

Reach T4.5 encompasses Lower Pond with a run-of-river dam at its downstream end. This reach was not assessed due to its status as pond rather than stream channel.

T4.6

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

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

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

Cross section measurements show the reach is not entrenched or incised. Minor degradation has occurred through reduction of sediment at dams. Multiple mid channel bars, an increase in sediment, and sediment buildup at constrictions signal minor aggradation of the reach. Minimal mid channel bars and a decrease in sediment load due to the dams signal minor channel widening. Minor planform adjustment is suggested by mid channel bars, the presence of flood chutes and channel constrictions. Overall, the geomorphology of reach T4.6 is in good condition and it appears to be in regime for its stream type (C4 Riffle-Pool). The stream is moderately sensitive to future disturbances.

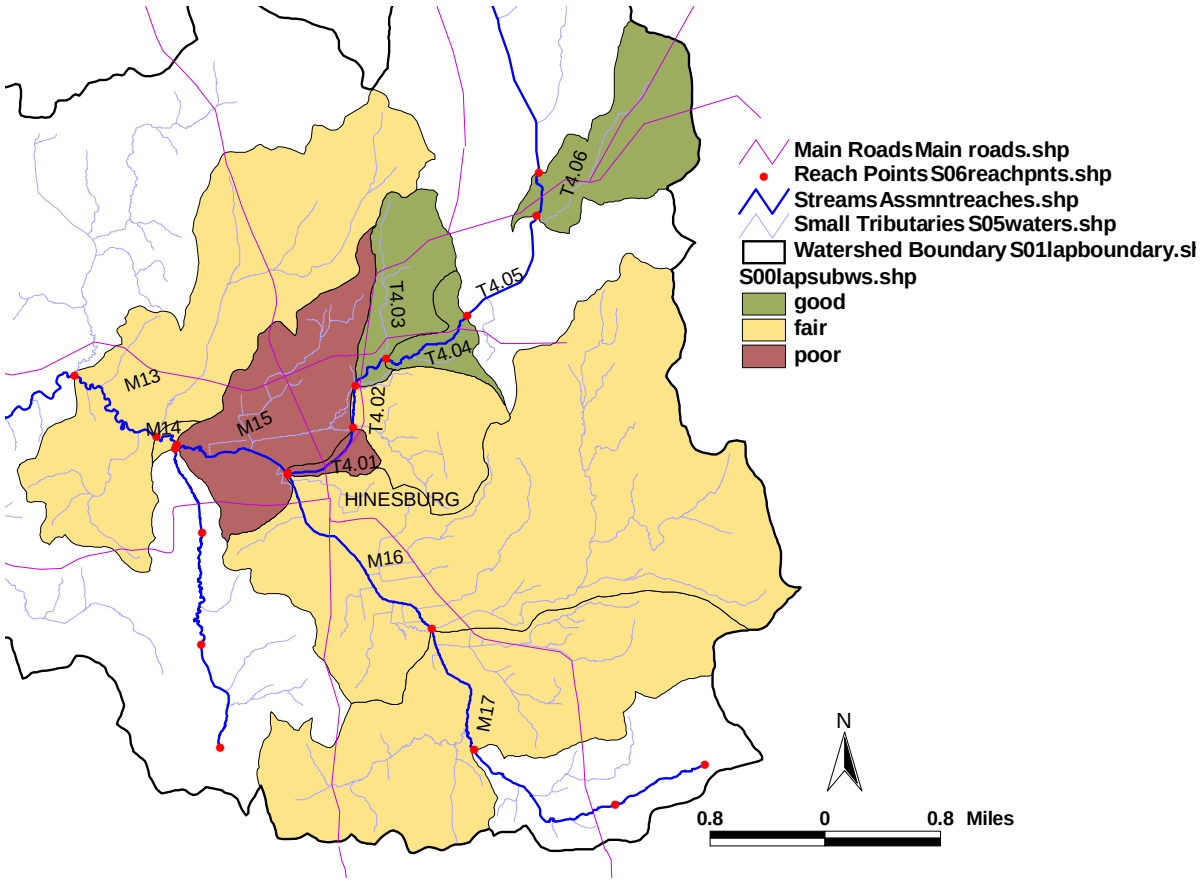

Figure 2. Rapid Habitat Assessment Condition Category for study reaches.

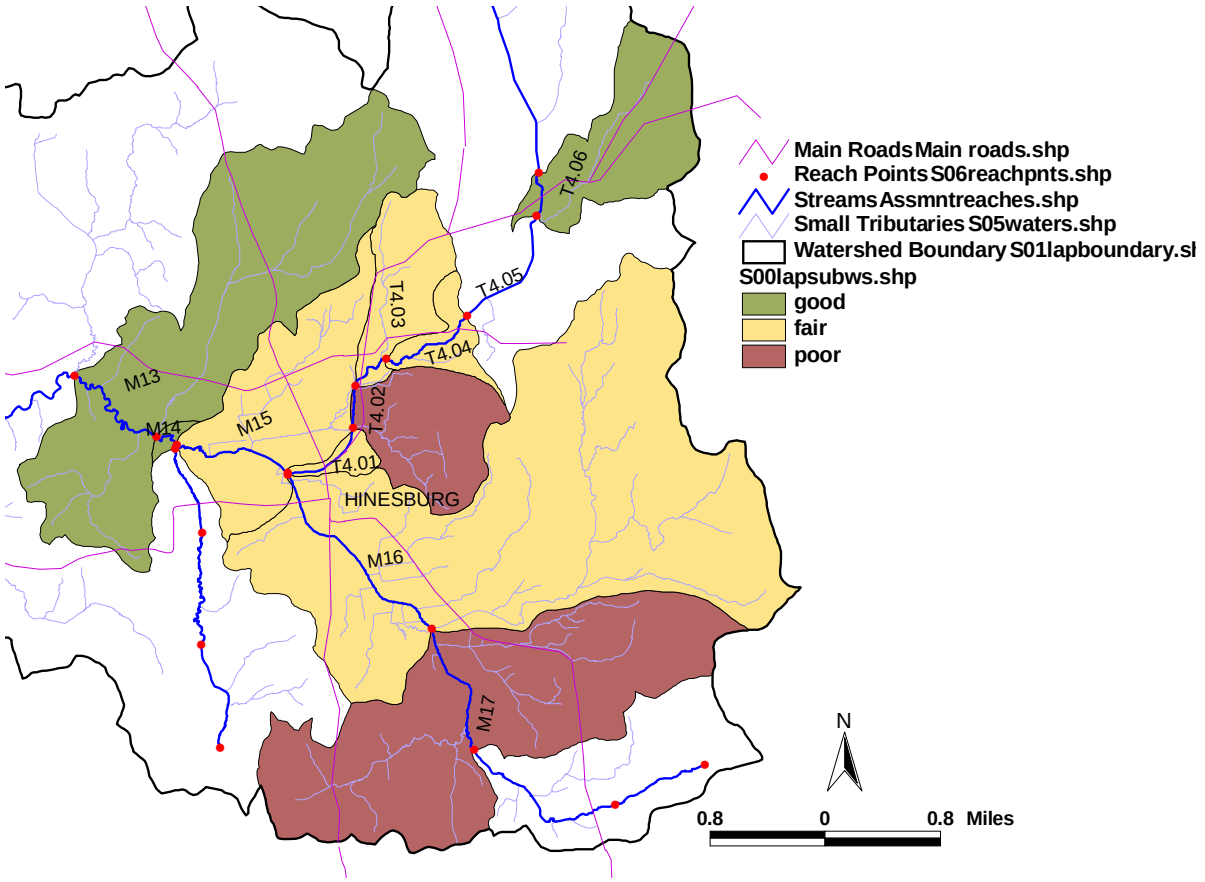

Figure 3. Rapid Geomorphic Assessment Condition Category for study reaches.

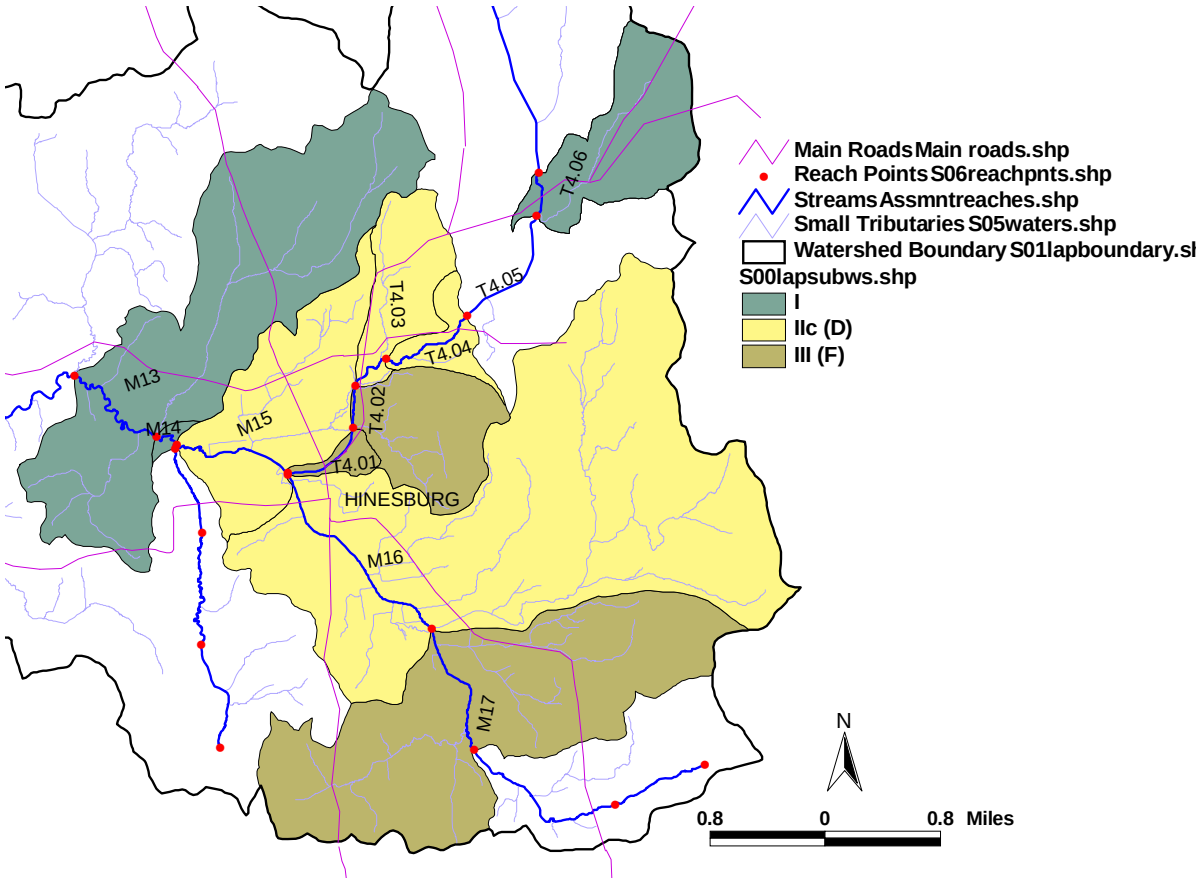

Figure 4. Phase II Assessment Channel Adjustment Stage for study reaches.

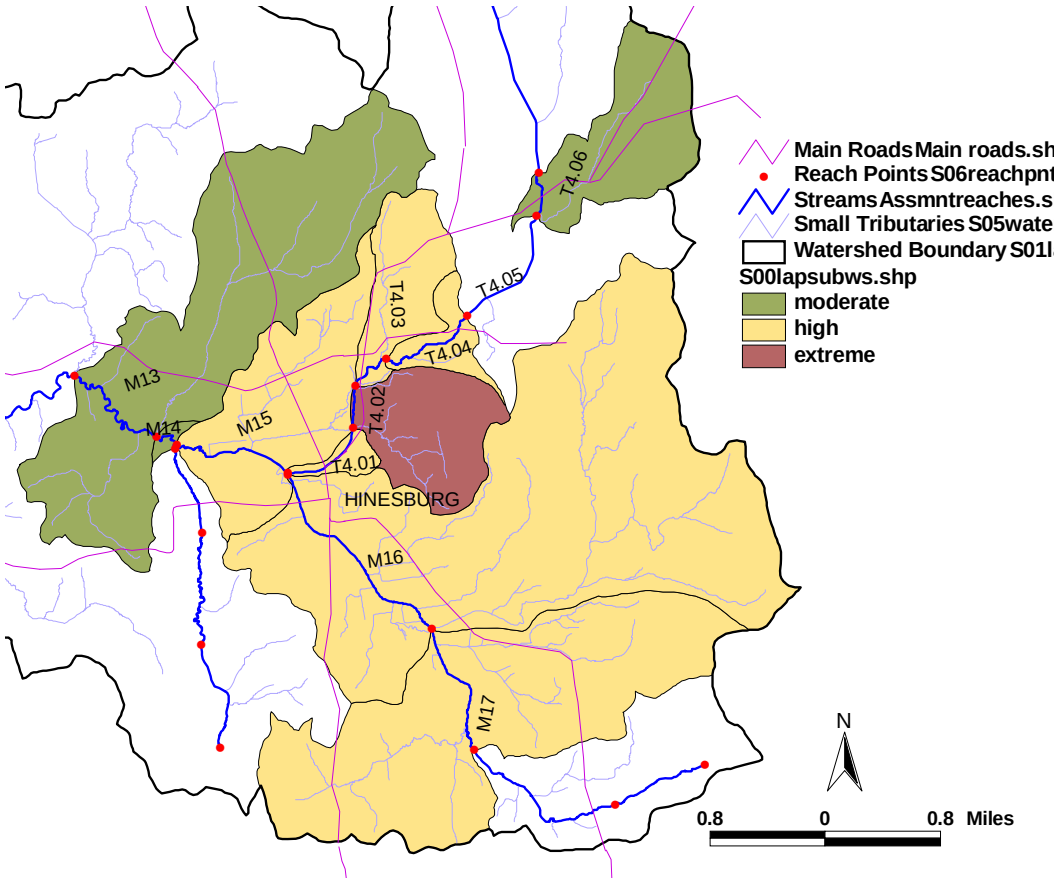

Figure 5. Phase II Assessment Stream Sensitivity Rating for study reaches.

Planning Issues

The goals of stream geomorphic assessments are to:

- Increase awareness of stream processes.
- Identify channel condition and adjustment process.
- Provide an information base for planning restoration or management activities.

This study aims to provide such information to landowners, towns, the state, and community members. Through this project, the LWP included volunteers to increase awareness of the LaPlatte and to increase understanding of stream dynamics.

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.

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, 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.

Reaches M15b through M17 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, eliminates channel meandering and thereby important instream habitat.

Planning and Management Strategies

Current research 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). Thus 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. All 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 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 and the reaches of 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.

Four basic management alternatives are analyzed below: Current Management, Conservation, Passive Restoration, and Active Restoration. Current management implies that whatever the current management practices are of a particular reach, they are expected to continue into the future (i.e. dams will be maintained, dredging will continue, straightening will be maintained). Conservation is an option where stream processes are mostly intact and would benefit from protection. Passive Restoration happens when factors affecting a reach are removed, such as a dam, riprap, or continued dredging, and the channel is allowed to progress to a stage of dynamic equilibrium where it regains balance with respect to its flow and sediment load, although may be slightly different than its historical condition. Active Restoration implies physical alteration of the channel to a geometry that has been calculated to be sustainable by the channel.

Current Management

Reaches T4.1, T4.2, T4.4 are being actively managed. T4.1 is a canal with a dam and berms on both banks. T4.2 is similarly confined with berms and a dam preventing flow into an abandoned channel. T4.4 has 2 large dams, which are maintained. 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).

Reaches T4.1 and T4.2 are therefore likely to remain channelized with poor habitat, a plane bed form, buildup of fine sediment, and little to no riparian buffer. Reach T4.2 is likely to require more management in the future as it is extremely sensitive to disturbance.

Management of these reaches is likely to continue in the short term due to the presence of infrastructure.

Conservation

Reaches T4.3 and T4.4 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 T4.6 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.

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, I use the term sustainable 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. Reaches 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.

Reaches M16, M17, and M18 have been straightened and are lacking channel the sinuosity and adjacent wetlands that would be expected. 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 conditions and may include sediment inputs. Varying degrees of actions that could be taken to speed the process are planting trees, opening berms, installing LWD, or recreating meander bends.

Reaches T4.1 and T4.2 could also be candidates for restoration, although the effectiveness of a passive approach may be limited due to the presence of riprap and berms and the need to protect infrastructure such as the Route 116 bridge and dam and buildings. A historical study may help in determining past placement of the Patrick Brook channel through town. Then restoration activities could be examined for feasibility within current infrastructure limitations.

Next Steps

The LaPlatte Partnership plans on continuing to work with town governments and landowners to help them understand how the information from this assessment can be used during development review process or town plan revisions to protect the resources of the LaPlatte. The LWP also has ongoing public education and involvement programs to increase public awareness of issues facing the LaPlatte Watershed and the Lake Champlain Basin.

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

The LWP has secured funding to continue Phase II Geomorphic Assessments elsewhere in the watershed for the Spring of 2005.

Planning for the Future

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

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

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

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

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Glossary of Terms

Aggradation - The build up of sediment in a stream bed.

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.

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.

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.

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

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.

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 by 6 feet long.

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

Project Budget Summary

Name of Project: Phase II Geomorphic Assessment on the LaPlatte River

Expense/Item	**Grant Funds**	**Other Funds (cash & in-kind)**	**Total Cost**
Project Coordinator	$1,090		$1,090
River Consultant and Volunteer Training	$3,360	$770	$4,130
Staff	$450		$450
Volunteers		$1,730 in-kind (1 volunteer/reach x 8 reaches x 8hrs x$15/hr)	$1,730
Field Equipment: Paper, tape measure, rods		$50	$50
Maps, printing	$100		$100
TOTALS	$5,000	$2,550	$7,550

Grant Amount: $ 5,000 **Total Cost of Project:** $ 7,550