Phase 2 Stream Geomorphic Assessment
Black River Watershed
Rutland & Windsor Counties, Vermont

Addendum 1: Patch Brook & Buffalo Brook Tributaries
Towns of Plymouth, Reading, Mount Holly, Ludlow

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Acknowledgements

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Field work was conducted with the cooperation of Plymouth, Reading, Mount Holly, and Ludlow landowners who granted permission to cross their property to access the river. Volunteer assistance was graciously provided by Sue Poirier and Peg Underwood.

EXECUTIVE SUMMARY

Phase 2 geomorphic assessments were completed in 2009 on 14 reaches (11.4 river miles) of the Patch Brook and Buffalo Brook tributaries to Black River, as well as one reach of the Black River main stem. This report serves as an addendum to the July 2009 Phase 2 Stream Geomorphic Assessment report for the Black River watershed completed by South Mountain Research & Consulting (SMRC) under contract to the Southern Windsor County Regional Planning Commission (SWCRPC). The reader is referred to this previous report for summaries of the regional geologic setting, hydrology, flood history, and land use as well as assessment results for surrounding reaches of Black River watershed.

In recent decades, residents in the vicinity of Lake Rescue have noted increasing volumes of sediment in a northern embayment of Lake Rescue known locally as Round Pond. Anecdotally, the aerial extent and thickness of these sand and silt deposits has increased markedly since the flood of June 1973. Patch Brook enters the Black River downstream of Echo Lake and approximately 0.6 mile upstream of Round Pond. A growing sediment delta has also been noted at Camp Plymouth State Park where the Buffalo Brook joins Echo Lake, approximately 1.2 miles upstream of Round Pond. This delta was observed to increase in size coincident with a June 2006 flood which impacted the Buffalo Brook tributary following sudden breaching of a dam at Reading Pond.

Assessment of the Patch Brook and Buffalo Brook tributaries was undertaken to: (1) evaluate the geology and land use history of the tributary watersheds; (2) identify sources of sediment in these watersheds that may be contributing to a build up of sediment deltas in Echo Lake and Round Pond; and (3) identify and prioritize restoration projects and practices to decrease sediment loading and increase flow and sediment attenuation in these tributary watersheds.

Field investigations and limited historical reviews have identified various watershed and channel disturbances that have impacted these Black River tributary reaches, including:

<u>Watershed-scale Modifiers</u>:

- Historic deforestation and subsequent reforestation from the mid-1800s through the early 1900s;
- Significant flood events in 1927, 1936, 1938, and 1973;
- Historic gold placer mining in the 1800s;
- Historic dams and diversions at multiple locations along the tributary reaches;
- Regulation of flows in the Black River including in-stream impoundments: Amherst Lake, Echo Lake, and Lake Rescue; and
- Upstream erosion and tributary sources of sediment.

<u>Reach-scale Modifiers</u>:

- Channelization (straightening) especially associated with development, bridge crossings and historic impoundments;
- Inferred gravel extraction, dredging and windrowing of the channel in response to the flood events of 1927, 1936 / 1938 and 1973, particularly along the Patch Brook through Tyson village;
- Reported gravel extraction, dredging, windrowing, impoundments, diversions, associated with historic gold placer mining along the Buffalo and Reading Pond Brook reaches in the 1800s;
- Berming along stream banks (along Dublin Road, Patch Brook; in vicinity of select bridge crossings on both tributaries);

- Streambank armoring (rip-rap) and retaining walls;
- Floodplain encroachment by roads and residential and commercial development;
- Undersized public bridges and in-stream culverts, serving as flow constrictors at bankfull flow or higher-magnitude flood events (particularly, Patch Brook Road culvert, Tatro Road bridge, and Library Road bridge on the Patch Brook; and Scout Camp Road bridge on the Buffalo Brook);
- Stormwater runoff from roads (particularly along Patch Brook Road on the Patch Brook and a network of forest roads along the Buffalo Brook, Reading Pond Brook and tributaries); and
- Sudden breaching of the dam on Reading Pond in a June 2006 flood event, resulting in impacts to downstream reaches of the Reading Pond Brook and Buffalo Brook.

The Patch Brook and Buffalo Brook / Reading Pond Brook channels are adjusting in response to these past and present watershed and channel disturbances. Adjustments have occurred to varying degrees, depending on many factors, including the magnitude and timing of past disturbances, the erosion resistance of sediment types in the channel bed and banks, the type and density of vegetative cover along stream banks, and presence of grade controls such as exposed bedrock.

In general, given the geologic and topographic setting, many of the Patch Brook and Buffalo Brook reaches are naturally transport-dominated due to the erosion resistance offered by bedrock in the channel bed or banks, the steepness of valley gradients, and/or close confinement of the channel by bedrock-controlled steep valley walls. Along some of the reaches where a limited degree of floodplain connection and deposition might have been expected, due to a locally broader valley section or reduced gradients, historic channel and floodplain modifications (straightening, berming, armoring) and encroachments (roads, bridges, homes, commercial buildings) in the river corridor have converted these reaches to a more transport-dominated condition. Due to increased erosional scour through these straightened and partly incised and entrenched reaches, they now serve as a source of sediment to downstream reaches. The Patch Brook reaches along Dublin Road are an example of this condition. Only a few segments in the Patch Brook watershed (and none in the Buffalo Brook watershed) have reasonable or partial access to the floodplain, and (where presently unconstrained by human-constructed features) may represent key sediment attenuation assets (three segments of Patch Brook reach M40T5.04 in the Calvin Coolidge State Forest). Overall, a more effective approach to address sedimentation in these tributary channels, may be to focus on mitigating point sources of increased stormwater and sediment loading - e.g., by controlling stormwater inputs along road lengths and at crossing locations, by re-wilding sections of abandoned forest roads in mid- to lower-reaches of the Buffalo Brook watershed where road segments now concentrate stormwater runoff and serve as a large source of sediment to downstream reaches.

A limited number of opportunities for river corridor restoration and conservation have been identified based on the Phase 2 geomorphic assessment results. A preliminary project listing forms the basis for follow-on project development and planning activities which can be carried out by watershed stakeholders.

1.0 INTRODUCTION

This report summarizes results of a Phase 2 geomorphic and habitat assessment and corridor planning recommendations for 14 reaches (11.4 river miles) of the Patch Brook and Buffalo Brook tributaries to Black River, as well as one reach of the Black River main stem. This report serves as an addendum to the July 2009 Phase 2 Stream Geomorphic Assessment report for the Black River watershed completed by South Mountain Research & Consulting (SMRC) under contract to the Southern Windsor County Regional Planning Commission (SWCRPC). The reader is referred to this previous report for summaries of the regional geologic setting, hydrology, flood history, and land use as well as assessment results for surrounding reaches of Black River watershed.

Phase 2 stream geomorphic assessments of the Patch Brook and Buffalo Brook were undertaken at the request of the Lake Rescue Association, in cooperation with SWCRPC. In recent decades, residents in the vicinity of Lake Rescue have noted increasing volumes of sediment in a northern embayment of Lake Rescue known locally as Round Pond. Anecdotally, the aerial extent and thickness of these sand and silt deposits has increased markedly since the flood of June 1973 (Figure 1). Patch Brook enters the Black River downstream of Echo Lake and approximately 0.6 mile upstream of Round Pond (Figure 2). A growing sediment delta has also been noted at Camp Plymouth State Park where the Buffalo Brook joins Echo Lake, approximately 1.2 miles upstream of Round Pond. This delta was observed to increase in size coincident with a June 2006 flood which impacted the Buffalo Brook tributary following sudden breaching of a dam at Reading Pond.

Assessment of the Patch Brook and Buffalo Brook tributaries was undertaken to:

- Evaluate the geology and land use history of the tributary watersheds;
- Identify sources of sediment in these watersheds that may be contributing to a build up of sediment deltas in Echo Lake and Round Pond; and
- Identify and prioritize restoration projects and practices to decrease sediment loading and increase flow and sediment attenuation in these tributary watersheds.

Assessments have been conducted utilizing the VTANR *Stream Geomorphic Assessment Protocols Handbooks* (2007a). Projects have been identified following the VTANR *River Corridor Planning Guide to Identify and Develop River Corridor Protection and Restoration Projects* (2007b). Assessment results can be used by landowners and other watershed stakeholders to:

- identify restoration and conservation projects intended to improve water quality and restore aquatic habitats;
- plan for future development which is more compatible with adjusting river channels; and
- reduce fluvial erosion hazards.

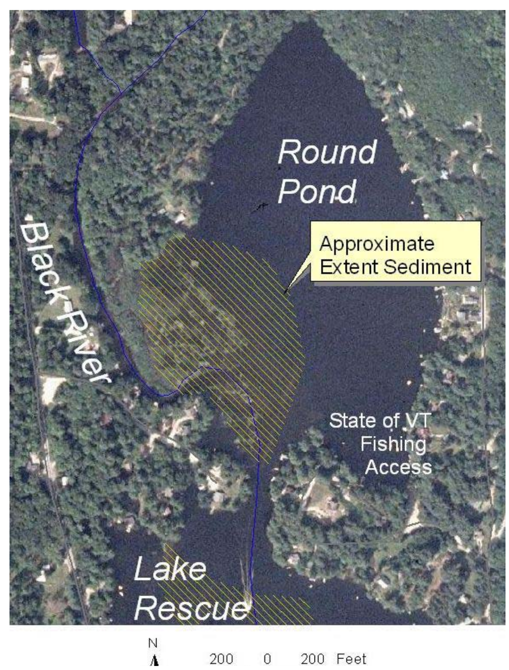
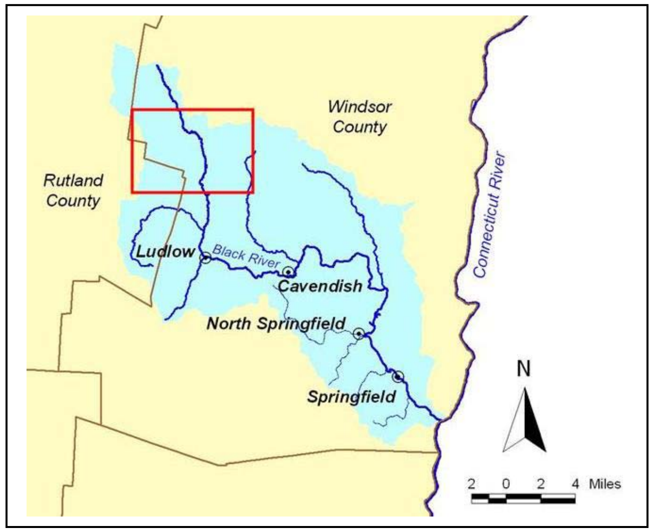


Figure 1. Approximate location of sediment accumulation in Round Pond

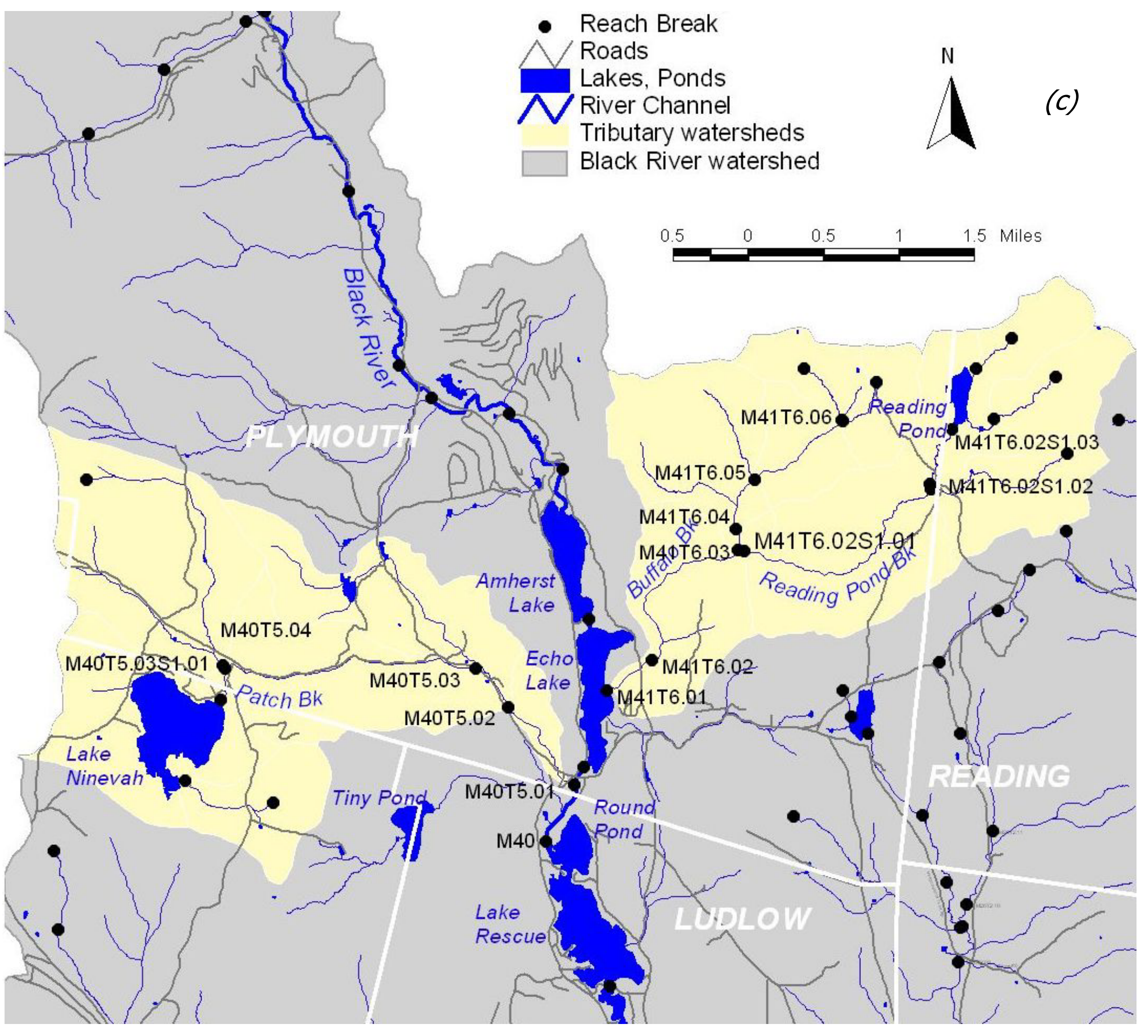
*Figure 2. Location map of:
(a) Black River watershed in Vermont; (b) Patch and Buffalo Brook watersheds in the Black River Watershed; and (c) study reaches in the Patch and Buffalo Brook watersheds.*

(a)

(b)



(c)



2.0 ASSESSMENT METHODOLOGY

This stream geomorphic assessment utilized the 2007 version of the protocols published by the Vermont Agency of Natural Resources, including selected updates published in 2008 (VTANR, 2007a; VTANR, 2008a, 2008b, 2008c). Reference is made to these protocols for a description of specific methods followed to complete Phase 2 Stream Geomorphic Assessments and Bridge and Culvert Assessments.

2.1 Phase 2 Stream Geomorphic Assessment

Reaches of the Patch Brook and Buffalo Brooks were assessed between August and October of 2009. The main stem reach, M40, was assessed by kayak while the remaining reaches were assessed on foot. Flow stages were low to moderate on the assessment dates. Specific features and channel positions were located using a Garmin™ 76CSx model global positioning system (GPS) unit. Pictures were recorded with a digital camera.

In accordance with protocols, select features were digitized in ArcView© 3.x and referenced to the Vermont Hydrography Dataset (VHD), using the Feature Indexing Tool, a component of the Stream Geomorphic Assessment Tool (SGAT, v. 4.57). Certain parameters documented during the original Phase 1 Stream Geomorphic Assessment were updated based on field observations in Phase 2 (see Section 2.2). Phase 2 assessment data were entered into the online Data Management System (DMS, v.4.56) a custom database of Phase 1, 2, and 3 geomorphic data developed and maintained by the Vermont Agency of Natural Resources (VTANR). A Phase 2 reach summary report is presented in Appendix A (standard output from the DMS).

Fifteen bridge and culvert crossings were encountered during the assessments. Spans, clearance and width measurements were conducted at each structure. The span of each crossing was compared to measured or predicted bankfull widths (VTDEC WQD, 2006) to determine if the structure was a constrictor of flows at the bankfull stage or the flood-prone-width elevation (10-year to 50-year flood). Appendix B of this report includes a summary of the bridge and culvert assessments completed for these structures in accordance with Appendix G of the VTANR protocols (2008c). Bridge and culvert data were entered into the Structures portion of the DMS (under the "Black River" database).

2.2 Phase 1 Updates

Original Phase 1 assessment data (SMRC, 2007) for the 14 reaches were reviewed and verified during field work as per VTANR protocols. As appropriate, GIS shape files were corrected or updated (using the Feature Indexing Tool). Phase 1 data in the DMS were updated, and the metadata for each Phase 1 step were reviewed and updated (where necessary) to reflect that data were supported by field observations. Updated Phase 1 reach summary reports are presented in Appendix A.

The reference stream type was updated as a result of field observation of valley confinement, sinuosity, channel gradient and dimensions. Elevation data for the downstream and upstream reach breaks were updated as a result of field-based observations and to correct for apparent interpolation or data entry errors in Phase 1 (see Appendix A). Accordingly, channel and valley gradient calculations were updated.

Based on field observations and following clarifications to valley wall delineation procedures articulated in protocol updates between 2004 and 2009, a shape file of the modified (Phase 2) valley wall was generated, representing modifications to the natural valley width caused by encroachments of artificial fill for semi-permanent structures such as major roads and railroads. An updated valley wall shape file is contained on the Project CD.

2.3 Quality Assurance / Quality Control

Phase 2 data were reviewed against standard DMS Phase 2 quality control checks (X.1 through X.4), and then submitted to the River Management Section for a quality assurance review. Quality assurance documentation is contained in Appendix C.

Using the Feature Indexing Tool (FIT) in SGAT, select Phase 2 features were indexed to the available Vermont Hydrography Dataset (VHD). Locations and lengths of features indexed to the VHD should be considered approximate. In some locations, surface waters depicted on the VHD are considerably offset from their present position, as revealed by comparison to 2009 channel positions (recorded with a hand-held GPS receiver).

3.0 PHASE 2 ASSESSMENT RESULTS

Phase 2 assessment results are discussed below for Patch Brook reaches and Black River reach M40 in Section 3.1 and for Buffalo Brook (including Reading Pond Brook) in Section 3.2. Reach and segment reports are provided in Appendix A. Detailed reach summaries are provided in Appendix E.

A reference stream type (Phase 1) and an existing stream type (Phase 2) have been classified for each reach/segment. Stream type designations are based on Rosgen (1996) and Montgomery & Buffington (1997). A sensitivity classification was also assigned to each reach based on the Phase 2 stream geomorphic assessment data. The sensitivity classification is intended to identify "the degree or likelihood that vertical and lateral adjustments (erosion) will occur, as driven by natural and/or human-induced fluvial processes" (VTANR, 2007b). Inherent in the stream sensitivity rating are:

- the natural sensitivity of the reach given the topographic setting (confinement, gradient) and geologic boundary conditions (sediment sizes) – as reflected in the reference stream type classification; and

- the enhanced sensitivity of the reach given by the degree of departure from reference (or dynamic equilibrium) condition – as reflected in the existing stream type classification and the condition (Reference, Good, Fair to Poor) rating of the Rapid Geomorphic Assessment).

Abbreviations used in the sections below include the following (see protocols for further description):

- Left Bank, facing downstream (abbreviated, "LB")
- Right Bank, facing downstream (RB).
- Incision Ratio (IR) = Low Bank Height / Bankfull Max Depth
    - IR_{RAF} = Recently Abandoned Floodplain Incision Ratio
    - IR_{HEF} = Human-Elevated Floodplain Incision Ratio

- Entrenchment Ratio (ER) = Flood Prone Width / Bankfull Width
- Width / Depth Ratio (W/D) = Bankfull Width / Mean Depth
- Flood Prone Width (FPW) – estimated as the 10- to 50-year flood event
- Stream Type Departure (STD)
- Large Woody Debris (LWD)
- Debris Jams (DJs)
- Rapid Geomorphic Assessment (RGA)
- Rapid Habitat Assessment (RHA)
- Vermont Hydrography Dataset (VHD)
- National Wetlands Inventory (NWI)
- Vermont Significant Wetlands Inventory (VSWI)

3.1 Patch Brook and Black River main stem reach M40

Patch Brook drains a 5.4-square-mile area west of Route 100 in the towns of Plymouth and Mount Holly (Figure 3). The drainage divide for this watershed – which includes Lake Ninevah - is defined to the northwest by Salt Ash Mountain, to the west by Proctor Hill, and to the south by Tiny Mountain. Tiny Pond is a nearby surface water body that drains separately (via Tiny Pond Brook) to the Black River main stem, at a point approximately 1,000 feet downstream of the Patch Brook confluence.

The Patch Brook watershed is underlain predominantly by glacial till sediments. There are isolated deposits of alluvial and glaciofluvial sediments associated with Lake Ninevah and a wetland area just to the north of this lake. Extensive glaciofluvial deposits are also mapped in the somewhat broader valley of lower Patch Brook along the Dublin Road, extending from the intersection of Patch Brook Road downstream to the Black River. A few outcroppings of bedrock were observed along the Patch Brook as channel-spanning ledge in remote segments north of Patch Brook Road, and in a prominent waterfall southwest of the intersection of Patch Brook Road and Dublin Road.

Patch Brook joins the Black River between Echo Lake to the north and Lake Rescue to the south - within reach M40. A total of five reaches (5.2 miles) of the Patch Brook watershed were assessed in 2009 (Figure 3), including a tributary to the Patch Brook which is the outlet channel from Lake Ninevah. The half-mile reach M40 of the Black River was also assessed; the Black River has an upstream drainage area of 34 square miles at this location. Results are summarized in Table 1, below. Detailed reach narratives are presented in Appendix E.

3.1.1 Land Use and Channel Management History

Patch Brook watershed is approximately 86% forested and 4% urban. A sparse network of gravel roads and trails provides recreational access to the more remote forested headwaters in the Calvin Coolidge State Forest. A history of logging is evident in this upper reach of the Patch Brook. A small diversion of flow from the brook is directed to a constructed pond with earthen dam located between 100 and 150 feet west of the brook. This impoundment appears to have been constructed between 1955 and 1994 and may be related to recent logging and/or recreational activities (see Appendix E). Given the regional history, this dam may have been constructed in support of recent logging or recreational activities. History of this dam and the surrounding property was not available in the resources consulted for this study. It is not listed on the Vermont Dam Inventory.

Lake Ninevah is described as a natural pond with an earthen dam that artificially increases the elevation and aerial extent of the lake (VTDEC, 2005). Historically, this pond was identified as "Patch Pond" on the 1893 Wallingford, VT USGS topographic map, and the "S.I. Co" (Spaffic Iron Company) reservoir on the 1869 Beers Atlas of Windsor County. The current dam was reportedly installed in 1930 (VT Dam Inventory) on the approximate site of the former dam(s) operated previously by Spathic Iron Co. (perhaps breached in the 1927 flood). The present dam is owned by Wilderness Corporation who purchased it from Central Vermont Public Service in 1984. The current purpose of the dam is recreational (VT Dam Inventory: VCGI, 2005). The original purpose of the dam was noted as hydroelectric; CVPS "used the dam as a storage reservoir to augment flows in the Black River for its Cavendish hydroelectric project" (VTDEC, 2005).

The approximate aerial extent of Lake Ninevah is published as 237 acres; maximum depth is 12 feet; and the upstream drainage area is 1.2 square miles (VTDEC, 2005). The dam operates as a run-of-river structure. In the 1980s and early 1990s, the lake was customarily drawn down in the winter months (October through May) by 3 to 4 feet by draining lake waters through a sluiceway over a period of approximately 2 weeks. In later years the amount of drawdown was reduced to approximately 6 inches. Following a June 2004 order from the VT Agency of Natural Resources, artificial drawdowns of the lake were discontinued for the sake of in-lake aquatic habitats (VTDEC, 2004).

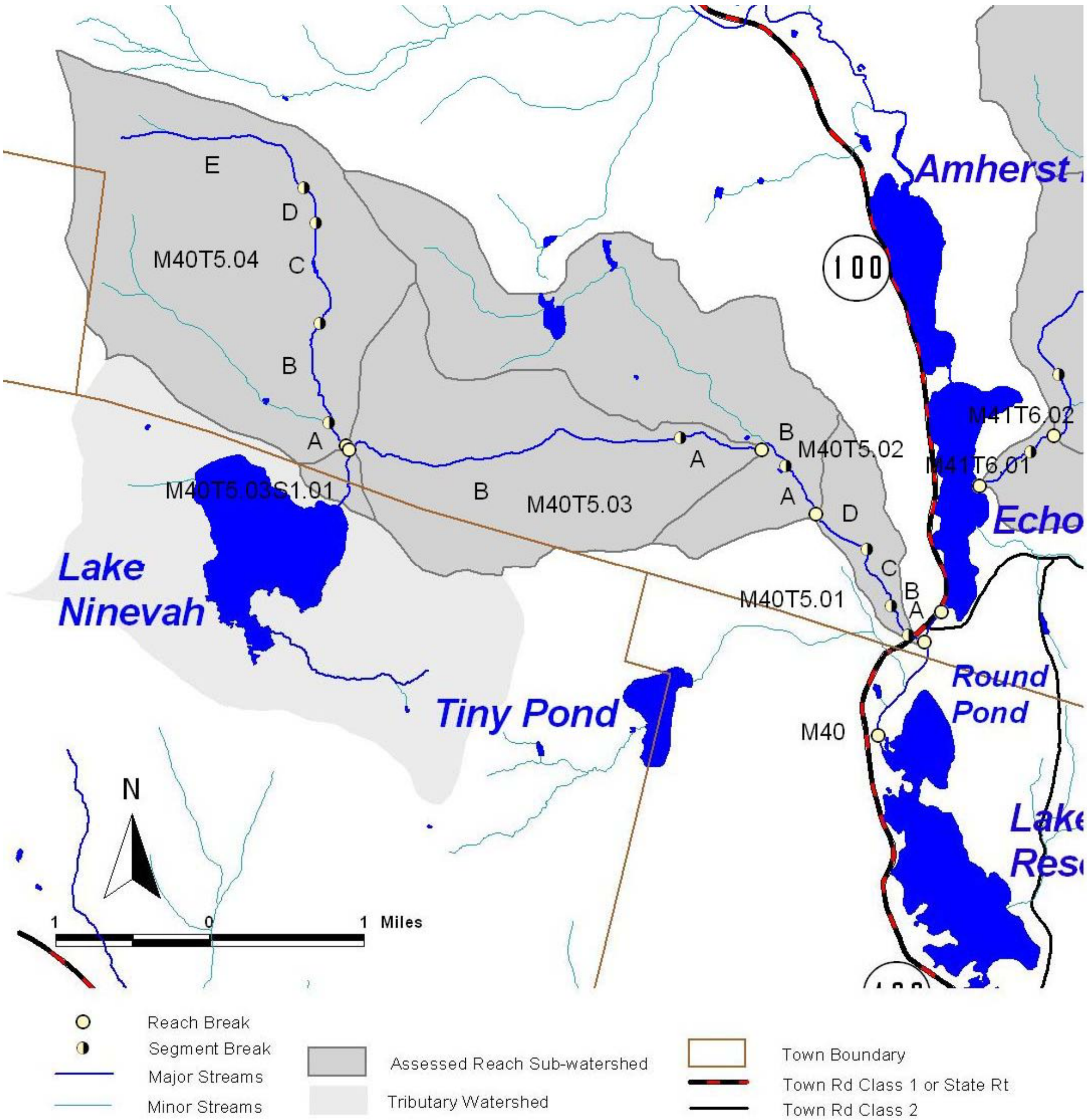


Figure 3. Location of Patch Brook and Black River main stem reaches assessed in 2009.

Table 1. Results of Phase 2 Geomorphic Assessments, 2009.
Patch Brook watershed and Black River main stem reach M40

Patch Brook - Plymouth, Mount Holly

Reach	Seg-ment	Channel Length (ft)	Channel Slope (%)	Drainage Area (sq mi)	Stream Type	Incision Ratio	Width Depth Ratio	RHA Condition	RGA Condition	Active Adjustment Process	Channel Evolution Stage	Stream Type Departure?	Sensitivity
M40T5.04	E	4,578	***9.7***		B4a-casc	1.0 [RAF]	11.2	0.82 Good	0.79 Good	Min wid (local), min PF	I [F]	None	Moderate
	D *	851	***4.6***		C4a-R/P	1.15 [RAF]	11.7	0.81 Good	0.76 Good	Min aggrad, PF	I [F]	None	High
	C *	2,297	***3.9***		C4b-S/P	1.64 [RAF]	13.6	0.79 Good	0.70 Good	Min aggrad, PF; Hist incis	II [F]	None	High
	B *	2,427	***2.0***		C4-R/P	1.18 [RAF]	12.1	0.70 Good	0.69 Good	Mod aggrad, Hist incis	II [F]	None	High
	A *	623	***0.3***	1.5	Not Assessed - Wetland dominated								
M40T5.03S1.01	--	1,221	2.3	1.7	B3-S/P	1.0 [RAF]	20.3	0.74 Good	0.85 Ref	None	I [F]	None	Moderate
M40T5.03	B	7,623	***5.0***		B3a-S/P	1.2 [RAF]	15.2	0.72 Good	0.68 Good	None. Historic incis.	V [F]	None	Moderate
	A *	1,856	***5.1***	4.2	F3a-PB	4.2 [HEF]	21.3	0.57 Fair	0.51 Fair	Minor aggrad	II [F]	Ca to Fa	Extreme
M40T5.02	B *	871	***2.9***		F3b-PB	4.0 [HEF]	15.7	0.61 Fair	0.61 Fair	Min PF, aggrad	II [F]	Cb to Fb	Extreme
	A	1,240	***3.2***	5.3	B4-PB	2.7 [RAF]	17.1	0.64 Fair	0.56 Fair	Min PF, aggrad	II [F]	B - Fb - B?	High
M40T5.01	D	1,382	***3.6***		F3b-PB	2.6 [RAF]	20.2	0.55 Fair	0.55 Fair	Mod wid; hist incis	III [F]	Cb to Fb	Extreme
	C	1,449	***3.8***		C3b-PB	1.4 [RAF]	37.7	0.61 Fair	0.55 Fair	Mod wid & PF; hist incis	III [F]	None	High
	B *	764	***3.3***		F3b-PB	3.7 [RAF]	23.4	0.43 Fair	0.50 Fair	Wid, min aggr; hist incis & PF	II [F]	Cb to Fb	Extreme
	A *	397	***2.5***	5.4	C3b-PB	1.5 [RAF]	17.6	0.45 Fair	0.53 Fair	PF, min Wid/Aggr, Hist incis	III [F]	None	Extreme **

Black River main stem - Plymouth, Ludlow

Reach	Seg-ment	Channel Length (ft)	Channel Slope (%)	Drainage Area (sq mi)	Stream Type	Incision Ratio	Width Depth Ratio	RHA Condition	RGA Condition	Active Adjustment Process	Channel Evolution Stage	Stream Type Departure?	Sensitivity
M40	--	3,131	0.5	34.1	C3-PB	1.85 [RAF]	35.1	0.59 Fair	0.48 Fair	None (Hist Incis, Wid, Aggr, PF)	III [F]	None	High

Notes / Abbreviations:

Channel Slope: Values in italic bold have been updated since the Phase 1 SGA, due to field-truthing and/or segmentation.

Stream Type: S/P = Step/Pool; R/P = Riffle/Pool; R/D = Ripple/Dune; PB = Plane Bed; Br = Braided; Casc = Cascade; Ref = Reference

Incision Ratio: RAF = Recently Abandoned Floodplain; HEF = Human-elevated Floodplain (following protocols, VTANR, 2007).

Condition: RHA = Rapid Habitat Assessment; RGA = Rapid Geomorphic Assessment (VTANR, 2007).

Adjustment: PF = Planform Adjustment; Aggr = Aggradation; Wid = Widening; Deg = Degradation; NM = Not Measured.

Channel Evolution Stage: F = F-stage model; D = D-stage model (see Appendix C of protocols, VTANR, May 2007).

* Subreach of alternate reference stream type.

** Sensitivity overridden to higher value due to setting of marked decrease in valley gradient and confinement ("alluvial fan").

Rural residential land use is evident in the Lake Ninevah area and along Dublin Road in the lower extent of the Patch Brook watershed. Commercial and residential developments are present near the downstream end of the tributary just west of VT Route 100, including the Echo Lake Inn, Tyson Library, and a church.

These buildings are located in the historic hamlet of Tyson Furnace. An iron works was established here circa 1837 by Isaac Tyson, Jr. Iron ore was obtained from several mines established generally within a a five-mile radius from the furnace (Thompson, 1842). This industrial center flourished for nearly 20 years, and produced a variety of products including farming implements, water pipes, and stoves (VT Historical Society, 2009; Thompson, 1842). The iron works were closed in 1855, but later re-opened during the Civil War and produced "iron for the building of the Monitor class gunboats" (Duffy *et al*, 2003). Following the war until 1872, the iron works were operated by Spathic Iron Company (Hartford, CT) for the production of steel cutlery (Ward, 1983; Duffy *et al*, 2003). It is likely that lumber was harvested from the headwaters of Patch Brook watershed (and the surrounding region) to supply charcoal to the iron furnace during its years of operation (Duffy *et al,* 2003).

Tyson constructed a mill dam and water works to power the furnace (Duffy *et al*, 2003). The Beers Atlas of Windsor County (1869) depicts a small mill pond and sawmill upstream of the village center. A flow diversion channel is depicted leading downstream from this mill pond and across Dublin Road and toward the Tyson furnace. Evidence of this historic flow diversion is also depicted on the 1859 Map of the Town of Plymouth (Scott, Stickney, & Pollard, publishers) (Figure 4). Presence of the former mill dam (now breached) and the diversion channel was confirmed by field observations during 2009 assessments. Remnants of the earth/stone dam are visible approximately 4,000 feet upstream of the confluence with Black River (segment M40T5.02-A). Just downstream of the former mill dam (near the upper end of reach M40T4.01), a small bypass channel has been constructed historically to convey a portion of the flow from Patch Brook to a culvert under Dublin Road and into a constructed channel that flows somewhat parallel to Patch Brook, but on the far side of residential homes to the west of Dublin Road. This "canal", as it is known locally, returns to the Patch Brook approximately 3,000 feet downstream, below the Dublin Road bridge (see also, Appendix E).

Figure 4. Excerpt from historic map of Tyson Furnace showing location of iron furnace and diversion canal from Patch Brook.

Source: Scott, Stickney & Pollard, publishers, 1859: Map of the Town of Plymouth.

Near the downstream end of Patch Brook, the channel is crossed by Library Road and VT Route 100. Based on historic topographic maps, sometime between 1932 and 1983, the alignment of Route 100 was straightened, possibly resulting in a shift in the bridge crossing site over Patch Brook. The bridge and culvert database maintained by VTrans suggests that the current VT Route 100 bridge was constructed in 1936. As viewed on the 1859 map of the town of Plymouth, the Patch Brook confluence with the Black River was historically located further south of its current position near the Ludlow town boundary. A local landowner indicates that the channel was reportedly diverted from a position approximately 50 yards south, to its current position in 1929 following the 1927 flood (Jefferies, 2009).

3.1.2 Assessment Results

Overall, the gradient of the Patch Brook decreases along the length of study, from 9.7% at the upper extent to 2.5% above the confluence with Black River (Figure 5). There is a local reduction in gradient in vicinity of Lake Ninevah above the valley pinch point that defines the beginning of the steep, confined reach along Patch Brook Road (M40T5.03). This reduction in gradient is also coincident with the wetland complex north of Lake Ninevah.

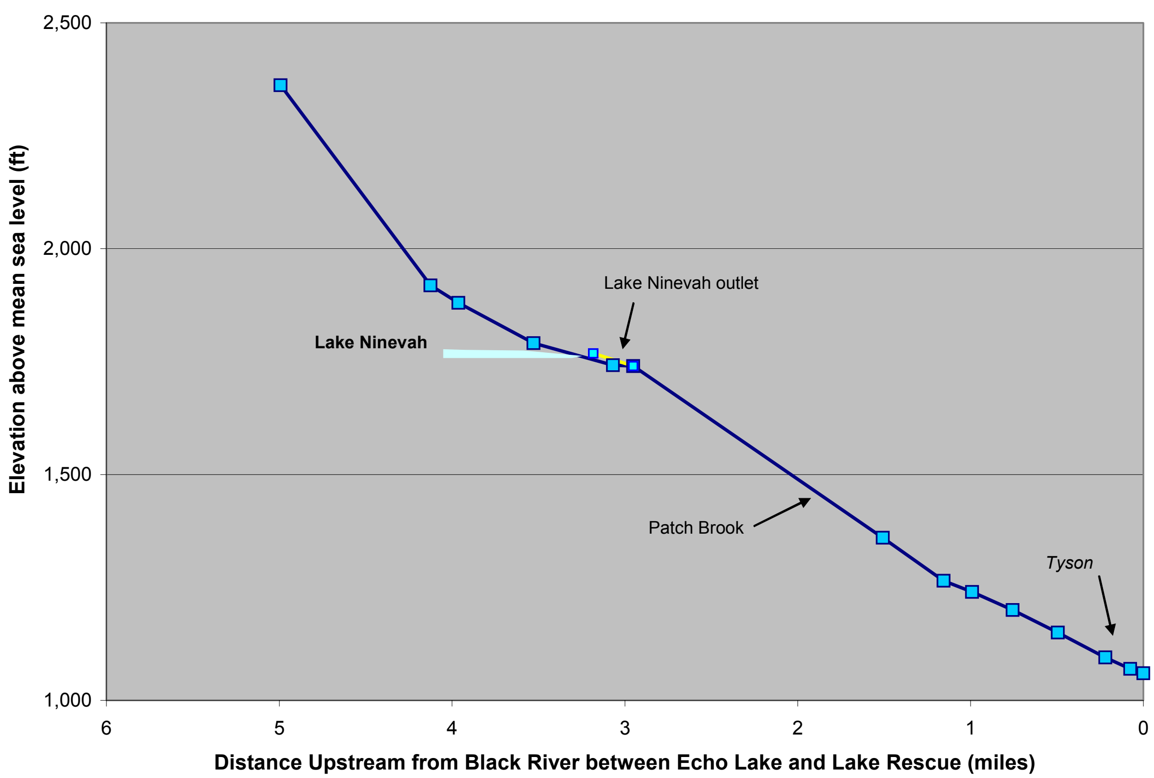


Figure 5. Longitudinal Profile of Patch Brook tributary.

Generally, the upper 3.7 miles of assessed channel (including the Lake Ninevah outlet) are in stable condition, with reasonable access to the floodplain (incision ratios less than 1.2), exhibiting minor degrees of aggradation and planform adjustment. One exception to this generalization is a 2,300-foot segment of the uppermost reach, M40T5.04-C, which appears to have undergone a moderate degree of historic incision (IR_{RAF} = 1.6) possibly related to historic channel management associated with the flow diversion to a nearby pond and/or recent or historic logging or mining activities. To the extent that ongoing channel adjustments in this segment yield sediments to the channel, downstream Segments M40T5.01-B and M40T5.01-A (wetland) offer opportunities for sediment attenuation.

Proceeding downstream from the wetlands above Townsend Barn Road crossing, Patch Brook shares a narrow stream valley with the gravel Patch Brook Road. Coarseness of bed and bank materials in this segment (M40T5.03-B) and occasional bedrock exposures offer stability to the channel despite the road encroachment which has lead to channel straightening and armoring in a few locations. Frequent cross culverts connect road ditches directly to the channel; and there are several locations of overland flow off the road. Erosion of the road can be extensive during heavy storms (Caduto, 2009). This steep, transport-dominated channel passes these road sediments downstream to lower reaches of the Patch Brook. In the 1980s to early 1990s, management of lake levels in Lake Ninevah may have lead to a marginal increase in sustained flows in Patch Brook during the Fall months that would enhance the transport function of this reach (temporarily).

In general, downstream of the Patch Brook Road / Dublin Road intersection, the Patch Brook is incised and entrenched below high terraces of glaciofluvial sediments – in part as a result of an extensive history of channel management including straightening, berming, armoring, inferred dredging, historic mill dam impoundments, and flow diversions. The upstream extent of historic incision is marked by a bedrock grade control (waterfall) at the segment break between M40T5.03-B and M40T5.03-A (Figure 6). At the lower end of reach M40T5.03, the natural valley confinement transitions from Semi-Confined to Broad, as the channel flows from glacial till deposits to glaciofluvial sediments. Increased lateral adjustment of the channel would be expected at such a transition. Instead the channel has been extensively managed in this location in response to past flood events (e.g., 1973, 1936/38, 1927) and to protect adjacent roads and residences. A high berm has been constructed along the left bank in two sections; these berms and the linear planform of the channel suggest a history of channelization with windrowing. The channel is now pinned along the right valley wall and is incised below the adjacent floodplain.

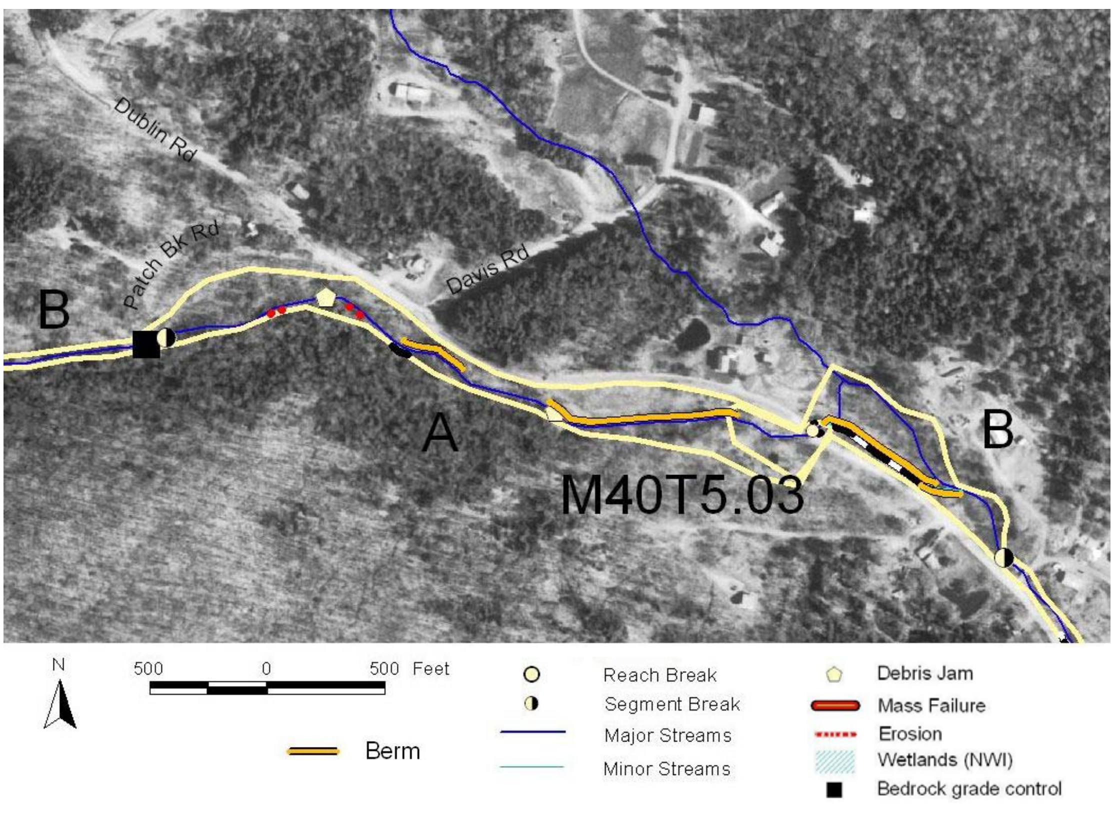


Figure 6. Features encountered along M40T5.03-A and upstream end of M40T5.02 (Segment B), 10 September 2009. (Pale yellow line indicates human-modified valley wall).

In downstream segment M40T5.02-B, the channel gradient begins to decrease, and a reduction in sediment transport capacity would be expected. Where this segment might ordinarily serve as a location for sediment attenuation, historic channelization, road encroachments and construction of berms have converted this segment to a transport-dominated condition. The channel has lost connection to the adjacent floodplain (in the LB corridor).

A similar incised and entrenched condition is evident in downstream segment M40T5.02-A. The Dublin Road and Tatro Road bridge crossings are undersized with respect to the bankfull width; stepped footers are evidence of historic incision affecting both structures. At present, the coarseness of bed and bank substrates, discrete sections of rip-rap armoring, and reasonably continuous tree buffers are moderating lateral adjustments in these segments along Dublin Road. They are not a significant source of sediments to downstream reaches. However, they remain highly susceptible to catastrophic erosion in a future flood due to the incised and entrenched nature of the channel cross section.

In reach M40T5.01, the Patch Brook pulls away from Dublin Road for approximately one half mile (Figure 7). Active widening and planform adjustments are more evident in Segments D and C which are severely to moderately incised, probably associated with historic channel management (straightening, flow diversion, mill dam impoundments). These reaches are producing sediment to downstream reaches as they adjust to build a new floodplain at a lower elevation. These segments presently have few encroachments. To the extent that floodplain-building channel adjustments can be supported through corridor protection strategies, over the long term these segments may offer some degree of sediment and flood attenuation upstream of the more densely populated lower segments in Tyson Furnace.

Within Segment B of M40T5.01, historic channel management (straightening, berming, armoring) and encroachments have resulted in a historically incised and entrenched channel. After the Patch Brook crosses under VT Route 100, it regains partial access to the floodplain, where the Brook has been known to jump its banks in past flood events. The landowner downstream of VT Route 100 has managed the channel and floodplain over the years, placing berms along the RB to prevent the channel from flowing out onto a cleared area.

Berms have also been constructed along reach M40 of the Black River main stem – at the confluence of Patch Brook and at the confluence of Tiny Pond Brook. These berms locally enhance the degree of channel entrenchment, in a reach that is historically moderately incised (IR_{RAF} = 1.85).

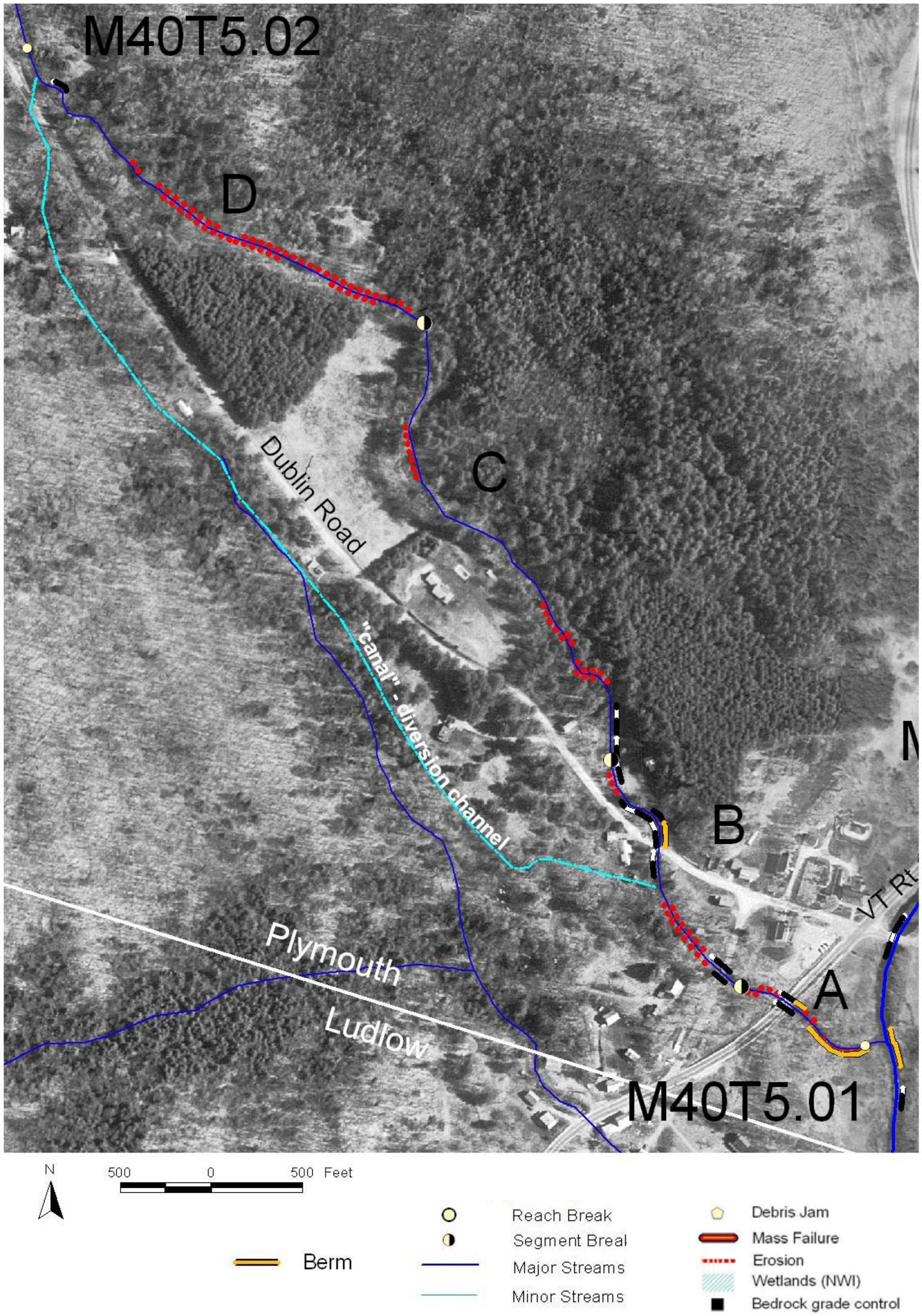


Figure 7. Diversion channel leading from the upstream end of reach M40T5.01 under Dublin Road, to the west of residential homes, and returning to the Patch Brook channel downstream of the Dublin Road bridge crossing.

3.2 Buffalo Brook and Reading Pond Brook

Buffalo Brook drains a 5.7-square-mile area east of Route 100 in the towns of Plymouth and Reading. The drainage divide at the headwaters for Buffalo Brook is defined by Mount Tom to the northeast, Blueberry Hill to the northwest, and Weaver Hill to the south. Reading Pond Brook is a major tributary to the Buffalo Brook, with its source near Reading Pond in the northeastern extent of the watershed. Reading Pond Brook drains a 2.9 square-mile area and joins the Buffalo Brook near the mid-point of the watershed.

The Buffalo Brook watershed is underlain by glacial till sediments, with isolated pockets of glaciofluvial sediments and alluvial sediments, particularly in the vicinity of Reading Pond. Bedrock controls the steep valley walls which closely confine the channels of Buffalo Brook and Reading Pond Brook for much of their length. Several outcroppings of bedrock were noted along the stream bed and banks during 2009 assessments.

Buffalo Brook joins the Black River at the eastern shore of Echo Lake. A total of eight reaches (5.6 miles) of the Buffalo Brook and Reading Pond Brook were assessed in 2009 (Figure 8). Results are summarized below in Table 2. Detailed reach narratives are presented in Appendix E.

3.2.1 Land Use and Channel Management History

Buffalo Brook watershed is approximately 94% forested and 1% residential. Much of the watershed is presently owned by the State of Vermont. There are a few private residences and camps accessed via Reading Pond Road. A sparse network of gravel forest roads and former skid trails provides recreational and logging access to the area, branching off the main roads (Reading Pond Road to the east and northeast, and Scout Camp Road to the west). Camp Plymouth State Park is developed along the eastern shore of Echo Lake near the confluence of Buffalo Brook.

By the early- to mid-1880s, it is likely that deforestation occurred across much of the watershed, consistent with statewide trends to support subsistence and sheep farming and the lumber industries (Thompson & Sorensen, 2000). More recent logging activity is suggested by a network of skidder trails and abandoned forest roads, as well as the relatively young age of some of the forest cover in the watershed.

Buffalo Brook and Reading Pond Brook watersheds were the location of extensive gold placer mining in the mid to late 1800s (Hitchcock *et al*, 1861; Child, 1884; Rutland Railroad Company, 1897; Smith, 1951; Ward, 1983). Reading Pond Brook and Buffalo Brook below its confluence were historically known as Gold Brook (Rutland Railroad Co., 1897; Hitchcock *et al*, 1861). Alluvial and glacial deposits of the river bed, banks and adjacent terraces were mined for gold flakes and nuggets. An 1859 map of the town of Plymouth (Scott, Stickney, & Pollard, publishers) indicates the extent of placer mining along the streams of Plymouth with a stippled pattern (Figure 9). Nearly the entire length of the Buffalo Brook and Reading Pond Brooks (as well as several tributaries) were mined for gold according to this historic map. In 1860 there were "seven companies at work on the Buffalo Brook…Miners take a lease on a certain number of lineal rods…along the stream with the right to dig in the 'dry' on either side… There are now sixteen dams." (Smith, 1951). Evidence of possible historic placer mining was observed in several reaches of the Buffalo and Reading Pond Brooks during 2009 assessments – including several breached earthen dams, decaying wooden platforms, and a few excavated depressions in stream terraces.

Mining of iron ore also occurred historically, on Weaver Hill at the southern extent of the Buffalo Brook watershed (Thompson, 1842; Beers, 1869). Ore was transported to the iron works at Tyson Furnace on the west side of Route 100.

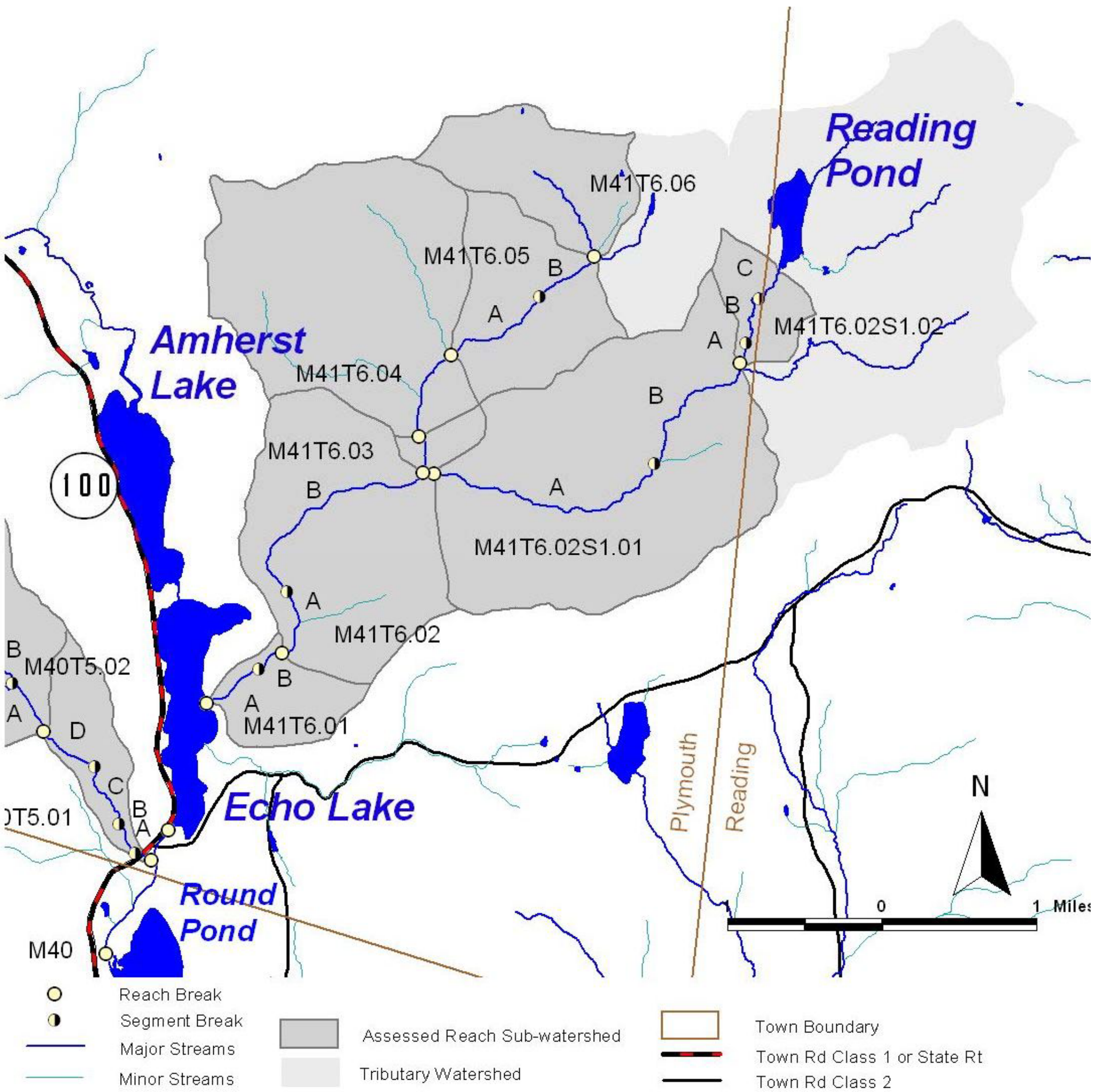


Figure 8. Location of Buffalo Brook and Reading Pond Brook reaches assessed in 2009.

Table 2. Results of Phase 2 Geomorphic Assessments, 2009.
Buffalo Brook reaches, including Reading Pond Brook tributary.

Buffalo Brook - Plymouth

Reach	Seg-ment	Channel Length (ft)	Channel Slope (%)	Drainage Area (sq mi)	Stream Type	Incision Ratio	Width Depth Ratio	RHA Condition	RGA Condition	Active Adjustment Process	Channel Evolution Stage	Stream Type Departure?	Sensitivity
M41T6.06	--	2,415	12.6	0.3	B1a-casc	Not Assessed - Bedrock Channel							Low
M41T6.05	B *	1,506	***8.0***		A1-casc	Not Assessed - Bedrock Channel							Low
	A	2,458	***4.5***	1.0	B4a-S/P	1.55[RAF]	55	0.74 Good	0.45 Fair	PF, Wid, Deg (hist)	IV [F]	No	High
M41T6.04	--	2,052	3.4	1.9	B3-S/P	1.0[RAF]	14.4	0.80 Good	0.70 Good	Minor (Hist Wid, PF)	IIc [D]	No	Moderate
M41T6.03	--	807	2.5	1.9	F4b-PB	2.4[RAF]	15.7	0.63 Fair	0.58 Fair	Min to mod PF; Hist incis	II [F]	Cb to Fb	Extreme
M41T6.02	B	5,083	***2.2***		F4b-PB	3.9[RAF]	26	0.69 Good	0.44 Fair	PF, min aggr; Hist incis, wid	II [F]	Cb to Fb	Extreme
	A *	1,556	***3.5***	5.6	B1-S/P	Not Assessed - Bedrock Channel							Low
M41T6.01	B *	649	***2.3***		C3b-PB	1.79[HEF]	19.4	0.55 Fair	0.69 Fair***	Minor aggrad; Hist incis	II [F]	None	Extreme **
	A	1,361	***1.4***	5.7	F4-R/P	2.75[RAF]	48.4	0.52 Fair	0.41 Fair	Mod aggr, wid, PF; Hist incis.	III [F]	C to F	Extreme

Reading Pond Brook - Reading, Plymouth

Reach	Seg-ment	Channel Length (ft)	Channel Slope (%)	Drainage Area (sq mi)	Stream Type	Incision Ratio	Width Depth Ratio	RHA Condition	RGA Condition	Active Adjustment Process	Channel Evolution Stage	Stream Type Departure?	Sensitivity
M41T6.02S1.02	C	765	***3.4***		F4b-PB	3.1 [RAF]	29.7	0.69 Good	0.46 Fair	Incis, Mod wid, PF.	II [F]	Cb to Fb	Extreme
	B	1,360	***2.2***		C4b-R/P	1.6 [RAF]	25.9	0.69 Good	0.50 Fair	PF, Min Aggr/Wid, Hist Incis	IV [F]	None	Very High
	A *	505	***4.0***	1.2	F3b-S/P	2.0 [RAF]	26.5	0.80 Good	0.49 Fair	Incis, Wid, PF; minor Aggr	III [F]	B to Fb	Extreme
M41T6.02S1.01	B	3,374	***5.3***		B3a-S/P	1.78 [RAF]	15.7	0.71 Good	0.36 Fair	Wid, Incis; aggr & PF (local)	III [F]	None	High
	A	5,564	***4.3***	2.9	F4a-PB	2.2 [RAF]	14.9	0.65 Good	0.40 Fair	Aggr, PF; Hist Wid & Incis	III [F]	Ba to Fa	Extreme

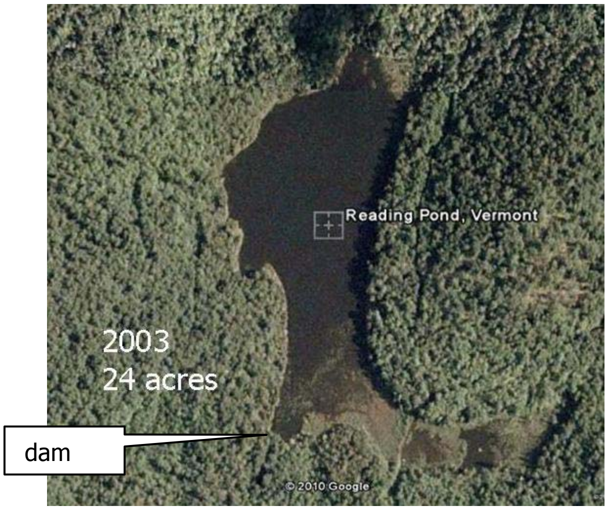
Notes / Abbreviations:

Channel Slope: Values in italic bold have been updated since the Phase 1 SGA, due to field-truthing and/or segmentation.
Stream Type: S/P = Step/Pool; R/P = Riffle/Pool; R/D = Ripple/Dune; PB = Plane Bed; Br = Braided; Casc = Cascade; Ref = Reference
Incision Ratio: RAF = Recently Abandoned Floodplain; HEF = Human-elevated Floodplain (following protocols, VTANR, 2007).
Condition: RHA = Rapid Habitat Assessment; RGA = Rapid Geomorphic Assessment (VTANR, 2007).
Adjustment: PF = Planform Adjustment; Aggr = Aggradation; Wid = Widening; Deg = Degradation; NM = Not Measured.
Channel Evolution Stage: F = F-stage model; D = D-stage model (see Appendix C of protocols, VTANR, May 2007).
* Subreach of alternate reference stream type.
** Sensitivity overridden to higher value due to setting of marked decrease in valley gradient and confinement ("alluvial fan").
*** RGA condition rating overridden from Good to Fair, despite score of 0.69, due to human modifications (armoring, berming, straigtening) that have reduced functionality of the reach/floodplain and constrained the reach from adjusting toward a more natural form.

Figure 9. Excerpt from historic map showing location of gold placer mining in Buffalo Brook watershed. Source: Scott, Stickney & Pollard, publishers, 1859: Map of town of Plymouth. (Stippled pattern along river indicates location of gold placer mining).

At the headwaters of Buffalo Brook is Reading Pond. In the limited resources consulted for this study, little information was available about the history of this pond. Given the topographic setting and the nature of surficial sediments in the vicinity (mapped as glaciofluvial and alluvial), it is likely that this pond has a natural, post-glacial origin. However, in June 2006, a flood event resulted in the sudden breaching of a beaver dam at the downstream end of this pond, and revealed remnants of a stone and earthen dam. Thus, it is likely that the depth and aerial extent of this natural pond was enhanced by construction of an earthen and stone dam at some point in the past – possibly associated with the logging and/or gold mining history of the area. During field assessments, a second breached dam constructed of stone was located approximately 350 feet downstream of the main dam (see Appendix E). A stone foundation was located along the LB near this second dam, suggesting a possible mill history. No evidence of a mill or dam in this location was noted on the Beers Atlas of Windsor County (1869).

The sudden breaching of Reading Pond dam resulted in a significant volume of water being released to the Reading Pond Brook and lower reaches of the Buffalo Brook. As observed in September of 2009, the southern shore line of Reading Pond is now located more than 700 feet to the north of its former position. The aerial extent of this pond has been reduced by approximately 10 acres (Figures 10-a & -b). It is likely that volumes of fine and coarse sediments were released from behind the dam as the pond drained (Figures 10-c, 10-d, 10-e). Today, the southern extent of the former pond has begun to revegetate (Figure 10-f).



(a) Reading Pond prior to 2006 dam breach.

(b) Reading Pond after 2006 dam breach.

(c) breached dam, 22 June 2006 (Source: VTDEC).

(d) breached dam, 22 June 2006 (Source: VTDEC).

(e) view upstream from breached dam, 22 June 2006 (Source: VTDEC).

(f) view upstream from breached dam, 4 September 2009

Figure 10. Site of breached dam, Reading Pond, town of Reading.

3.2.2 Assessment Results

Generally speaking, the gradient of the Buffalo Brook decreases along the length of study, from 12.6% at the upper extent to 1.4% above the confluence with Echo Lake (Figure 11). The profile of the Reading Pond Brook is somewhat less steep, as this tributary channel originates near the Reading Pond where topography is gentler and a local accumulation of glaciofluvial deposits supported the formation of Reading Pond.

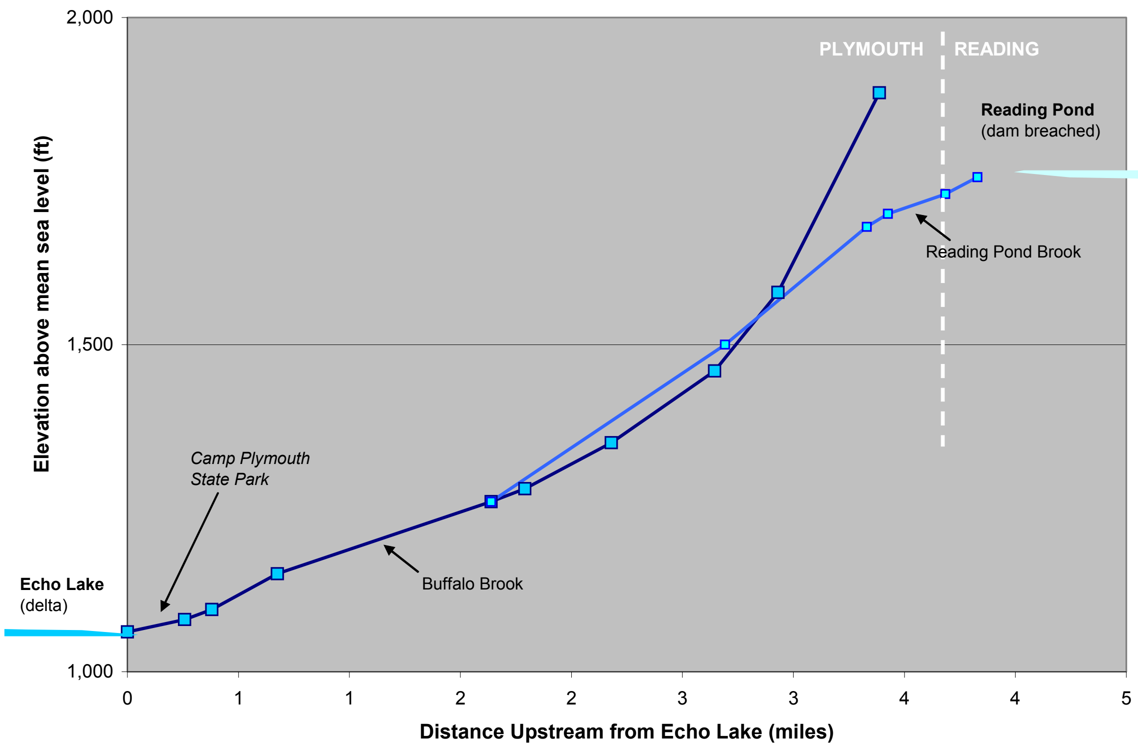


Figure 11. Longitudinal Profile of Buffalo Brook tributary.

The assessed reaches of Reading Pond Brook (downstream of Reading Pond) vary somewhat in their valley setting and reference stream type. From Reading Pond downstream to the Reading Pond Road culvert crossing (approximately 2100 feet), the channel is an unconfined, gravel–riffle/pool channel of moderate gradient (3.4 to 2.2%). Below the culvert crossing, this tributary transitions to a steep-gradient, cobble step/pool and cobble-cascade channel, semi-confined between extremely-steep, till-mantled bedrock valley walls. These upper reaches of Reading Pond Brook are exhibiting active incision in some locations, overprinted on historic (or post-glacial) incision, as well as system-wide planform adjustments and widening. Mass failures are prevalent within a mile downstream of the breached Reading Pond. Density of large woody debris is very high, with frequent channel-spanning debris jams or occasional boulder steps contributing to upstream sediment accumulation.

In contrast to the Reading Pond Brook, the upper 4,000 feet of Buffalo Brook is narrowly- to semi-confined between extremely-steep, bedrock controlled valley walls. Bedrock is exposed frequently in the channel bed and banks. These segments (M41T6.06, M41T6.05-B) are fairly stable, have good access to a very narrow floodplain, and have resistant boundary conditions (shallow bedrock) that moderate lateral adjustments. As gradients decrease in Segment M41T6.05-A, and M41T6.04, and a forest road (now abandoned) joins the narrow stream valley, a degree of historic (or post-glacial) incision below discontinuous stream terraces is evident, along with signs of moderate planform adjustment (flood chutes) and localized widening. Intermediate reach M41T6.04 is vertically and laterally stable. At reach M41T6.03, just above the confluence of Reading Pond Brook, there is a local accumulation of glaciofluvial sediments, and the channel has become historically (or post-glacially) entrenched below high terraces of unconsolidated sediments. Incision may reflect a tributary rejuvenation process extending upstream in the reach from historically-incised lower reaches of the Buffalo Brook.

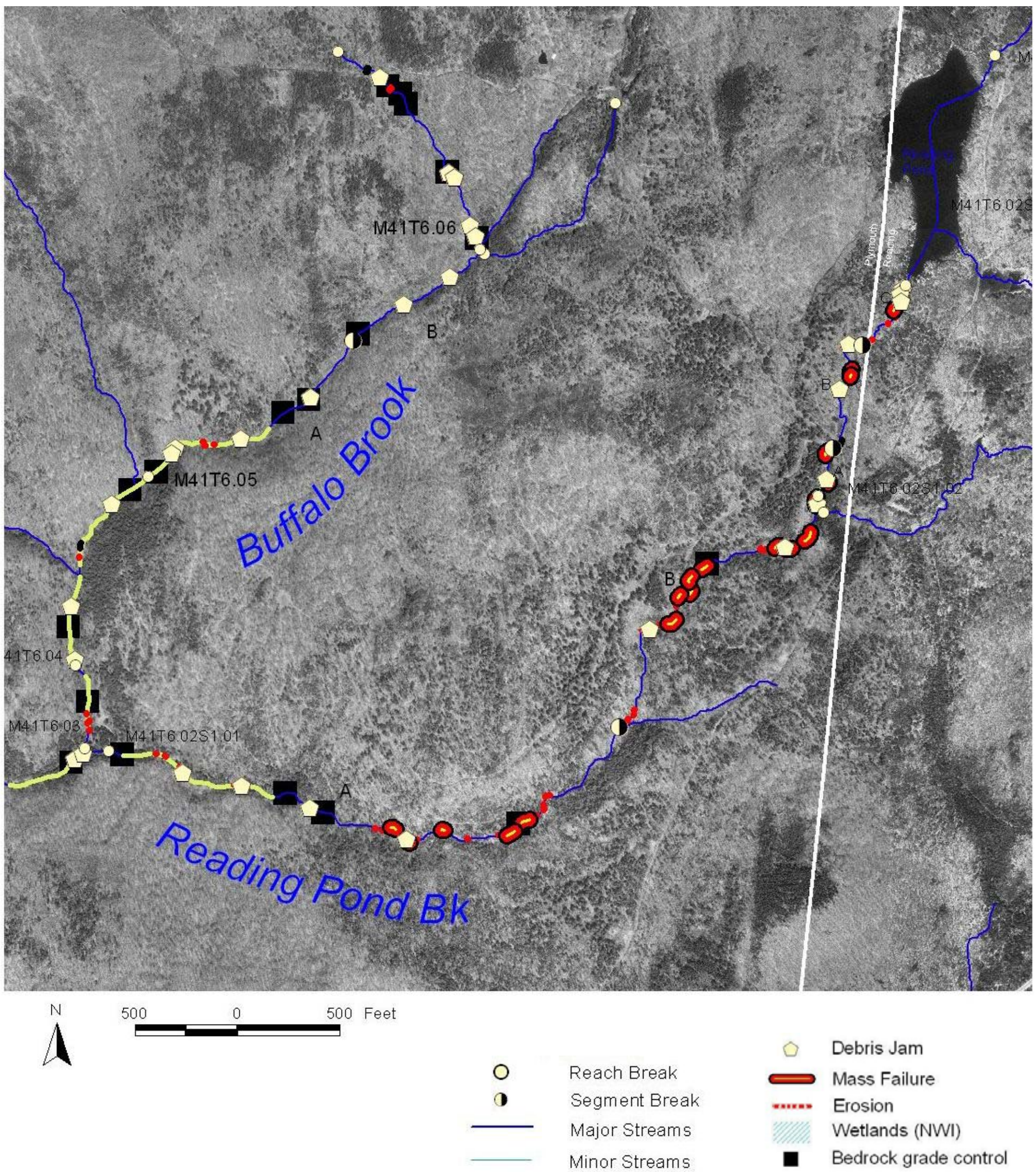


Figure 12. Observed features on upper reaches of Buffalo Brook and Reading Pond Brook. Pale green line indicates length of channel with abandoned forest road within one channel width to either side of stream.

Downstream of the confluence with Reading Pond Brook, the Buffalo Brook channel is characterized by historic (or post-glacial) incision, with localized aggradation, widening and planform adjustments (flood chutes, bifurcations) at sites of debris jams, or log steps. A forest road follows the channel for nearly the entire length down to a short bedrock gorge above Camp Plymouth State Park. Frequently, the channel has avulsed to erode a portion of the road bed or occupy the road as a flood chute during higher water. In this manner, the road bed has served as a source of sediments to downstream reaches (Figure 13).

Figure 13. View downstream, recent avulsion along the former path of the forest road in LB corridor, Segment B, M41T6.02, Buffalo Brook, 24 September 2009

At the lower extent of Buffalo Brook (where it flows through Camp Plymouth State Park), the gradient and valley confinement are notably less than in upper reaches. A decreased sediment transport capacity is expected due to the decreasing gradient on approach to the relatively fixed base level of Echo Lake. Where this segment / reach might ordinarily serve as a location for sediment attenuation, historic incision (channelization) and construction of berms and armoring of the channel have served to convert the upper end of reach M41T6.01 (Segment B) to a transport-dominated condition. Sediments are conveyed through the segment, under Scout Camp Road, to downstream Segment A.

Some lateral adjustments are occurring in the lower segment of M41T6.01 through the state park. A large sediment delta has accumulated – particularly since the June 2006 flood – in Echo Lake at the confluence of Buffalo Brook (Figure 14).

Figure 14. View downstream to delta of fine gravels and sands which extends out into Echo Lake from the mouth of Buffalo Brook, reach M41T6.01, Segment A, 7 August 2009. Kayak paddles mark approximate lateral extent of deposits.

4.0 DEPARTURE ANALYSIS, STRESSOR IDENTIFICATION & SENSITIVITY

Phase 1 and Phase 2 stream geomorphic assessments provide for a better understanding of how human-caused disturbances at the watershed and reach level may have altered or constrained the river's ability to convey the water and sediment inputs to the watershed. Consideration of the current state of channel evolution and reach sensitivity will help to ensure that identified river management strategies and restoration or conservation projects will be successful over the long term.

Channel and watershed disturbances that exceed thresholds for change can upset the dynamic equilibrium of stream systems. Imbalance in the channel affects the sediment transport capacity of the stream system, and has significant consequences for erosion hazards, water quality and riparian habitats. Equilibrium can be disturbed locally and result in channel adjustments that are limited in magnitude and extent (for example, scour at an undersized culvert crossing). Alternately, the disturbance (or an overlapping combination of disturbances) can be of sufficient size, duration, or frequency to cause substantial channel adjustments that result in a system-wide imbalance extending far upstream and downstream through the river network.

Such imbalances, whether localized or systemic, can interfere with the river's ability to efficiently convey its water and sediment loads. These interruptions may be expressed as a sediment transport deficiency where sediment accumulates in the channel (which itself may lead to further imbalances - e.g., flow widens and splits to erode streambanks on either side, or flow may avulse or jump its banks in a flood event). Alternately, the imbalance can be expressed as an increase in sediment transport capacity. For example, a channel that has been straightened, dredged, armored and bermed has a local increase in channel slope and channel entrenchment, which creates higher flow velocities, and an increased power to erode the streambed. If the channel bed is scoured, this condition often leads to further channel adjustments including streambank collapse and widening.

Sediment transport capacity of the channel can be inferred from the geomorphic features observed during field work and from the identified reach-scale and watershed-scale stressors. Even a qualitative understanding of features and fluvial processes can help to identify and prioritize appropriate management strategies for the river that will facilitate a return toward a more balanced (dynamic equilibrium) condition.

As stated in VTANR (2007) guidance: "Within a reach, the principles of stream equilibrium dictate that stream power and sediment will tend to distribute evenly over time (Leopold, 1994). Changes or modifications to watershed inputs and hydraulic geometry create disequilibrium and lead to an uneven distribution of power and sediment. Large channel adjustments observed as dramatic erosion and deposition may be the result of this uneven distribution and may continue until [quasi-]equilibrium is achieved."

The departure analysis and sensitivity analysis presented below characterize the current condition of the subject reach, T02.08, and its degree of departure from reference, or a pre-disturbed state.

4.1 Departure Analysis

The departure analysis reviews watershed-level and reach-level disturbances to the channel and characterizes the potential nature and extent of these disturbances as stressors to the overall equilibrium of the river network. Changes to the hydrology and/or sediment load are important as they may significantly affect the hydraulic geometry and fluvial processes of the river and lead to an imbalance of the river network. A channel in dis-equilibrium may undergo substantial lateral and vertical adjustments that may be "at odds" with human infrastructure or land uses in the river corridor. Watershed-scale hydrologic and sediment regime stressors are addressed in Section 4.1.1. Changes in sediment loading characteristics that influence sediment regime at both the watershed level and reach level are addressed in Section 4.1.2. Direct disturbances of the channel and/or surrounding floodplain are addressed as possible modifiers of the channel slope, channel depth, and channel and riparian boundary conditions (Sections 4.1.3 and 4.1.4). While these factors are addressed in separate sections below, in reality they are inextricably linked in the overall cause and effect cycles and fluvial processes which together govern the form and function of the river network.

As defined in VTANR guidance (VTANR, 2007), the hydrologic regime of the river system refers to the "input and manipulation of water at the watershed scale" that may modify the timing, volume, duration and periodicity of flows in the river network. In turn, these changes to the hydrologic regime may have the potential to cause adjustments in the channel dimensions, slope, or planform – and influence the sediment transport regime. The sediment regime is defined in VTANR guidance as "the quantity, size, transport, sorting, and distribution of sediments".

4.1.1 Watershed Scale Hydrologic and Sediment Regime Stressors

Data are not sufficient to know with certainty whether (and to what extent and in what locations) a given change in the water or sediment inputs to a river corridor will cause the channel to incise or aggrade, widen or shift its planform. However, potential influences on the hydrology of the Patch Brook and Buffalo Brook watersheds can be identified in a qualitative sense as a possible contributor(s) to channel dis-equilibrium. Watershed-level hydrologic and sediment regime stressors are identified through a review of existing Phase 1 and Phase 2 stream geomorphic data and include deforestation, stormwater inputs, dams, flow regulations, land use (degree of urbanization), ditching, and wetland loss. Watershed stressors are summarized in Table 3.

Deforestation

Widespread deforestation of Vermont's landscape occurred by the early- to mid-1880s (Thompson & Sorensen, 2000) to support subsistence and sheep farming and the lumber industries. In the Patch Brook watershed (and likely in the Buffalo Brook watershed), lumber was harvested to produce charcoal to fuel the iron ore furnaces at Tyson village. Deforestation is inferred to have caused increased water and sediment loads to be mobilized from these watersheds. Rainfall, which would previously have been intercepted by tree leaves and branches, and which would have been taken up by tree roots and evapo-transpired, instead ran off the land surface. Infiltrative capacities of the soils would have been reduced by compaction of the soils during harvesting. Increased volumes of stormwater runoff would have had increased capacity for gullying and entrainment of soils and sediments from the land surface, delivering increased sediment loads to the river network. Sediment supplies to Black River and tributary reaches would have been increased especially during flood events, leading to aggradation and planform adjustments (with the increased sediment loading), and possibly localized incision and widening (where increased hydrologic loading occurred).

Forest cover in the Vermont highlands began to regenerate in the late 1800s and early 1900s, during the industrial age and abandonment of upland farms and sawmills. During reforestation, the water and sediment balance would have again shifted (independent of global climate cycles) back to lesser volumes of runoff and reduced sediment loading. This change in the hydrologic and sediment regimes may have led to net incisional processes in parts of the Patch Brook and Buffalo Brook channel networks.

Table 3. Watershed Stressors, Assessed reaches of the Patch Brook and Buffalo Brook tributaries.

	Watershed Input Stressors	
Stressor Type	**Hydrologic Regime**	**Sediment Regime**
Floods	Events (such as the floods of 1973, 1938, 1936, and 1927) imparted event-based **increase** in hydrologic loading to the watershed (see Section 2.5).	**Increased** sediment loading from active channel adjustments in upstream reaches, would be expected as a result of major flood events, such as the 1973, 1938, 1936, and 1927 (see Section 2.5).
Deforestation	**Increased** hydrologic loading due to deforestation in mid- to late-1800s; subsequent **decreased** hydrologic loading as slopes partially reforested through the 1900s.	**Increased** sediment loading due to deforestation in mid- to late-1800s; subsequent **decreased** sediment loading as slopes partially reforested through the 1900s.
Gold Placer Mining	Localized Impacts on hydrologic regime expected related to potential impoundments and/or diversions	Changes in sediment regime expected related to excavations in the bed/banks, selective removal of larger clasts, and flow diversions and impoundments.
Urbanization	**Minor** increased hydrologic loading inferred due to development and increased road densities of reach subwatersheds and upstream drainage areas in recent decades. Upstream watershed development percentages (0.0 to 4.0%) are at or below the threshold of concern (5%) noted in VTANR guidance (11 July 2007).	**Minor** increased sediment loading inferred due to development and increased road densities of reach subwatersheds and upstream drainage areas in recent decades. Upstream watershed development percentages (0.0 to 4.0%) are at or below the threshold of concern (5%) noted in VTANR guidance (11 July 2007).
Stormwater Inputs	**Localized increases** in hydrologic loading inferred due to road ditch and overland flow stormwater inputs.	**Localized increases** in sediment loading inferred due to road ditch and overland flow stormwater inputs.
Dams / Impoundments	Two dams are currently located immediately upstream of assessed reaches (one breached in June 2006). Present and historic dams possibly contributed to historic incision due to "hungry water" effects downstream of the dam sites, and due to breaching effects upstream of the dam sites.	Two dams are currently located immediately upstream of assessed reaches (one breached in June 2006). At present and historic dam sites, sediments may be trapped in impoundments and may have been released to downstream reaches upon dam breaching.
Diversions / Water Withdrawals	Unknown hydrological impacts of historic operation of flow diversions from Patch Brook along Dublin Road (reach M40T5.01) and possible historic diversion on Reading Pond Brook (reach M41T6.02S1.02).	**Minor** sediment regime impacts inferred from flow diversions from Patch Brook along Dublin Road (reach M40T5.01) and possible historic diversion on Reading Pond Brook (reach M41T6.02S1.02).
Loss of Wetlands	Neglible impacts to hydrologic regime as a result of conversion of wetlands (hydric soils). Very minor extent of mapped wetlands and hydric soils in the upstream watesheds of assessed reaches.	Neglible impacts to sediment regime as a result of conversion of wetlands (hydric soils). Very minor extent of mapped wetlands and hydric soils in the upstream watesheds of assessed reaches.
Crop Lands	Neglible impacts to hydrologic regime as a result of crop land uses. Less than 1% crop uses in the upstream watershed of assessed reaches.	Neglible impacts to sediment regime as a result of crop land uses. Less than 1% crop uses in the upstream watershed of assessed reaches.

Gold Placer Mining

As previously noted, Buffalo Brook and Reading Pond Brook watersheds were the location of extensive gold placer mining in the mid to late 1800s (Hitchcock *et al*, 1861; Child, 1884; Rutland Railroad Company, 1897; Smith, 1951; Ward, 1983). Gold placer mining involved a number of practices which could lead to destabilization of the channel (Madison, 1981), such as:

- Diversion of stream water into a network of wooden sluiceways to wash sediments and separate out the heavier gold flakes and nuggets;
- Damming of the channel to support diversion of water into the sluiceways;
- Excavation of channel bed, banks and adjacent terraces to mine the sediments for gold;
- Selective removal of larger boulders/ cobbles from the stream bed to facilitate excavations, resulting in an overall decreased size of bed materials; and
- Extensive sediment yields (and increased turbidity) to downstream reaches as a result of sluice operations and/or hydraulic mining.

A description of the gold mining methods in Plymouth is provided in *Report on the Geology of Vermont* (Hitchcock, *et al*, 1861, pp. 845-847) and *The Plymouth Gold Rush* published in Vermont Life magazine (Smith, 1951). Several historic photographs (copyrighted) of gold mining in the Plymouth area are available for viewing at the Perkins Landscape Change web site.

Floods

Floods are natural events which influence the sediment and hydrologic regimes of river networks. Increased flows can lead to channel widening and incision, where the increased scour energy exceeds thresholds for erosion in the streambank and bed materials. In turn, flood-event erosion mobilizes sediments that can lead to downstream aggradation and lateral adjustments. Large-magnitude flood events occurring decades in the past may still be influencing the morphology and active adjustment processes of river channels today. Available historic resources indicate that the Black River watershed has been affected by the large events of 1927, 1936, 1938 and 1973, as well as several smaller flood events (see Section 2.5 of SMRC, 2009). These flood events would have episodically increased flows and sediment loading in the channels of the Black River watershed.

Recent trends indicate an increased frequency of larger floods. Average annual precipitation in the Northeastern United States has increased approximately 3.3 inches over the period from the year 1900 to 2000 (UNH Climate Change Research Center, 2005). The frequency and number of intense precipitation events (defined as more than two inches of rain in a 48-hour period) has also increased, particularly in the last quarter of the 19th century (UNH Climate Change Research Center, 2005).

Urbanization

Urbanized land uses in the watershed draining to the river can be a source of increased runoff that may serve as a stressor to the channel. Regionally, the balance of water and sediment loads conveyed within a watershed is altered by the density of settlements on the landscape and its effect on the percent of land area impervious to rainfall. Impermeable (or partially impermeable) surface types associated with development can include roof-tops, pavement, roads, and dense gravel-pack roads or driveways. Percent imperviousness refers to the proportion of the land surface converted to impermeable or reduced-permeability surfaces. In general, development results in a reduction in total land area remaining pervious to rainfall. Rainfall and snowmelt waters quickly run off the land surface to the nearest swale or stream; they are not able to infiltrate through the surface soil layers and flow diffusely through the subsurface to the river network. Instead, stormwaters are delivered in higher magnitudes to stream networks and over shorter durations, leading to a prevalence of "flashy" runoff conditions. Stormwaters diverted overland in this way have high velocities and therefore an increased capability to erode soils and debris from the land surface. Upland development can also bring more localized stressors to the river channel including: (1) additional bridge and culvert crossings which are often undersized with respect to the bankfull widths and (2) floodplain encroachment by roads, driveways, and crossing structures which reduce the floodplain area available to the river during flood stage. Such floodplain access is a critical need of the river channel in order to dissipate energies associated with flood-stage flows – serving as a kind of pressure release valve for the river.

VTANR guidance suggests evaluating the Land Cover / Land Use data developed in the Phase 1 Stream Geomorphic Assessment (Step 4.1) to identify the potential for changes to the hydrologic regime from urbanization. Caution should be applied in using these data, due to: (1) the fact that percent development does not necessarily equate to percent imperviousness (particularly in rural watersheds); (2) the fact that developed (impervious) surfaces are hydrologically connected to the river to varying degrees; and (3) scale, minimum mapping units, age, and accuracy of the land cover / land use data sets utilized (*Landcover / Landuse for Vermont and Lake Champlain Basin [LandLandcov_LCLU, edition 2003]. Source dates of 1991 to 1993. Available at: http://www.vcgi.org/metadata/LandLandcov_LCLU.htm).*

The upstream watersheds draining to each of the assessed reaches of the Patch Brook and Buffalo Brook have urbanized land percentages ranging from approximately 0.0 to 4.0% (Phase 1 data, SMRC, 2007). This range of values is at or below the percentage (5%) suggested as a threshold of concern in VTANR guidance (2007b). Thus, watershed-scale urbanization is expected to represent a relatively minor stressor to the Patch Brook and Buffalo Brook tributaries.

Road Networks / Ditches

In rural watersheds, particularly on upland slopes, road and driveway ditches can be a significant contributor of stormwater and sediment to receiving tributaries and rivers. Often road ditch networks terminate at stream crossings without provision for sediment and stormwater retention, detention or treatment.

The upper reaches of both Patch Brook and Buffalo Brook watersheds contain a network of gravel roads and trails that have been used in the past to access logging operations (and possibly mining operations) and are presently used for recreational and residential access. In the Buffalo Brook watershed a network of abandoned roads closely follows the channel in many reaches and has facilitated channel avulsions and lead to increased sediment runoff to the channel.

Stormwater inputs

The previous sections indirectly addressed the potential for stormwater runoff, through review of urbanized land cover and road density at the watershed scale. This section more directly evaluates stormwater inputs to the channel, including such features as road ditch outlets, road culvert outlets (connected to road ditches), and points of concentrated runoff from overland flow. While the flow of an individual stormwater outlet may be quite small, cumulatively stormwater inputs can have a measurable effect on a receiving channel, depending on the magnitude of the cumulative stormwater input compared to the flow of the receiving water. The concentration of flows from stormwater runoff can also lead to increased power to erode sediments in the stormwater channel, leading to increased gullying, sediment mobilization to the river and a potential impact on the sediment regime of the river.

VTANR guidance (2007b) suggests that stormwater inputs are potentially significant only in reaches with upstream drainage areas less than 15 square miles due to the assimilative capacity of larger channels. Each of the assessed reaches of the Patch Brook and Buffalo Brook watersheds has an upstream drainage areas less than 15 square miles. Several reaches had numerous stormwater inputs:

- In the Patch Brook watershed, reach M40T5.03 of shares a narrow, steep valley with the gravel Patch Brook Road. Road ditches were prevalent along the uphill (north) side of the road. These ditches receive not only shtormwater runoff but also tributary drainage off slopes to the north. At least 21 cross culverts were indexed along a channel length of 1.4 miles. Often, fine sand and gravels obstructed culvert inlets and culvert outlets were unstable (no headers). Road sediment was observed directly entering the channel at the outlet of several culverts. A few additional locations of direct sediment runoff by overland flow were indexed along the reach. No turn-outs or check dams were observed along the road ditches, although it should be noted that physical space to install and maintain such structures is limited in this narrow valley.

Figure 15. Examples of stormwater inputs to the Patch Brook reach M40T5.03 Segment B; 29 October 2009

- In the Buffalo Brook watershed, an abandoned road network shares a narrow valley with the stream channel in several reaches of the Buffalo Brook and Reading Pond Brook. In some locations evidence of the road has been eroded away as the stream has avulsed to flow in the path of the road. In other locations, the former road grade has been eroded to form a flood chute (Figure 16). As stormwater flows are concentrated along the road grade, sediments are eroded, and "sunken road" segments, or "dug-ways", have been created (see previous Figure 13).

Figure 16. View downstream, river crossing old road bed, which now functions as a flood chute during higher-flow conditions upstream of the crossing, Segment A, reach M41T6.05, Buffalo Brook, 22 October 2009

Dams / Impoundments

Dams disrupt the flow dynamics (and sediment transport continuity) of rivers to varying degrees and extents, depending on their size, height, topographic setting, and operational status, and depending on the hydrologic, geomorphic and geologic characteristics of the river being impounded (Williams and Wolman, 1984; Kondolf, 1997). Depending on the size of the impoundment and operational status of the dam, sediments can be trapped in the impoundment upstream of a dam; bed load and a portion of the suspended sediment load settle out in the still water environment of the reservoir. The sediment (bed) load of water leaving the impoundment may be significantly reduced, and the water may possess enhanced energy to erode the stream bed and banks. Depending on the nature of sediments in the channel margins and underlying surficial deposits, and vegetative boundary conditions, this increased erosional potential can lead to channel incision and/or widening downstream of the dam as the river seeks to restore its sediment load – a condition often termed "hungry water" (Kondolf, 1997). If scour is significant, the channel can incise below the surrounding floodplain. On the other hand, if flows are regulated so as to significantly reduce flood peaks and magnitudes, channel aggradation and/or narrowing may result downstream of the dam. Sediments may accumulate in the downstream channel, where they are mobilized from tributaries, if flushing effects of bankfull flows and low-magnitude flood events have been eliminated or reduced as a result of flow regulation (Kondolf, 1997).

Degraded aquatic systems may result from flow regulation by dams, due to reduced frequency and magnitude of overbank flooding which is a requirement for many riparian and floodplain ecosystems (Magilligan, *et al*, 2003).

There are no existing dams/ impoundments on assessed reaches of the Patch Brook and Buffalo Brook tributaries. However, nearby dams /impoundments have influenced the base levels and sediment transport characteristics of these tributary channels to varying degrees.

- Lake Ninevah (tributary to Patch Brook: M40T5.03S1.02)
  This earthen dam is owned by Wilderness Corporation who purchased it from CVPS in 1984. The current purpose of the dam is recreational (VT Dam Inventory). The original purpose of the dam was noted as hydroelectric; former owner, Central Vermont Public Service, "used the dam as a storage reservoir to augment flows in the Black River for its Cavendish hydroelectric project" (VTDEC, 2005). The dam was reportedly installed in 1930 (VT Dam Inventory) on the

approximate site of a former dam (perhaps breached in the 1927 flood). A dam appears at this location on the 1869 Beers Atlas (with the impoundment labeled as "Spathic Iron Co.") as well as the 1893 topographic map (with the impoundment noted as "Patch's Pond"). The approximate aerial extent of Lake Ninevah is published as 237 acres; maximum depth is 12 feet; and the upstream drainage area of 1.2 square miles (VTDEC, 2005). This operates as a run-of-river dam. In the 1980s and early 1990s, the lake was customarily drawn down in the winter months (October through May) by 3 to 4 feet by draining lake waters through a sluiceway over a period of approximately 2 weeks. In later years the amount of drawdown was reduced to approximately 6 inches. Following a June 2004 order from the VT Agency of Natural Resources, artificial drawdowns of the lake were discontinued for the sake of in-lake aquatic habitats (VTDEC, 2004). Past breaching events, and artificial drawdowns of lake levels in the 1980s to early 1990s, would have caused event-based increases in flow that would enhance the transport function of the Lake Ninevah outlet channel and Patch Brook downstream of the Lake. It appears that the natural boundary conditions of these channels (bedrock, large boulders, forested buffers) were sufficient to moderate lateral or vertical adjustments for at least 1.7 miles downstream. Increased erosional energies may have been translated to downstream reaches of the Patch Brook along Dublin Road.

- <u>Reading Pond</u> (Reading Pond Brook: M41T6.02S1.03)
  This is a high-elevation, 22-acre pond (VTDEC, no date) at the headwaters of Buffalo Brook which drains to Echo Lake. In the limited resources consulted for this study, little information was available about the history of this pond. Given the topographic setting and the nature of surficial sediments in the vicinity (mapped as glaciofluvial and alluvial), it is likely that this pond has a natural, post-glacial origin. However, in June 2006, a flood event resulted in the sudden breaching of a beaver dam at the downstream end of this pond, and revealed remnants of a stone and earthen dam. Thus, it is likely that the depth and aerial extent of this natural pond was enhanced by construction of an earthen and stone dam at some point in the past. Construction of this historic dam may have contributed to downstream incision due to "hungry water" effects, depending on the nature of operations. Breaching of this dam in June 2006 resulted in the sudden release of water and sediment that has apparently contributed to active channel adjustments in at least 1.1 miles of the Reading Pond Brook channel downstream of the Pond.

- <u>Amherst Lake</u> (Black River: M42)
  This lake is approximately 81 acres in area (VTDEC, no date) and represents an impounded reach of the Black River. Water is impounded behind a concrete gravity dam on a bedrock and soil foundation, which is presently owned by Lakeside Associates, Inc. This dam was constructed by Central Vermont Public Service in 1950 (VT Dam Inventory) to replace a timber crib dam (Haybrook, 1953). A photograph in *A Plymouth Album* (Ward, 1983) depicts a horse and buggy on a timber bridge over a dam at the "Interlock Amherst and Echo, Tyson, VT". A saw mill and grist mill were noted at the approximate location of this dam on the Beers Atlas of Windsor County (1869). Prior to 1886, this lake was known as Upper Plymouth Pond. The historic red mill was located near the dam and contained three water wheels for grinding corn, wheat, and oats (Greene, 1997). Historic regulation of flows from Amherst Lake (or past breaching events) would affect, to some degree, the surface elevation of Echo Lake, which is the local base level for Buffalo Brook.

- <u>Echo Lake</u> (Black River: M41)
  This is a natural water body approximately 104 acres in area (VTDEC no date). Prior to the late 1800s, this lake was known as the Lower Plymouth Pond, or Tyson Pond, and once "provided waterpower for the mills in [Tyson] village" (Greene, 1997). A 1953 study indicates that the discharge capacity of the Echo Lake outlet is substantially less than that of the Lake Amherst

dam, so that the level of Echo Lake rises faster in a flood than does the level of Lake Amherst (Haybrook, 1953). Observations reported to the Vermont Department of Water Resources by Central Vermont Public Service in August of 1973 indicate that during the flood of July 1973, Lake Amherst rose to approximately 94 inches over the crest of the dam…[and] that Lake Echo had backed up into Amherst Dam. Leveling from an existing high water mark on the north shore of Lake Echo, [they] were able to determine that Echo's level was approximately 4 – 5 inches higher than Amherst's level" (Graham, 1973). While an exact accounting of historic lake levels is not available, it is likely that historic (and post-glacial) fluctuations in the elevation of Echo Lake have contributed to historic aggradation and historic incision in the lowest reach of Buffalo Brook. Today, the net result of post-glacial and historic channel adjustments is a partially incised and entrenched channel near the mouth of Buffalo Brook.

- Lake Rescue (Black River: M39)
  Lake Rescue is approximately 180 acres in area. This natural pond was reportedly "raised some 8 feet by an embankment and dam built by one of the woolen mill companies of Ludlow" (Gay, 1927). During the flood of 1927, "40 ft of the embankment at Lake Rescue, near the Plymouth line, broke away" and a wall of water moved downstream through Ludlow (Gay, 1927). According to the VT Dam Inventory, the town of Ludlow is listed as the current owner of this earth, concrete and stone dam constructed on a bedrock and soil foundation. The dam was refurbished in 1977 following damages sustained in the floods of 1976 and 1973 (Dufresne & Henry, 1994). Lake Rescue includes a small embayment at the northern end known as Round Pond. Historic regulation of lake levels, past breaching events, and past flood events would influence the surface elevation of Lake Rescue (Round Pond) which serves as the local base level for the short reach of Black River connecting Echo Lake to Round Pound and receiving Patch Brook. While it is unlikely that fluctuations of Lake Rescue surface elevations have directly caused significant vertical adjustments within the lower Patch Brook channel, the impact of such fluctuations on the Black River channel may have indirectly lead to vertical adjustments in the Patch Brook. Today, the net result of post-glacial and historic channel adjustments is a partially incised and entrenched channel in the Black River (reach M40) and lower reaches of the Patch Brook.

Several historic dams were present on the Buffalo Brook and Patch Brook tributaries. While these past structures no longer impound the channels, knowledge of their historic presence aids in characterizing the overall sensitivity of the river reaches and their degree of departure from reference condition, where applicable. In some cases, the present morphology and sediment regime of the river channel can still be influenced by the historic disruption of fluvial and sediment transport processes imparted by a dam(s).

Just as the presence of a dam influences the natural river balance, the subsequent removal of a dam can have an impact on future adjustment of the river channel. As the river readjusts to the lowered base level, incision and widening might be expected to migrate upstream from the former dam site. Sediments mobilized from the incising areas might contribute to aggradation, widening or planform adjustments downstream of the former dam site.

As further detailed in Appendix E, the historic dams along the main stem reaches may have contributed to historic incision in these reaches as a result of "hungry water" effects downstream of the dam sites while these structures were intact and subsequent to breaching effects upstream of the dam sites. While operating, these historic dams may have impounded sediments to varying degrees, depending on impoundment size and height. Upon breaching of the dams (especially during the flood of 1927 or the floods of the 1930s), sediments would have been released to downstream reaches.

Diversions, Water Withdrawals (flow regulation)

Changes in the flow characteristics of a river imparted by diversion structures or substantial water withdrawal sites can influence the magnitude of flows and interrupt the sediment transport functions of rivers, potentially resulting in areas of exacerbated erosion or system-wide instability in the river.

Two diversion sites were noted on the assessed reaches:

- Patch Brook reach M40T5.04
  Within Segment C is a small flow diversion consisting of a 4-inch black flex hose leading from the channel to a nearby impoundment. The intake in the channel is a PVC pipe connected by a Fernco™ fitting to a flexible hose. The hose was traced through the woods to a narrow pond impounded by a horse-shoe shaped earthen dam approximately 8 feet high and 270 feet long. A culvert was located at the downstream end of the pond and apparently drains the pond. Matted vegetation patterns indicated that the pond had overtopped the dam crest in a few locations east of the culvert outlet, in days prior to the assessment date. The exact outlet location of the culvert could not be located, although seepage was evident at the base of the dam along a majority of its length. A return channel joins the main Patch Brook channel approximately 650 feet downstream of the intake location.

- Patch Brook reach M40T5.01
  Near the upper end of Segment D, a small bypass channel has been constructed historically to convey a portion of the flow from Patch Brook to a culvert under Dublin Road and into a constructed channel that flows somewhat parallel to Patch Brook, but on the far side of residential homes to the west of Dublin Road. This "canal", as it is known locally, returns to the Patch Brook approximately 3,000 feet downstream in Segment B. This diversion channel was constructed historically to support operations at Tyson Furnace (Scott, Stickney, & Pollard, 1859). (See Figure 9, Section 3.1.2).

Possible lasting impacts of these historic diversion channels on the present condition of these segments is difficult to predict and would be difficult to distinguish from the effects of more recent channel adjustments.

Loss of Wetlands / Agricultural Ditching

Channel-contiguous wetlands offer important flood attenuation functions in the river corridor, slowing the velocity of flows and thereby reducing erosion of the stream bed and banks. Over the last 200 or more years, wetland or hydric soils along the floodplains of Vermont rivers have commonly been converted to agricultural fields or to support residential land uses. Often, field drainage is improved by channelization of small tributaries or through installation of a network of constructed ditches or underground tiles. Conversion of channel-contiguous wetlands to agricultural uses and associated ditching can increase runoff volumes and velocities in the receiving river channel. In turn, those increased flows can exceed erosion thresholds in the channel bed and banks. This factor, along with periodic ditch maintenance, can result in increased sediment mobilization to the river.

Conversion of wetlands in the Patch and Buffalo Brook watersheds is not expected to be a significant watershed stressor. The aerial extent of mapped wetlands and hydric soils is minor in the study area.

Crop Lands – Exposed Soils

VTANR guidance (2007b) states that the area of cultivated lands draining to each reach can suggest the potential for land surface erosion and sediment mobilization to assessed reaches. Caution should be applied, as such an evaluation does not take into account the degree of hydrologic connection of the noted crop lands to the receiving waters. Nor does it adjust for potential erosion prevention measures or practices in place on the indicated crop lands. Further limitations of this methodology are related to the scale, accuracy, and currency of the land cover / land use data sets utilized to summarize the data: (*Landcover / Landuse for Vermont and Lake Champlain Basin (LandLandcov_LCLU, edition 2003). Source dates of 1991 to 1993. Available at: http://www.vcgi.org/metadata/LandLandcov_LCLU.htm.)*

Phase 1 stream geomorphic data (SMRC, 2007) indicate that crop land use in the upstream watersheds draining to assessed reaches of the Patch Brook and Buffalo Brook is negligible (less than 1%) and less than the threshold (5%) considered to be of significance in VTANR guidance (2007b).

4.1.2 Sediment Regime Stressors (Watershed and Reach Scale)

Sediment regime stressors for the assessed reaches are summarized in Table 3 (Watershed Level Stressors) and in Appendix F (Reach Level Stressors); they are discussed briefly in the following sections. The purpose of this section is to evaluate the "cumulative impact of erosion and subsequent deposition at the watershed scale" through review of reach-based features (VTANR 2007b). Features were compiled from a review of Phase 1 and Phase 2 Stream Geomorphic Assessment data and included:
(1) depositional bars / planform migration features; (2) bank erosion; (3) mass wasting sites; and (4) gully sites or rejuvenating tributaries.

Depositional bars and planform migration features

Select depositional and migration features are identified in VTANR guidance as indications of potentially enhanced sediment loading or a decreased sediment transport capacity of the river channel, or both. Features include steep riffles, mid-channel bars, delta bars, flood chutes, avulsions and channel braiding. Sediment contained in the depositional bars theoretically has its source from upstream, as well as in-reach, erosion. As sediment accumulates in the channel it can cause flow in the channel to diverge and create flood chutes or avulse into a different path altogether. Thus, multiple bars and lateral adjustments in a reach may indicate a reduction in sediment transport capacity and reflect the cumulative effects of erosion at the watershed scale.

Along the Patch Brook channel, three segments show a relatively high density of depositional and planform migration features:

- Segment M40T5.04-D where the channel transitions from upstream semi-confined sections of steeper gradient, to a lesser confinement and gradient.

- Segment M40T5.04-C where channel gradient continues to decrease (i.e., reduced sediment transport capacity) and which may be influenced by a flow diversion.

- Segment M40T5.04-B where the channel gradient continues to decrease on approach to a wetland-dominated downstream segment.

In the Buffalo Brook watershed, five segments show a relatively high density of depositional and planform migration features:

- Segment M41T6.02-B where the channel transitions to a slightly less-confined, and lower-gradient setting. Increased deposition and lateral adjustments in this segment may also be related to increased sediment production in upstream reaches of the Reading Pond Brook tributary.

- Segment M41T6.01-A where the valley gradient has decreased substantially at the base of Semi-confined, steeper-gradient reaches, on approach to the fixed base level of Echo Lake.
- Segment M41T6.02S1.02-B (Reading Pond Brook) which is a location of reduced valley gradient downstream of an actively incising segment (S1.02-A).
- Segments M41T6.02S1.01-B and S1.01-A (Reading Pond Brook) which are Semi-confined, steep-gradient reaches undergoing active lateral and vertical adjustments (including substantial mass wasting) in response to June 2006 flooding impacts.

Bank Erosion

Generally, excess stream bank erosion was not noted in most of the assessed reaches. Erosion resistance in the channel boundaries has been offered by coarse-grained bank sediments, occasional lateral bedrock grade controls, and forested buffers. Through the village area in the lower Patch Brook watershed, rip-rap or hard bank armoring features offer temporary stability to the banks. Erosion was of some significance along segments where planform adjustment and/or widening are the dominant adjustment processes; for example:

- Patch Brook segments M40T5.01-D, and -C;
- Reading Pond Brook segments M41T6.02S1.02-A, and S1.01-B which have been impacted by the sudden breaching of Reading Pond in June 2006; and
- Buffalo Brook segment M40T6.01-A in the Camp Plymouth State Park, where increased sedimentation since the June 2006 flood has lead to lateral adjustments.

Mass wasting and gully sites or rejuvenating tributaries

Several mass wasting sites and rejuvenating tributaries were identified on Reading Pond Brook segments M41T6.02S1.02-A, and S1.01-B which have been impacted by the sudden breaching of Reading Pond in June 2006 (See previous Figure 12).

4.1.3 Reach Scale Modifiers

Valley, floodplain and channel modifications to accommodate human infrastructure and land uses can alter the channel cross section, profile and position in the landscape. Natural features of the river network, such as bedrock grade controls or tributary confluences, also influence the hydraulic geometry of the river. These modifications and features can be categorized broadly into:

- changes in channel slope and channel depth, which influence the energy gradient (stream power) of the river and the capacity to transport sediment, and
- changes in the boundary conditions (channel bed, banks, and riparian vegetation) which influence the resistance to erosion.

The impacts of reach-scale modifiers on the hydraulic geometry of the channel are complex. The influence of multiple stressors may overlap within a reach. The following sections describe reach-scale modifications in more detail. Tables F-1 through F-3 (in Appendix F) present a summary of the reach-scale modifiers catalogued for the assessed reaches, together with the flow and sediment load modifications previously described.

Stream Power Modifiers

Channel Slope

Channel slope modifiers include stressors that lead to an ***increase*** in stream power, such as:

- channelization (straightening),
- floodplain encroachments (roads, berms, railroads),
- localized reduction of sediment supply below grade controls (bedrock, dams) or channel constrictions;

as well as stressors that can be expected to lead to a ***decrease*** in stream power, such as:

- a downstream grade control (dams, weirs),
- a downstream constriction (undersized bridge or culvert, bedrock constriction, armoring).

Channel Depth

Channel depth modifiers include stressors that lead to an ***increase*** in stream power, such as:

- dredging and berming,
- localized flow increases below stormwater and other outfalls;
- localized flow increases below constrictions (undersized bridge or culvert; armoring);

as well as stressors that can be expected to lead to a ***decrease*** in stream power, such as:

- gravel mining, bar scalping, where such activities result in overwidened conditions;
- localized increases of sediment supply occurring at tributary confluences and backwater areas, and impoundments behind beaver dams.

(VTANR guidance, 2007b)

A stressor imparting an increase in stream power may or may not lead to channel incising or widening. Effects are dependent on the magnitude of the stream power increase, the resistance to erosion offered by the unique set of boundary conditions, and whether there are other stressors acting on the reach that may decrease stream power, or lead to channel aggradation.

A stressor imparting a decrease in power may or may not lead to channel aggradation or planform adjustment. Effects are dependent on the magnitude of the stream power decrease, the degree of valley or infrastructure confinement of the channel, and whether there are other stressors acting on the reach that may increase stream power, or lead to channel incision.

Erosion Resistance Modifiers (Boundary Conditions / Riparian Vegetation)

The nature of sediments in the channel banks (e.g., grain sizes, cohesiveness) and the vegetative cover (e.g., type and density) or other "treatments" (e.g., rip-rap, gabion baskets, revetments, large woody debris) along the stream banks control the strength of the banks and their resistance to erosion. These boundary conditions in turn influence the degree and rate of channel widening or other lateral movement, thus influencing the ability of the river to adjust its cross-sectional dimensions to most effectively convey the water and sediment inputs to the channel. Boundary conditions also influence the nature and amounts of sediment available to be transported to downstream reaches.

Channel Bed

Channel bed modifications that lead to a ***decrease*** in erosion resistance include:

- snagging (removal of large woody debris),

- dredging, and
- windrowing.

Channel bed modifications that lead to an ***increase*** in erosion resistance include:

- grade controls (dams, weirs, channel-spanning bedrock), and
- bed armoring.

Streambank and Near-bank Riparian Area

Bank and riparian modifications that lead to a ***decrease*** in erosion resistance include:
- removal of vegetation.

Bank and riparian modifications that lead to an ***increase*** in erosion resistance include:
- bank armoring (rip-rap, gabion baskets, revetments, large woody debris).

(VTANR guidance, 2007b)

It is important to note that enhanced erosion resistance offered by the boundary conditions in one location along a river network may translate into increased stream power at a downstream site. For example, it is very common to observe streambank erosion beginning at the downstream end of a length of channel armoring, or bed scour downstream from a bedrock grade control or dam site.

4.1.4 Sediment Regime Departure, Constraints to Sediment Transport & Attenuation

Within a given reach, the watershed-level and reach-level flow and sediment load modifications, combined with the reach-scale modifiers of stream power and boundary resistance, together govern adjustments in the channel dimensions, profile and planform over time. These lateral and vertical adjustments, in turn, influence how the river channel transports its sediment and water inputs.

The **Departure Analysis Tables** (Tables G-1 through G-3) in Appendix G summarize the apparent status of the assessed reaches as either transport- or attenuation-dominated. These tables also indicate the natural constraints (e.g., bedrock) and human constraints (e.g., roads, development, land uses) to channel adjustment that are, in part, influencing the current transport or attenuation status.

Bedrock-controlled reaches are natural transport-dominated reaches, due to the erosion resistance offered by the bedrock and the steepness of gradient that is typical for reaches of this type. It is likely that the sediment entering these channel segments is balanced by the sediment carried out of the reach (steady-state, dynamic equilibrium conditions). Three of the assessed channel segments were classified as bedrock channels (M41T6.06, M41T6.05-B and M41T6.02-A). Generally, bedrock gorges were not prioritized for assessment, but are recognized for their role as bedrock grade controls and points of fixed elevation in the overall river network (over recent history).

Nine other assessed reaches/segments were identified as natural transport-dominated reaches/segments, although bedrock exposures in the bed and banks were not prevalent. Close positioning of bedrock-controlled, steep valley walls along these reaches results in a Semi-confined status and governs the transport-dominated condition (M40T5.04-E, M40T5.03S1.01, M40T5.03-B, M40T5.02-A in the Patch Brook watershed; M41T6.05-A, M41T6.04, M41T6.02S1.02-A, M41T6.02S1.01-B, and M41T6.02S1.01-A in the Buffalo Brook watershed).

Three segments are located in unconfined, low- to moderate-gradient (<2%) valley settings, and contain few or no channel-spanning exposures of bedrock (M40T5.04-B, M40, and M41T6.01-A). Under dynamic equilibrium conditions these (reference C stream type) segments might be expected to deposit fine sediments in their floodplains through periodic bankfull and flood-stage flows, and balance the transport of coarser sediments (bed load), such that the bedload volumes entering the reach would be similar to bedload volumes leaving the reach averaged over a one- to two-year period.

The remaining fourteen segments are transitional between upstream bedrock-controlled, confined channels and downstream, lower-gradient, unconfined settings. They are generally unconfined by valley walls, but have moderate to steep slopes (2.2% to 5.1%) - reference Ca or Cb stream types. Due to the relaxed valley confinement, these fourteen segments are expected to represent locations of increased lateral migration. Depending on the gradient these fourteen segments are expected to represent locations of decreased sediment transport capacity (to varying degrees) and to be natural attenuation-dominated segments. Six segments have been classified as "alluvial fans" by VTANR protocols (although surficial geologic mapping to confirm this classification is beyond the scope of a Phase 2 geomorphic assessment). Segments M40T5.03-A, M40T5.01-B, and M40T5.01-A in the Patch Brook watershed and M41T6.03, M41T6.01-B, and M41T6.01-A in the Buffalo Brook watershed are identified as "alluvial fans" to highlight their expected function as natural depositional zones prone to enhanced lateral channel adjustments. Sediment deposition in these locations was probably much more active in earlier post-glacial environments (1,000s of years before present), under more intense hydrologic and sediment regimes, just after glaciation and prior to vegetation of the landscape. These locations may also have seen renewed sedimentation and lateral adjustments during widespread deforestation of upland slopes in the 1800s (Bierman *et al*, 1997).

Several of the unconfined segments have been converted from depositional or equilibrium conditions to transport-dominated conditions by virtue of various channel and watershed disturbances (Tables F-1 through F-3, Appendix F). Equilibrium transport of coarse sediment fractions that might be expected in these unconfined valley settings has been compromised substantially, and these segments have been converted to a transport-dominated condition as a result of:

- channelization, removal of meanders;
- dredging, windrowing (especially following the 1927, 1936/38, and 1973 floods);
- historic incision and the resultant decrease in degree of floodplain connection;
- floodplain encroachments (berming; roads); and
- corridor development (residential, commercial, municipal – particularly in the historic village area of Tyson Furnace).

Only a few segments in the Patch Brook watershed (and none in the Buffalo Brook watershed) have reasonable or partial access to the floodplain (IR < 1.4), and (where presently unconstrained by human-constructed features) may represent key attenuation assets:

- M40T5.04-D, M40T5.04-B, and M40T5.01-C in the Patch Brook.

The current geomorphic condition of these reaches/segments, as modified by human factors, is summarized in the following Sediment Regime Departure Maps in Figures 17 and 18. These classifications are based on guidance contained in the VTANR River Corridor Planning Guide (2007).

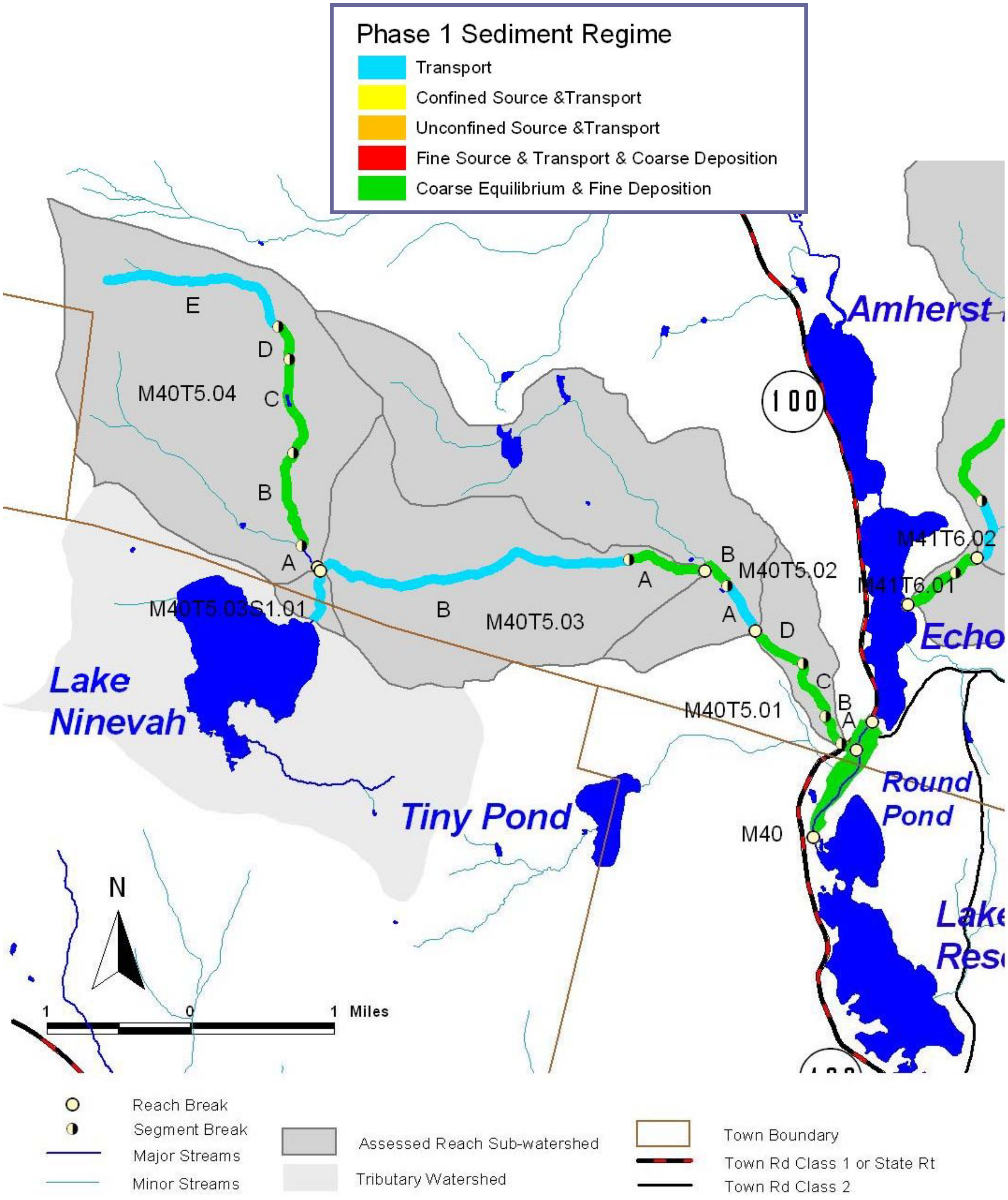


Figure 17-a. Phase 1 (Reference) Sediment Regime Map
Assessed Reaches of the Patch Brook & Black River main stem.

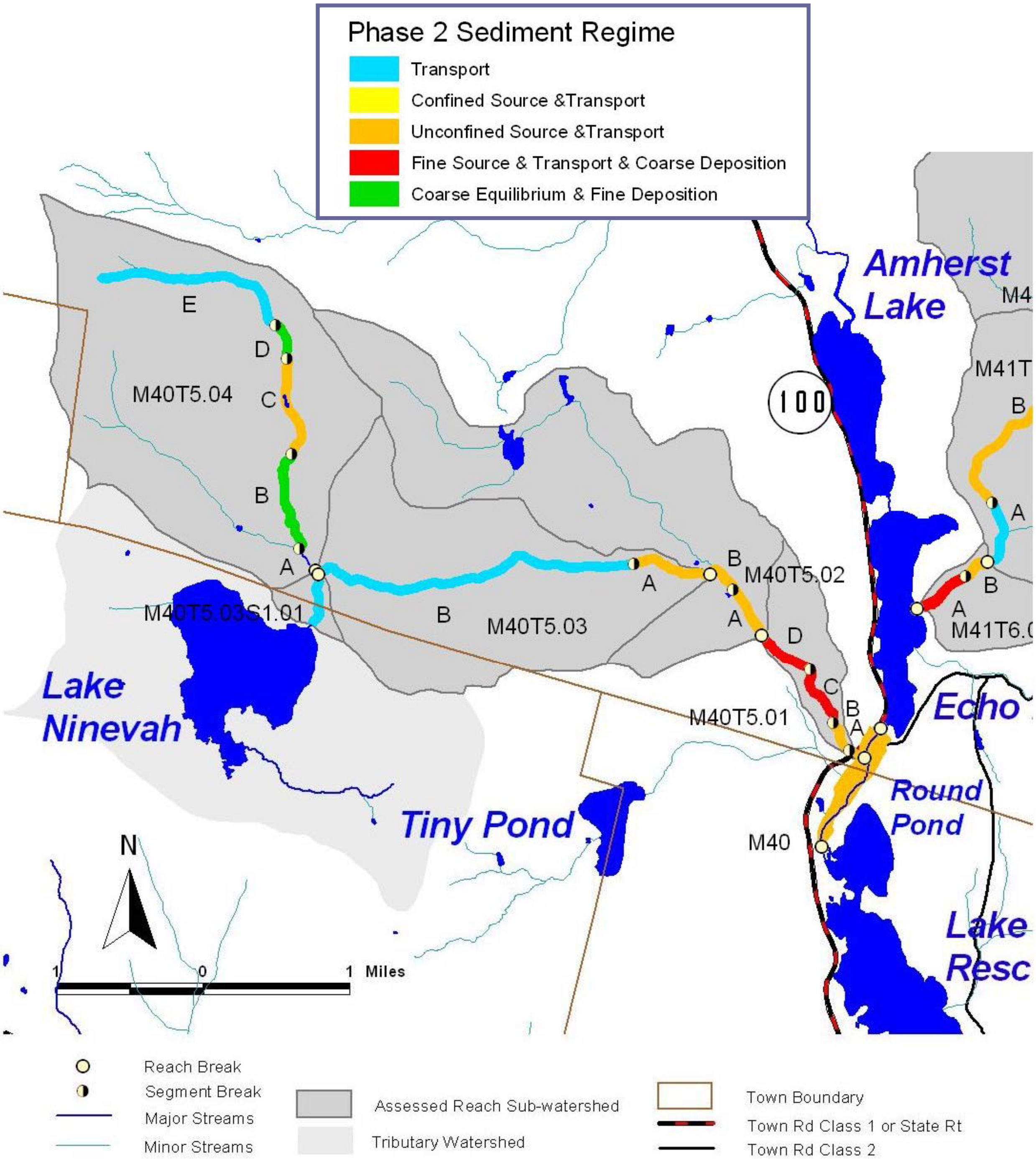


Figure 17-b. Phase 2 (Existing) Sediment Regime Map
Assessed Reaches of the Patch Brook & Black River main stem.

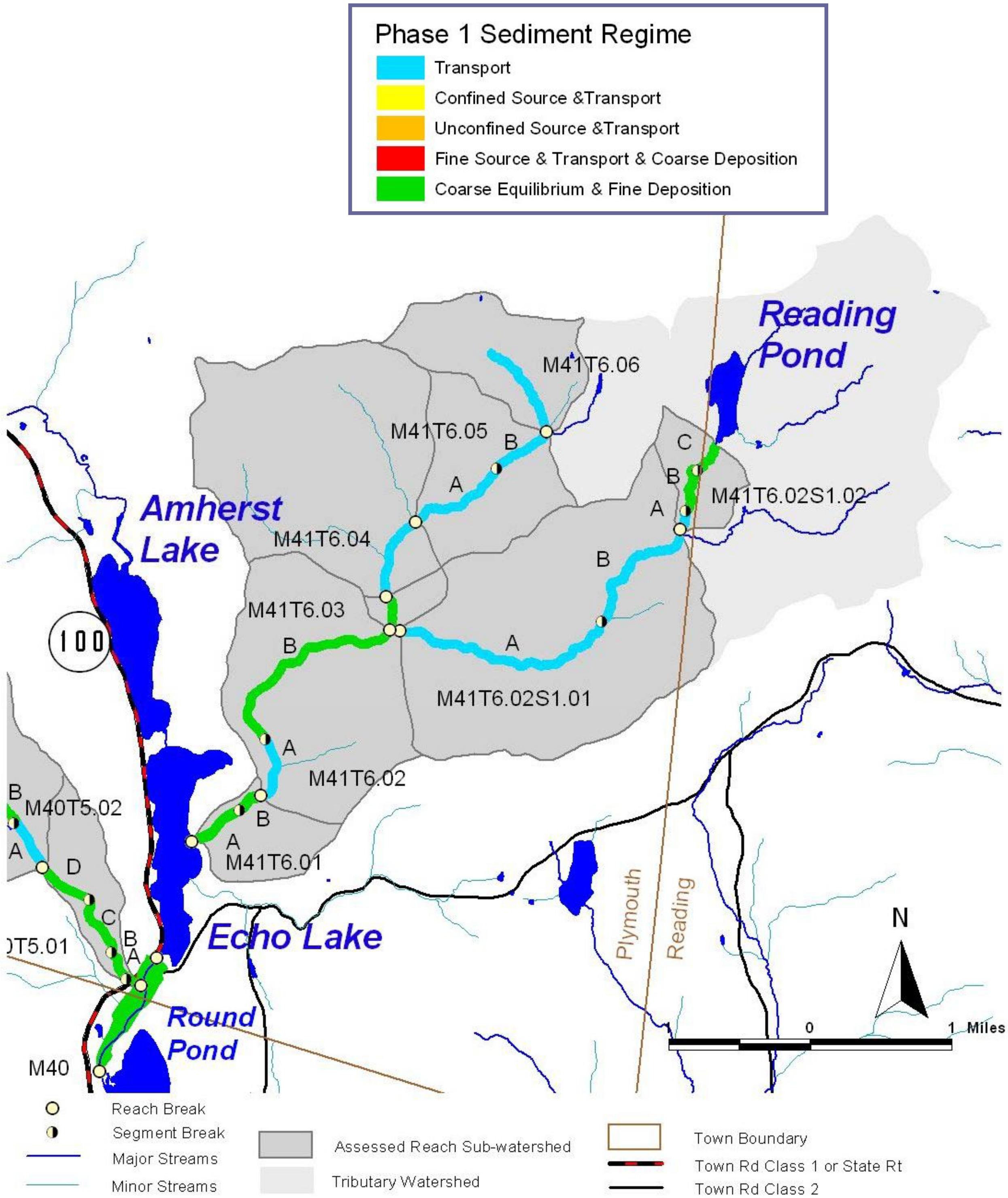


Figure 18-a. Phase 1 (Reference) Sediment Regime Map
Assessed Reaches of the Buffalo Brook and Reading Pond Brook.

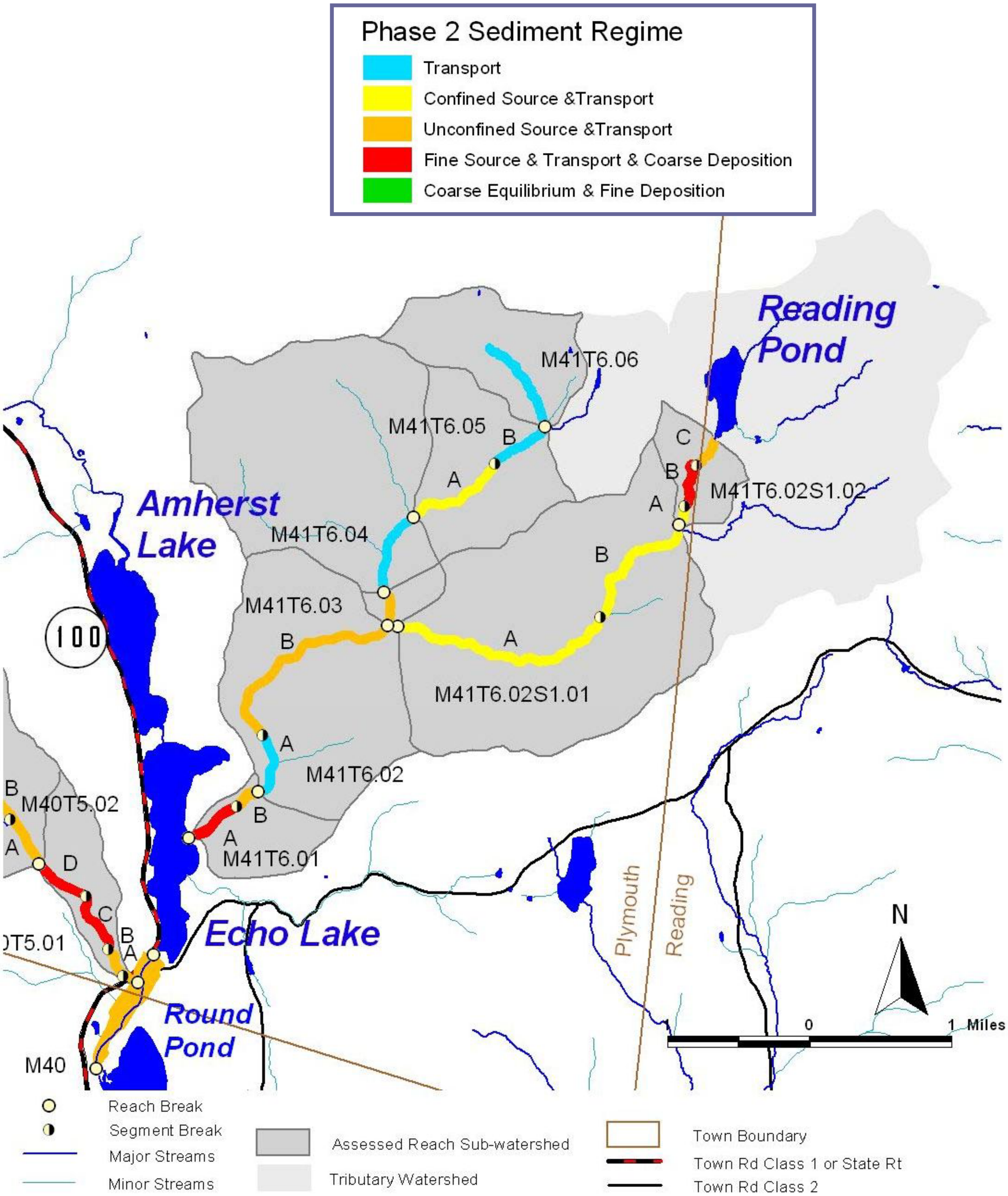


Figure 18-b. Phase 2 (Existing) Sediment Regime Map
Assessed Reaches of the Buffalo Brook and Reading Pond Brook.

Phase 1 (Reference) Sediment Regime

Figures 17-a and 18-a display the ***reference*** sediment regimes that are theorized to be characteristic of the assessed reaches of Patch Brook and Buffalo Brook (respectively) prior to widespread human disturbance of the watershed (approximately, 300 years before present)

Transport (coded blue in figures)
Bedrock-controlled segments have been assigned a *Transport* classification for the reference (Phase 1) sediment regime.

Tributary	Reach/Segment	Phase 1 Reference Stream Type
Buffalo Brook	M41T6.06	B1a-cascade
Buffalo Brook	M41T6.05-B	A1-cascade
Buffalo Brook	M41T6.02-A	B1-step/pool

Nine additional segments, while not characterized by fully-exposed bedrock in the channel bed and banks, are confined by steep, bedrock-controlled valley walls. The natural steepness of the channel gradient and close valley confinement results in a somewhat linear planform with limited available floodplain or meanders for storage of sediment. Also, the erosion resistance offered by the occasional exposures of bedrock in the channel boundaries, as well as forested buffers, means that these channels would not be a significant source of coarse and fine sediments. Therefore, these reaches were also classified with a *Transport* reference sediment regime.

Tributary	Reach/Segment	Phase 1 Reference Stream Type
Patch Brook	M40T5.04-E	B4a-cascade
Lake Ninevah outlet	M40T5.03S1.01	B3-step/pool
Patch Brook	M40T5.03-B	B3a-step/pool
Patch Brook	M40T5.02-A	B4-step/pool
Buffalo Brook	M41T6.05-A	B4a-step/pool
Buffalo Brook	M41T6.04	B3-step/pool
Reading Pond Brook	M41T6.02S1.02-A	B3-step/pool
Reading Pond Brook	M41T6.02S1.01-B	B3a-step/pool
Reading Pond Brook	M41T6.02S1.01-A	B4a-step/pool

Coarse Equilibrium & Fine Deposition (coded green in figures)
Between these bedrock and transport reaches, the Patch Brook, Buffalo Brook and Reading Pond Brook tributary channels are less confined by the valley walls, and have a generally lesser gradient. Pockets of floodplain are available to most of these segments – either as terraces within Narrow to Semi-confined valley walls – or (in the case of M41T6.01 and M40T5.01 and M41T6.03) as a broader floodplain surface at an alluvial-fan-like setting. Theoretically, in a pre-disturbed condition, these channels would be connected to their surrounding floodplains. Fine sediments would be deposited through periodic overbank flows, and the transport of coarser sediments (bed load) would be balanced, such that the bedload volumes entering the reach would be similar to bedload volumes leaving the reach averaged over a one- to two-year period.

Phase 2 (Existing) Sediment Regime

Figures 17-b and 18-b display the ***existing*** sediment regimes that are hypothesized based on Phase 2 assessment results and the departure analysis previously described. The contrast in coding of the reaches between the Phase 1 (Reference) Sediment Regime figures and these Phase 2 (Existing) Sediment Regime figures illustrates the degree of departure from reference that is inferred.

Transport (coded blue in figures)

The bedrock-channel segments and some of the semi-confined segments of the Patch Brook and Buffalo Brook tributaries have not undergone significant lateral or vertical adjustments in response to channel and watershed disturbances, given the stability offered by the underlying bedrock and resistant boundary conditions. Thus, a *Transport* classification has been assigned for the Phase 2 (Existing) sediment regime of these segments, and they have not undergone a sediment regime departure.

Tributary	Reach/Segment	Phase 1 Reference Stream Type	Phase 2 Reference Stream Type
Patch Brook	M40T5.04-E	B4a-cascade	B4a-cascade
Lake Ninevah outlet	M40T5.03S1.01	B3-step/pool	B3-step/pool
Patch Brook	M40T5.03-B	B3a-step/pool	B3a-step/pool
Buffalo Brook	M41T6.06	B1a-cascade	B1a-cascade
Buffalo Brook	M41T6.05-B	A1-cascade	A1-cascade
Buffalo Brook	M41T6.04	B3-step/pool	B3-step/pool
Buffalo Brook	M41T6.02-A	B1-step/pool	B1-step/pool

Coarse Equilibrium & Fine Deposition (coded green in figures)

Based on Phase 2 assessments, a subset of the reaches/ segments appear not to have undergone a significant sediment regime departure (listed below). A minimal degree of net lateral and vertical adjustment in response to channel and watershed disturbances is apparent in these reaches/ segments. These reaches/segments have not undergone a vertical stream type departure and have maintained good floodplain access (IR < 1.2). Therefore, a *Coarse Equilibrium & Fine Deposition* classification has been assigned for the Phase 2 (Existing) sediment regime.

Tributary	Reach/Segment	Phase 1 Reference Stream Type	Phase 2 Reference Stream Type
Patch Brook	M40T5.04-D	C4a-riffle/pool	C4a-riffle/pool
Patch Brook	M40T5.04-B	C4-riffle/pool	C4-riffle/pool

In some cases, this inferred dynamic-equilibrium condition is associated with a relative lack of channel or watershed stressors. In other cases, the equilibrium condition exists despite the presence of channel and watershed disturbances, suggesting that boundary conditions offer sufficient resistance to stressors and/or stressors are low in magnitude or extent.

A minor (or localized) increase in sediment attenuation is sometimes evident in these segments, as a result of downstream grade controls or valley pinch points (and associated decrease in valley gradient), or as a result of downstream human-made constrictions such as bridge or culvert crossings. These segments were identified as sediment attenuation assets (see Section 4.1.4 and Appendix G). The presence of occasional mid-channel or diagonal bars suggests that limited storage of coarser sediment fractions is occurring within the bankfull channel (sometimes at the expense of pool depths and riffle/pool diversity). However, such attenuation is not substantial enough to have resulted in dis-equilibrium conditions or a sediment regime departure.

On the other hand, a degree of sediment regime departure is theorized for the remaining assessed segments of Patch Brook and Buffalo Brook tributaries:

Confined Source & Transport (coded yellow in figures)
Four (4) of the assessed segments are classified in this category (listed below). Each were inferred to have undergone a sediment regime departure from *Transport* category to *Confined Source & Transport* by virtue of a moderate to severe degree of channel incision (IR_{RAF} values ranging from 1.5 to 2.2). For two of the four segments, incision has lead to a vertical stream type departure (highlighted in yellow, below).

In the case of the Buffalo Brook segment (M41T6.05-A), incision is regarded as historic and may be related to historic logging activities and/or gold placer mining in the watershed. Along the Reading Pond Brook segments, there is evidence of both active and historic incision. Active incision is likely related to the flood of June 2006 and the sudden breaching of the Reading Pond dam. Whereas, historic incision is probably related to a history of gold placer mining which involved direct manipulation of the channel and close floodplain including gravel mining, earthen dams, short channel diversions, and selective removal of larger boulders/cobbles. It is likely that there is some degree of postglacial incision recorded in the moderate-height terraces along the channel floodplain. Surficial geologic studies to ascertain the origin, age and composition of the stream terraces was beyond the scope of this stream geomorphic assessment.

Tributary	Reach/Segment	Phase 1 Reference Stream Type	Phase 2 Reference Stream Type
Buffalo Brook	M41T6.05-A	B4a-step/pool	B4a-step/pool
Reading Pond Brook	M41T6.02S1.02-A	B3-step/pool	F3b-step/pool
Reading Pond Brook	M41T6.02S1.01-B	B3a-step/pool	B3a-step/pool
Reading Pond Brook	M41T6.02S1.01-A	B4a-step/pool	F4a-plane bed

Unconfined Source & Transport (coded orange in figures)
Eleven (11) of the assessed reaches/segments are classified in this category (listed below). Due to the vertical stream type departure (C-to-F or Ca-to-Fa or Cb-to-Fb) of eight segments and loss of floodplain connection (IR_{RAF} values ranging from 1.5 to 4.2) in all eleven segments, these channels have been converted from a deposition-dominated condition to a transport-dominated condition. They are inferred to have persisted in channel evolution stage II [F] or early III [F] following historic degradation often associated with channelization, windrowing, gravel mining, armoring, and/or berming. Following flood episodes, select segments have been managed (through continued channelization and berming) to maintain a transport-dominated function. Presence of historic dams along the Patch Brook and Buffalo Brook tributaries may also have contributed to historic degradation – either through "hungry water" effects downstream of the dam sites or as a result of dam-breaching effects upstream of the dam sites, or both.

Plane-bed and weak step/pool morphologies dominate these segments. Both fine and coarse sediment fractions are exported through the segments due to the minimal available floodplain and enhanced velocities of the incised and entrenched cross section. In various cases, extensive bank armoring, maintenance of tree buffers, cohesive sediments in the channel boundaries, and lateral exposures of bedrock provide erosion resistance which has moderated the degree of lateral and vertical adjustments. Width/depth ratios are generally low (14.0 to 33.7). The existing sediment regime for these segments has been classified as *Unconfined Source & Transport.*

Tributary	Reach/Segment	Phase 1 Reference Stream Type	Phase 2 Reference Stream Type
Patch Brook	M40T5.04-C	C4b-step/pool	C4b-step/pool
Patch Brook	M40T5.03-A	C3a-step/pool	F3a-plane bed
Patch Brook	M40T5.02-B	C3b-step/pool	F3b-plane bed
Patch Brook	M40T5.02-A	B4-step/pool	B4-plane bed
Patch Brook	M40T5.01-B	C3b-step/pool	F3b-plane bed
Patch Brook	M40T5.01-A	C3b-riffle/pool	C3b-step/pool
Black River main stem	M40	C3-riffle/pool	C3-plane bed
Buffalo Brook	M41T6.03	C4b-step/pool	F4b-plane bed
Buffalo Brook	M41T6.02-B	C3b-step/pool	F4b-plane bed
Buffalo Brook	M41T6.01-B	C3b-riffle/pool	C3b-plane bed
Reading Pond Brook	M41T6.02S1.02-C	C4b-riffle/pool	F4b-plane bed

Fine Source & Transport / Coarse Deposition (coded red in figures)

Four of the assessed segments of Patch Brook and Buffalo Brook tributaries were classified in this category. These segments are moderately to substantially incised (IR_{RAF} values ranging from 1.4 to 2.8). Two of these four segments have undergone a vertical stream type departure (C-to-F or Cb-to-Fb). This sediment regime category includes segments classified in stage III [F] or IV [F] of channel evolution. Like the other incised and entrenched segments, these segments have experienced increased velocities of bankfull and flood-stage flows, with enhanced scour energies, and have been converted to a transport-dominated condition by virtue of the reduced frequency of overbank flooding. However, these segments are generally more prone to lateral adjustments, given: (1) the relative lack of armoring, extensive berms or encroachments, and (2) the presence of more erodible sediments in the channel boundaries. Historic and active widening and planform adjustments (flood chutes, bifurcations, meander extension) have begun to create narrow, discontinuous pockets of floodplain at an elevation below the recently abandoned floodplain in some segments. Well-developed tree buffers are frequently present along both banks of these segments and provide some measure of erosion resistance. On the other hand, historic recruitment of trees and debris jams probably contributed to the formation of flood chutes, bifurcations, and localized meander development. A low to moderate degree of coarse sediment deposition is occurring, leading to a locally shallow and overwidened bankfull cross section with little pool definition. A weak riffle/pool bedform has developed, characterized by diagonal riffles and a secondary, low-flow sinuosity. Generally, width/depth ratios of these segments are slightly greater than their *Unconfined Source & Transport* counterparts (ranging from 20 to 48). In-segment and upstream erosion is contributing to coarse sediment deposition within these segments, particularly at sharp bends or upstream of constrictions (bridge and culvert crossings, debris jams). Thus, these segments have been converted from a *Coarse Equilibrium* condition to *Coarse Deposition*.

Tributary	Reach/Segment	Phase 1 Reference Stream Type	Phase 2 Reference Stream Type
Patch Brook	M40T5.01-D	C3b-step/pool	F3b-plane bed
Patch Brook	M40T5.01-C	C3b-step/pool	C3b-plane bed
Buffalo Brook	M41T6.01-A	C4-riffle/pool	F4-riffle/pool
Reading Pond Brook	M41T6.02S1.02-B	C4b-riffle/pool	C4b-riffle/pool

4.2 Sensitivity Analysis

The sensitivity classification is intended to identify "the degree or likelihood that vertical and lateral adjustments (erosion) will occur, as driven by natural and/or human-induced fluvial processes" (VTANR 2007b). Inherent in the stream sensitivity rating are:

- the natural sensitivity of the reach given the topographic setting (confinement, gradient) and geologic boundary conditions (sediment sizes) – as reflected in the reference stream type classification (after Rosgen, 1996 and Montgomery & Buffington, 1997); and

- the enhanced sensitivity of the reach given by the degree of departure from reference (or dynamic equilibrium) condition – as reflected in the existing stream type classification and the condition (Reference, Good, Fair to Poor ratings in the Rapid Geomorphic Assessment).

The sensitivity classification is intended to identify "the degree or likelihood that vertical and lateral adjustments (erosion) will occur, as driven by natural and/or human-induced fluvial processes" (VTANR 2007b).

Figure 19 and 20, respectively, illustrate the sensitivity classifications assigned to Patch Brook and Buffalo Brook reaches. These stream sensitivity data were utilized during subsequent planning steps to inform the identification and prioritization of restoration and protection projects and practices (Section 5).

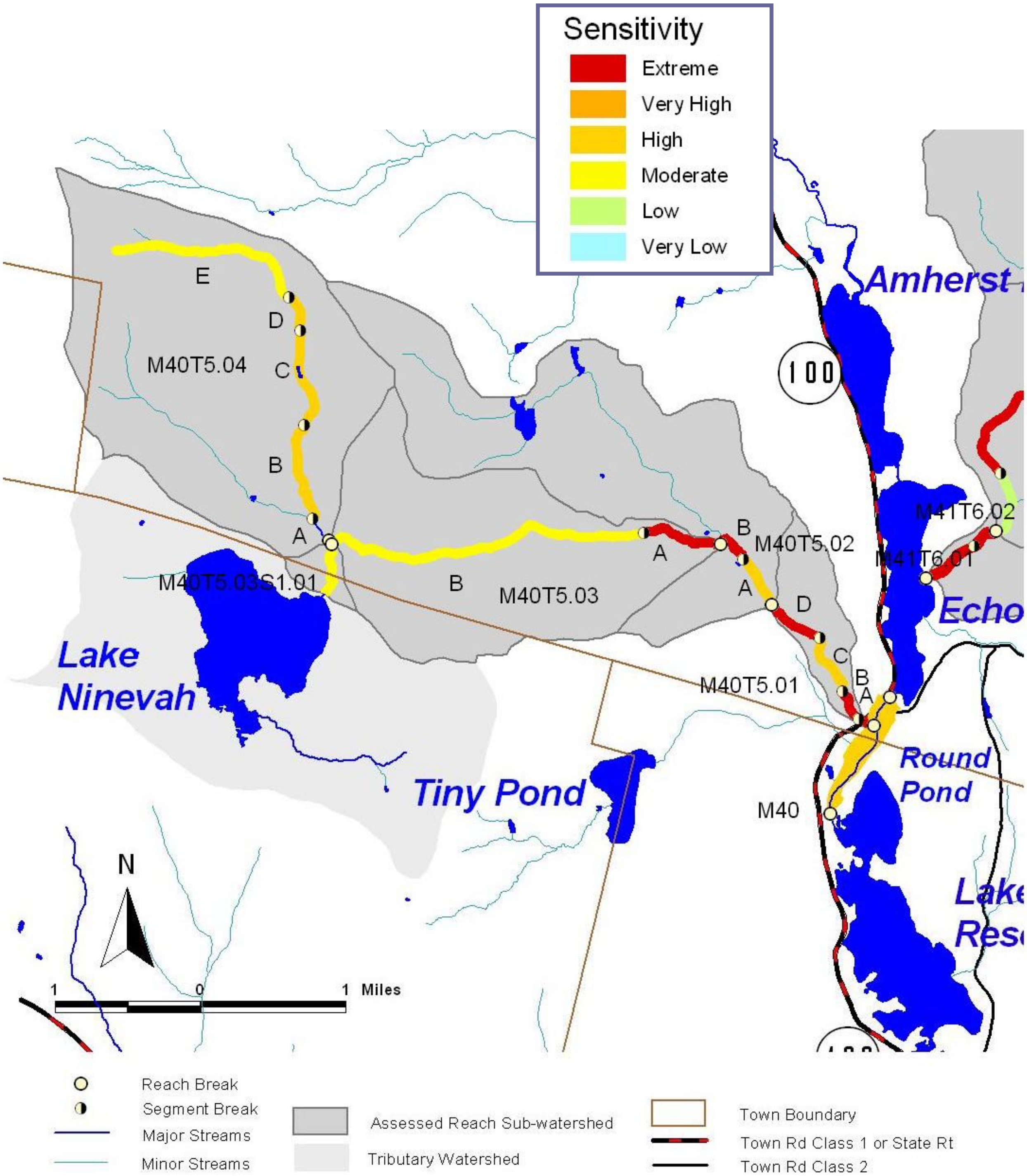


Figure 19. Stream Sensitivity Map
Assessed Reaches of the Patch Brook and Black River Main Stem.

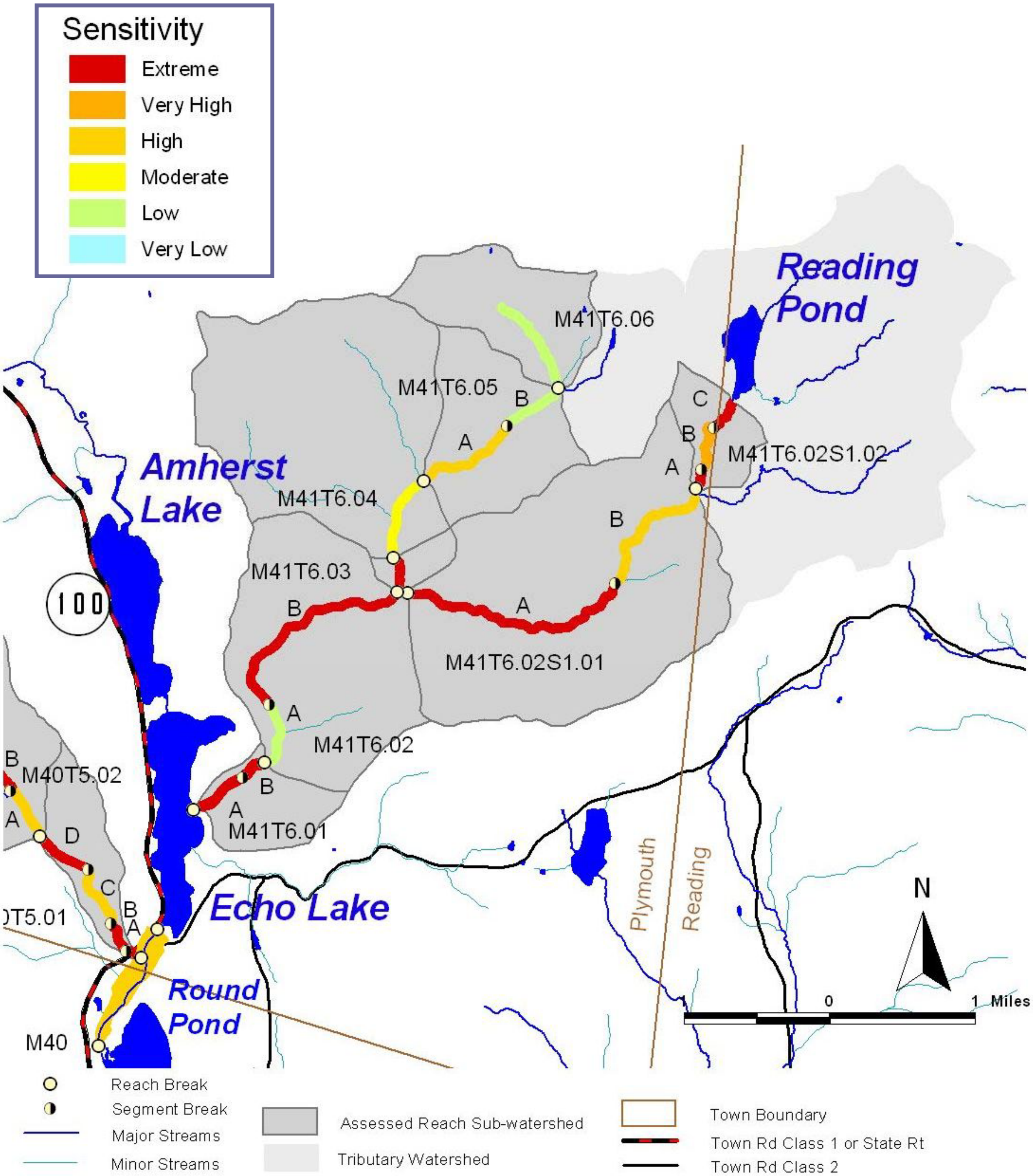


Figure 20. Stream Sensitivity Map
Assessed Reaches of the Buffalo Brook & Reading Pond Brook.

5.0 PRELIMINARY PROJECT IDENTIFICATION (Reach & Corridor Scale)

A listing of preliminary projects and practices for the Patch Brook and Buffalo Brook watersheds has been developed, following the *Step-Wise Procedure for Identifying Technically Feasible River Corridor Restoration and Protection Projects* included in VTANR guidance (2007b).

The preliminary identification and prioritization of corridor restoration and protection projects outlined below has been informed by:

- stream sensitivity data;
- qualitative observations of sediment transport and attenuation characteristics; and
- preliminary departure analysis contained in Section 4.

Each category of restoration and conservation strategies identified in VTANR guidance (2007b) is discussed in Sections 5.1 through 5.8. An additional category (mitigating point sources of stormwater and sediment loading) is presented in Section 5.9.

For a more detailed background explanation on the purpose and need for various restoration and conservation strategies, the reader is referred to the companion report to which this report is an addendum (Section 5 of the July 2009 *Phase 2 Stream Geomorphic Assessment of the Black River Watershed*). Section 7 of the Black River report also provides important recommendations for watershed strategies to support passive restoration, reduce sedimentation and avoid fluvial erosion hazards – that are applicable to the Patch Brook and Buffalo Brook watersheds.

The work scope for this Phase 2 assessment has not included public outreach or analysis to determine the technical, financial and social feasibility of these listed project opportunities. Instead, this listing will form the basis for future project development and implementation efforts in the context of watershed, community, and corridor planning projects. A few of these projects (e.g., buffer plantings) can be considered for immediate implementation, independent of other watershed projects, and will require only minimal feasibility analysis and project development activities. Other identified projects may require further evaluation and efforts to perform alternatives analyses, conduct landowner outreach and negotiations, and identify potential stakeholders and funding sources.

5.1 Protecting River Corridors

River corridor protection is recommended as a high priority along the following reaches:

In the Patch Brook watershed:

- Segments M40T5.03-A, M40T5.02-B and M40T5.01-A where reduced valley confinement (entrenchment) and gradient make these locations particularly prone to lateral adjustments.

- Segments M40T5.01-D, and –C to support ongoing lateral adjustments that are building floodplain capacity to attenuate future flows and sediment upstream of the village area of Tyson Furnace – and where there is the potential for increased residential or commercial development.

In the Buffalo Brook watershed:

- Segment M41T6.01-B, where reduced valley confinement and gradient make this location particularly prone to lateral adjustments and potential catastrophic erosion in a future flood.

5.2 Planting Stream Buffers

Forested buffers are present along a majority of the reaches, even where narrower than optimal due to close encroachment of a road or occasional residential land use. Thus, restoration of stream buffers is not a high-priority practice recommended at this time for the Patch Brook or Buffalo Brook reaches.

5.3 Stabilizing Stream Banks

Streambank stabilization can be considered in "laterally-unstable, [but vertically stable] reaches where human-placed structures are at high risk and not taking action may result in increased risk of erosion, to not only the structure, but lands that would provide the opportunity to establish a buffer" (VTANR, 2007b). Any bank stabilization project should be considered in the broader context (both in time and space) for the channel adjustment processes such management will set in motion and for the consequences to upstream and downstream reaches.

No bank stabilization projects have been identified as a high priority along the assessed reaches at this time. The few study reaches that are vertically stable and have good floodplain access are located in remote settings with relatively limited encroachments (and little potential for future development – i.e., state forest land). It is important to allow lateral adjustments to proceed unconstrained in these reaches in order to support passive channel restoration and a return toward dynamic equilibrium that will result in greater channel stability and reduced sediment production over the long term.

5.4 Arresting Head Cuts and Nick Points

Possible head cuts and rejuvenating tributaries were identified in segments of the Reading Pond Brook (M41T6.02S1.01-B and M41T6.02S1.02-A), as well as in the upper end of reach M41T6.02S1.02 in Segment C (just downstream of the breached dam at Reading Pond). Active incision in these segments is likely related to the June 2006 sudden breaching of the upstream dam at Reading Pond.

Segment M41T6.02S1.01-B contains channel-spanning exposures of bedrock that may serve to limit headward migration of incision. The Reading Pond Road culvert crossing at the upstream end of this segment may be at risk in the unlikely event that incisional processes continue to work headward in this reach.

Given the valley setting and adjustment processes within and upstream of the segments in question, it is expected that these headcuts will stabilize within a short upstream distance. Colluvial and mass wasting processes are actively contributing coarse sediments and woody debris to the channel to offset the localized incision that is occurring. For these reasons, no active restoration projects are recommended at this time to arrest head cuts within these segments. The Reading Pond Road culvert should continue to be monitored for signs of nearby incisional processes that may result in undermining of this structure.

5.5 Removing Berms / Other Constraints to Flood & Sediment Load Attenuation

Removing berms or other constraints to the full meander expression and floodplain connection of a river channel may accelerate a return to dynamic equilibrium in the channel, and reduce impacts to downstream segments, by creating more opportunities for sediment and flow attenuation along the corridor. Further study is necessary to evaluate the feasibility of various active geomorphic and engineering techniques to remove constraints. The benefits of such projects need to be evaluated in light of the costs and potential short-term consequences in terms of sediment and nutrient mobilization, and risk to infrastructure and public safety.

While berms were noted along portions of one or both banks of several study reaches, berm removal was considered a low to moderate priority in each case (following VTANR guidance) due to the fact that:

- the channel was already incised below the floodplain (IR_{RAF} greater than 1.5) such that berm removal alone would not result in greater floodplain access except in infrequent, flooding events. For example:
    - Left-bank (LB) berms along Patch Brook downstream of the Patch Brook Road / Dublin Road intersection;
    - LB berm along Patch Brook downstream of the upper Dublin Road bridge crossing;
    - LB berm along Buffalo Brook in segment M41T6.01-B just upstream of the Scout Camp Road crossing;
    - LB berm along lower end of Black River main stem reach M40.
- residential (State Park) infrastructure was present close to the channel and would be placed at greater risk of flooding if the berm were removed (e.g., RB berm along Buffalo Brook in segment M41T6.01-B);
- the noted berm(s) was very short in length and/or was associated with nearby valley fill for a bridge crossing that was likely to be maintained (e.g., LB berm on the upstream side of the lower Dublin Road bridge crossing of Patch Brook, M40T5.01-B, just upstream from the Echo Lake Inn); and/or
- the noted berm(s) had well-established mature tree or shrub buffers which – if removed – would degrade habitats or result in significant disruption of the corridor lands (true of each of the above-listed berms).

One RB berm along Patch Brook segment M40T5.01-A just above the confluence with Black River reach M40 is of relatively recent construction (no well-established trees). The channel has moderate access to the adjacent flood plain, such that berm removal might permit some flow attenuation and sediment accumulation on adjacent lands. This same location might also serve as a flow and fine-sediment attenuation location for the Black River main stem.

Further evaluation would be required to understand the potential costs and benefits of a berm removal project in this location, as well as to ascertain the degree of landowner support. Ideally, sediment and flow attenuation should occur further upstream in the watershed, closer to the source of sediments. Given the topography, geology, and history of channel management in upstream reaches, however, opportunities for upstream sediment attenuation are quite limited.

5.6 Removing / Replacing Structures

Human-placed structures which span and "constrain the vertical and lateral movement of the channel and/or result in a significant constriction of the floodplain" can be considered for removal or replacement to support dynamic equilibrium of the channel (VTANR, 2007b)". In the study reaches, constraining structures include bridges and culverts (section 5.6.1), and old dam abutments (section 5.6.2).

5.6.1 Bridge and Culvert Crossings

A total of 15 bridge and culvert crossings were encountered on the assessed reaches: 12 bridges and 3 instream culverts. Thirteen structures (including the 3 culverts) supported public road or logging road crossings. Two structures (both bridges) supported a trail or footpath crossings. The status of each bridge and culvert as either a bankfull- or flood-prone-width constrictor is summarized in Step 4.8 of the Phase 2 reach reports (Appendix A) and in the Bridge & Culvert Assessment reports (Appendix B). Thirteen of the 15 crossings were bankfull-constricting structures.

Table 5 below presents a listing of the 15 bridges and culverts, along with an indication of relative priority for replacement. Priority is suggested without regard to technical feasibility, social feasibility, or cost; rather the priority is based on the geomorphic and habitat condition of the given reach or segment, and its relationship to (and potential impact on) the crossing structure. They are listed as priorities for replacement: (1) since the span of these structures is less than 50% of the reference (or measured) bankfull channel width; and/or (2) due to conditions that suggest localized channel instability that has the potential to impact the stability of the crossing structure itself (e.g., sharp approach angle, scour undermining the abutments, sediment obstructing the inlet, scour pool developing at the outlet); and/or (3) due to conditions (e.g., perched culvert) impacting fish passage and continuity of aquatic habitats.

5.6.2 Other constrictions

Other constrictions encountered in the Patch and Buffalo Brook watersheds included remnants of three breached dams: at the upper end of Patch Brook segment M40T5.03-B; at the downstream end of Patch Brook segment M40T5.02-A and at the upstream end of Reading Pond Brook segment M41T6.02S1.02-C. Each of these abutments (as a result of breaching events) is no longer a significant constrictor of the bankfull width. Therefore, they are not recommended for removal at this time.

5.7 Restoring Incised Reaches

Further study can evaluate the feasibility of various active geomorphic and engineering techniques to restore historically-incised reaches, accelerate a return to dynamic equilibrium of the channel, and reduce impacts to downstream segments, by creating more opportunities for sediment and flow attenuation along the corridor.

A majority of the study reaches are historically (and post-glacially) incised and many have undergone a vertical stream type departure, losing access to the surrounding floodplain. Generally, historic incision on the lower reaches of the Patch Brook is inferred to have been caused by a long history of channelization/ dredging/ berming/ armoring in response to past flood events, as well as historical operation of dams and diversion channels. In the Tyson Furnace village area, development and encroachments have contributed to the incised and entrenched status of the channel. None of the Patch Brook study reaches/segments was noted as having undergone active or recently-occurring incision.

In the Buffalo Brook watershed, there is a degree of active incision (related to June 2006 breaching of the Reading Pond dam) that is overprinted on historic (and post-glacial) incision – in part related to a history of deforestation and gold placer mining.

Table 5. Bridge and Culvert Crossings Encountered on assessed reaches of the Patch Brook and Buffalo Brook, 2009.

Channel	Reach/Segment	Town	Road	Structure Type	Constriction Status	Other Issues	Priority
Patch Brook	M40T5.04-E	Plymouth	Unknown Soldier Rd	bridge	55%		Low
Patch Brook	M40T5.04-C	Plymouth	Catamount Trail	bridge	40%	DA	Low
Patch Brook	M40T5.04-B	Plymouth	Patch Brook Road	culvert	24%	SB	Very High
Lake Ninevah outlet	M40T5.03S1.01	Plymouth	Loop Road	bridge	41%	A	Low
Patch Brook	M40T5.03-B	Plymouth	Townsend Barn Rd	bridge	62%	stepped footers	Medium
Patch Brook	M40T5.03-A	Plymouth	Dublin Road	bridge	53%	stepped footers, A, DA	Very High
Patch Brook	M40T5.02-A	Plymouth	Tatro Road	bridge	46%	stepped footers, DA, SB	Very High
Patch Brook	M40T5.01-B	Plymouth	Dublin Road	bridge	87%	A, DA, SA, SB	Very High
Patch Brook	M40T5.01-B	Plymouth	Library Road	bridge	48%	DA	Very High
Patch Brook	M40T5.01-A	Plymouth	VT Route 100	bridge	155%		Low
Black River	M40	Plymouth	Kingdom Road	bridge	81%	SB	Medium
Buffalo Brook	M41T6.06	Plymouth	forest road	culvert	49%	perched	Very High
Buffalo Brook	M41T6.01-B	Plymouth	Scout Camp Road	bridge	46%	A, DA, DB, SB	Very High
Buffalo Brook	M41T6.01-A	Plymouth	footpath	bridge	120%		Low
Reading Pond Bk	M41T6.02S1.02-B	Plymouth	Reading Pond Road	culvert	58%	DA, SB	Very High

Note: Constriction status is calculated as structure span divided by bankfull width, expressed as percent.
Abbreviations: A = Alignment; DA = Deposition above; DB - Deposition below; SA = Scour above; SB = Scour below

Generally, active restoration of incised reaches in the study area is considered a low priority (following VTANR guidance) for the following reasons:

- Given the topographic and geologic setting, the natural floodplains available to the channel are quite narrow, and would offer little opportunity for sediment and flow attenuation should floodplain connection be restored.
- In the lower segments of Patch Brook there is a relatively high density of commercial and residential development and related encroachments that will likely require ongoing management of the entrenched and transport-dominated condition of the channel through the village area (e.g., M40T5.01-B, -A);
- On the Patch Brook there are relatively intractable constraints of infrastructure (roads, bridge / culvert crossings) that limit the full expression of meanders and floodplain access and would reduce the technical feasibility or effectiveness of active channel restoration (e.g., M40T5.03-A, M40T5.02-B, M40T5.02-A).

Instead, passive restoration through corridor protection is recommended as a High to Very High priority for incised reaches in relatively undeveloped sections of the study area (see Section 5.1) to support meander redevelopment and floodplain building. Naturally-enhanced attenuation at transition points of reduced valley gradient and/or confinement (enhanced by natural LWD recruitment) will accomplish channel restoration within reasonable timeframes at much lower cost and higher success rates, if the corridor is protected and society refrains from further channel management (e.g., M40T5.01-D, M40T5.01-C).

5.8 Restoring Aggraded Reaches

Further study is sometimes warranted to evaluate the feasibility of various active geomorphic and engineering techniques to restore aggraded reaches which could accelerate a return to dynamic equilibrium of the channel, by restoring equilibrium of sediment transport processes. Aggrading reaches can also be restored through passive measures including corridor protection.

Four of the study segments were identified with locally aggrading conditions (M40T5.04-D, M40T5.04-B, and M40T5.01-C in the Patch Brook and M41T6.01-A in the Buffalo Brook). The channel in each of these segments is relatively unconstrained by encroachments, and is reasonably free to adjust its planform, dimensions and profile in response to changes in sediment and water loading. These segments are partially or fully incised below their floodplains, and active aggradation and lateral adjustments are serving to build sections of new floodplain at a lower elevation. Active restoration of the moderately-aggraded condition might be feasible (e.g., placement of structures to restore equilibrium W/D ratio and support further development of the incipient floodplain). However, such an approach is not recommended at this time. Instead of active restoration measures in these segments, a return toward equilibrium conditions can be supported through passive restoration techniques in the context of river corridor protection (Section 5.1 above).

5.9 Mitigating Point Sources of Increased Stormwater and Sediment Loading

There are opportunities to improve management of stormwater runoff and reduce erosion along abandoned forest roads and Class 4 roads in the Buffalo Brook watershed and along road ditches and at culvert outlets in the Patch Brook watershed.

Specifically, the following projects are recommended:

In the Patch Brook watershed:

- Review the potential for improved road maintenance and drainage practices along Patch Brook Road between Townsend Barn Road intersection and Dublin Road. Road maintenance practices to mitigate for stormwater and sediment runoff may include: stabilization of road surfaces (different gravel materials), improvement of roadside ditches (excavation, stone lining and/or seeding and mulching), alternative grading practices (turnouts, check-basins); re-orientation of culvert crossings; protection of culvert headers; and gully stabilization. Technical and financial resources are available to the towns through the Better Back Roads program (Northern Vermont Resource Conservation and Development Council) as well as the VT Department of Transportation.

  Given the constraints of this narrow valley setting, which may limit the feasibility of stormwater retention practices, this evaluation should consider abandonment or relocation of Patch Brook Road out of the Patch Brook valley – through connections to other existing roads or redevelopment of Class 4 road segments, where feasible.

In the Buffalo Brook watershed:

- Work with landowners, including the State of Vermont Forest & Parks, to evaluate the potential for reduced sediment production and improved sediment retention within the lower reaches of Buffalo Brook (M41T6.02-B) and Reading Pond Brook (M41T6.02S1.01-A) through implementation of stormwater management practices along the abandoned forest road sections. Projects could include:

  - Construction of water bars, broad-based dips, and turn-outs to direct surface water off the road (and away from the channel) onto terraces where stormwater can slowly infiltrate;
  - Other projects consistent with Vermont's Acceptable Management Practices for Maintaining Water Quality on Logging Jobs in Vermont (2006);
  - Possible "re-wilding" of these mostly abandoned forest road segments on State and private lands, where landowners are willing; and
  - Possible introduction of boulders or large woody debris or other engineered structures in eroded sections of road which have been periodically occupied by the river – in order to increase roughness elements, slow flood waters and trap sediments.

5.10 Additional Recommendation

<u>Re: dam / diversion channel identified on the upper Patch Brook (Segment M40T5.04-C):</u>
The landowner should be contacted to determine the construction details and purpose of the dam. As appropriate, the Dam Safety & Hydrology Section of the VT Agency of Natural Resources, Department of Environmental Conservation should be notified of the existence and location of the dam, so that it can be inspected and a hazard rating assigned. In the event of dam failure, a considerable volume of water and sediment would be released to downstream reaches of the Patch Brook.

Dams that are currently not serving a useful purpose should be considered for removal to restore the natural flow and sediment transport functions of the channels that they now impound and for the associated benefits to instream and riparian habitats.

Dam removal options should carefully consider the:

- Impacts to flow and sediment regimes in the upstream and downstream channels, and the potential for increased fluvial erosion;
- Impacts to instream and riparian habitats that may affect fish and other aquatic organisms;
- Consequences related to flooding of upstream or downstream communities;
- Consequences of potential groundwater elevation changes upstream and downstream of the structure;
- Potential contaminant legacy of impounded sediments; and
- Impacts to cultural / historical / archaeological resources.

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APPENDIX A

Phase 1 (Updated) and
Phase 2 Stream Geomorphic Assessment
Reach Summary Reports

Black River

Phase 1 - Reach Summary Report

Basin: **Ottauquechee, Black**
Stream Name: **Black River**
Topo Maps: **LUDLOW**
Watershed: **Black & Otttauquechee Rivers**
Sub-watershed: **Black River (Connecticut River drainage)**

Reach ID: **M40**
SGAT Version: **4.56**
Date Last Edited: **November, 15 2010**
QA Status: **Step 2 done**
Is Reach An Impoundment?: **No**

Step 1. Reach Location **Channel between Echo Lake and Lake Rescue**

1.1 Reach Description:
1.2 Towns: **Ludlow, Plymouth**
1.3 Downstream Latitude: **43.4588933889**
1.3 Downstream Longitude: **-72.7072837659**

Step 2. Stream Type

2.1 Elevation Upstream: **1,061**
2.1 Elevation Downstream: **1,044**
2.1 Is Gradient Gentle?: **No**
2.2 Valley Length: **3,010.0** ft. **0.57** Miles
2.3 Valley Slope: **0.6**
2.4 Channel Length: **3,131.0** ft. **0.59** Miles
2.5 Channel Slope: **0.54 %**
2.6 Sinuosity: **1.04**
2.7 Watershed Area: **34.1** Square Miles
2.8 Channel Width: **61.9** feet
2.9 Valley Width: **510.0** feet
2.10 Confinement Ratio: **8.2**
2.10 Confinement Type: **Broad**
2.11 Reference Stream Type: **C**
Bedform: **Riffle-Pool**
Sub-Class Slope: **None**
Bed Material: **Cobble**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **None**
3.3 Dominant Geological Mat.: **Ice-Contact** **71.0** %
3.3 Sub-dom. Geological Mat.: **Alluvial**
3.4 Valley Slope Left: **Very Steep**
3.4 Valley Slope Right: **Steep**
3.5 Soils
Hydrologic Group: **B** **68.0** %
Flooding: **None/Rare** **71.0** %
Water Table Deep: **2.5** **40.0** %
Water Table Shallow: **1.5** **68.0** %
Erodibility: **Moderate** **31.0** %

7.4 Comments:
Phase 1 updated (October 2010) based on field observations in Phase 2 (8/7/2009).
Historic maps (Beers, 1869) note iron furnaces at Tyson.

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover:
Current Dominant Land Cover: **Forest** **89.0** %
Current Sub-Dominant Land Cover: **Urban**
4.2 Corridor
Historic Land Cover::
Current Dominant Land Cover: **Forest** **49.0** %
Current Sub-Dominant Land Cover: **Urban**

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**51-100**
Sub-dominant:	**51-100**	**0-25**
Length w / less than 25 ft.:	**321.0** ft.	**991.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications
5.1 Flow Regulation - (old):
Type: **None**
Use:
5.2 Bridges and Culverts: **1** **4.8** %
5.3 Bank Armoring: **181.6** **5.8** %
Left: **57.5** ft. Right: **124.2** ft.
5.4 Channel Straightening: **3,036.1** **97.0** %
5.5 Dredging History: **Dredging**

Step 6. Floodplain Modifications
6.1 Berms & Roads - old: **1,523.8** ft. **48.7**

	One Side	Both Sides
Road:	**567.9** ft.	**460.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**495.8** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.
6.2 Development:	**724.2** ft.	**56.8** ft.

6.3 Channel Bars: **Multiple**
6.4 Meander Migration: **Flood Chute**
6.5 Meander Width: **61 ft.** Rato: **1.0**
6.6 Wavelength: **61 ft.** Ratio: **1.0**

Step 7. Windshield Survey
7.1 Bank Erosion: **0** ft
7.2 Bank Height: **No Data** ft
7.3 Ice/Debris Jam Potential: **Bridge**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
1 Low	2 High	2 High	0 N.S.	0 N.S.	1 Low	2 High	2 High	2 High	2 High	1 Low	1 Low	2 High	2 High	0 N.S.	1 Low	21

Black River

Phase 1 - Reach Summary Report

Basin:	**Ottauquechee, Black**	Reach ID:	**M40T5.01**
Stream Name:	**Patch Brook**	SGAT Version:	**4.56**
Topo Maps:	**LUDLOW**	Date Last Edited:	**November, 15 2010**
Watershed:	**Black & Otttauquechee Rivers**	QA Status:	**Step 2 done**
Sub-watershed:	**Black River (Connecticut River drainage)**	Is Reach An Impoundment?:	**No**

Step 1. Reach Location **Along northeast side Dublin Rd u/s from Tyson at southern end Echo Lake**

1.1 Reach Description:

1.2 Towns: **Plymouth**

1.3 Downstream Latitude: **43.4643246084**

1.3 Downstream Longitude: **-72.7036645556**

Step 2. Stream Type

2.1 Elevation Upstream:	**1,200**		
2.1 Elevation Downstream:	**1,060**		
2.1 Is Gradient Gentle?:	**No**		
2.2 Valley Length:	**3,820.0** ft.	**0.72**	Miles
2.3 Valley Slope:	**3.7**		
2.4 Channel Length:	**3,992.0** ft.	**0.76**	Miles
2.5 Channel Slope:	**3.51 %**		
2.6 Sinuosity:	**1.05**		
2.7 Watershed Area:	**5.4** Square Miles		
2.8 Channel Width:	**27.6** feet		
2.9 Valley Width:	**80.0** feet		
2.10 Confinement Ratio:	**2.9**		
2.10 Confinement Type:	**Semi-confined**		
2.11 Reference Stream Type:	**C**		
Bedform:	**Step-Pool**		
Sub-Class Slope:	**b**		
Bed Material:	**Cobble**		

Step 3. Basin Charateristicts

3.1 Alluvial Fan:	**Yes**	
3.2 Grade Control:	**None**	
3.3 Dominant Geological Mat.:	**Ice-Contact**	**99.0** %
3.3 Sub-dom. Geological Mat.:	**Other**	
3.4 Valley Slope Left:	**Steep**	
3.4 Valley Slope Right:	**Steep**	
3.5 Soils		
Hydrologic Group:	**A**	**59.0** %
Flooding:	**None/Rare**	**100.0** %
Water Table Deep:	**6.0**	**59.0** %
Water Table Shallow:	**6.0**	**59.0** %
Erodibility:	**Severe**	**59.0** %

7.4 Comments:

Updated (Oct 2010) based on Phase 2 field data (Sept 2009)

Step 4. Land Cover - Reach Hydrology

4.1 Watershed

Historic Land Cover:

Current Dominant Land Cover: **Forest** **86.0** %

Current Sub-Dominant Land Cover: **Urban**

4.2 Corridor

Historic Land Cover::

Current Dominant Land Cover: **Forest** **39.0** %

Current Sub-Dominant Land Cover: **Urban**

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**0-25**
Sub-dominant:	**0-25**	**51-100**
Length w / less than 25 ft.:	**676.0** ft.	**2,346.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old):

Type: **Small Bypass**

Use: **Other**

5.2 Bridges and Culverts: **3** **10.0** %

5.3 Bank Armoring: **807.5** **20.2** %

Left: **475.0** ft. Right: **332.5** ft.

5.4 Channel Straightening: **1,730.4** **43.3** %

5.5 Dredging History: **Dredging**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **795.6** ft. **19.9**

	One Side	Both Sides
Road:	**534.2** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**261.4** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **279.9** ft. **242.8** ft.

6.3 Channel Bars: **Multiple**

6.4 Meander Migration: **Multiple**

6.5 Meander Width: **N/A** Ratio: **0.0**

6.6 Wavelength: **N/A** Ratio: **0.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **2444.7** ft

7.2 Bank Height: **3** ft

7.3 Ice/Debris Jam Potential: **Multiple**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
1 Low	2 High	2 High	1 Low	1 Low	2 High	2 High	2 High	1 Low	1 Low	0 N.S.	1 Low	0 N/A	0 N/A	2 High	1 Low	19

Black River

Phase 1 - Reach Summary Report

Basin: **Ottauquechee, Black**
Stream Name: **Patch Brook**
Topo Maps: **LUDLOW**
Watershed: **Black & Otttauquechee Rivers**
Sub-watershed: **Black River (Connecticut River drainage)**

Reach ID: **M40T5.02**
SGAT Version: **4.56**
Date Last Edited: **November, 15 2010**
QA Status: **Step 2 done**
Is Reach An Impoundment?: **No**

Step 1. Reach Location **Along northeast side Dublin Rd**
1.1 Reach Description:
1.2 Towns: **Plymouth**
1.3 Downstream Latitude: **43.4717829302**
1.3 Downstream Longitude: **-72.7123171631**

Step 2. Stream Type
2.1 Elevation Upstream: **1,265**
2.1 Elevation Downstream: **1,200**
2.1 Is Gradient Gentle?: **No**
2.2 Valley Length: **1,879.0** ft. **0.36** Miles
2.3 Valley Slope: **3.5**
2.4 Channel Length: **2,111.0** ft. **0.40** Miles
2.5 Channel Slope: **3.08 %**
2.6 Sinuosity: **1.12**
2.7 Watershed Area: **5.3** Square Miles
2.8 Channel Width: **27.2** feet
2.9 Valley Width: **45.0** feet
2.10 Confinement Ratio: **1.7**
2.10 Confinement Type: **Narrowly Confined**
2.11 Reference Stream Type: **B**
Bedform: **Step-Pool**
Sub-Class Slope: **None**
Bed Material: **Cobble**

Step 3. Basin Charateristicts
3.1 Alluvial Fan: **None**
3.2 Grade Control: **None**
3.3 Dominant Geological Mat.: **Ice-Contact** **97.0** %
3.3 Sub-dom. Geological Mat.: **Till**
3.4 Valley Slope Left: **Very Steep**
3.4 Valley Slope Right: **Steep**
3.5 Soils
Hydrologic Group: **B** **98.0** %
Flooding: **None/Rare** **100.0** %
Water Table Deep: **2.5** **95.0** %
Water Table Shallow: **1.5** **95.0** %
Erodibility: **slight** **3.0** %
7.4 Comments:
Update (oct 2010) based on Phase 2 field observations (Sept 2009).

Step 4. Land Cover - Reach Hydrology
4.1 Watershed
Historic Land Cover:
Current Dominant Land Cover: **Forest** **85.0** %
Current Sub-Dominant Land Cover: **Urban**
4.2 Corridor
Historic Land Cover::
Current Dominant Land Cover: **Urban** **37.0** %
Current Sub-Dominant Land Cover: **Forest**

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**51-100**
Sub-dominant:	**0-25**	**0-25**
Length w / less than 25 ft.:	**572.0** ft.	**1,007.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications
5.1 Flow Regulation - (old):
Type: **None**
Use:
5.2 Bridges and Culverts: **1** **3.6** %
5.3 Bank Armoring: **992.6** **47.0** %
Left: **333.4** ft. Right: **659.2** ft.
5.4 Channel Straightening: **1,963.1** **93.0** %
5.5 Dredging History: **Dredging**

Step 6. Floodplain Modifications
6.1 Berms & Roads - old: **2,392.9** ft. **113.4**

	One Side	Both Sides
Road:	**1,624.2** ft.	**213.4** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**482.4** ft.	**72.8** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **53.6** ft. **172.7** ft.
6.3 Channel Bars: **Point**
6.4 Meander Migration: **Flood Chute**
6.5 Meander Width: **N/A** Rato: **0.0**
6.6 Wavelength: **N/A** Ratio: **0.0**

Step 7. Windshield Survey
7.1 Bank Erosion: **108.08** ft
7.2 Bank Height: **4** ft
7.3 Ice/Debris Jam Potential: **Bridge**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
1 Low	2 High	2 High	0 N.S.	0 N.S.	2 High	2 High	2 High	2 High	1 Low	0 N.S.	1 Low	0 N/A	0 N/A	1 Low	1 Low	17

Black River

Phase 1 - Reach Summary Report

Basin: **Ottauquechee, Black**
Stream Name: **Patch Brook**
Topo Maps: **LUDLOW**
Watershed: **Black & Otttauquechee Rivers**
Sub-watershed: **Black River (Connecticut River drainage)**

Reach ID: **M40T5.03**
SGAT Version: **4.56**
Date Last Edited: **November, 15 2010**
QA Status: **Step 2 done**
Is Reach An Impoundment?: **No**

Step 1. Reach Location **Along Patch Brook Rd**

1.1 Reach Description:
1.2 Towns: **Plymouth**
1.3 Downstream Latitude: **43.4755205329**
1.3 Downstream Longitude: **-72.7166595253**

Step 2. Stream Type

2.1 Elevation Upstream: **1,740**
2.1 Elevation Downstream: **1,265**
2.1 Is Gradient Gentle?: **No**
2.2 Valley Length: **9,200.0** ft. **1.74** Miles
2.3 Valley Slope: **5.2**
2.4 Channel Length: **9,479.0** ft. **1.80** Miles
2.5 Channel Slope: **5.01 %**
2.6 Sinuosity: **1.03**
2.7 Watershed Area: **4.2** Square Miles
2.8 Channel Width: **24.6** feet
2.9 Valley Width: **40.0** feet
2.10 Confinement Ratio: **1.6**
2.10 Confinement Type: **Narrowly Confined**
2.11 Reference Stream Type: **B**
Bedform: **Step-Pool**
Sub-Class Slope: **a**
Bed Material: **Cobble**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **Yes**
3.2 Grade Control: **Waterfall**
3.3 Dominant Geological Mat.: **Till** **81.0** %
3.3 Sub-dom. Geological Mat.: **Ice-Contact**
3.4 Valley Slope Left: **Ext. Steep**
3.4 Valley Slope Right: **Ext. Steep**
3.5 Soils
Hydrologic Group: **C** **76.0** %
Flooding: **None/Rare** **97.0** %
Water Table Deep: **3.5** **59.0** %
Water Table Shallow: **2.0** **59.0** %
Erodibility: **Very Severe** **90.0** %
7.4 Comments:
Updated (Oct 2010) based on Phase 2 field observations (Oct 2009).

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover:
Current Dominant Land Cover: **Forest** **84.0** %
Current Sub-Dominant Land Cover: **Urban**
4.2 Corridor
Historic Land Cover::
Current Dominant Land Cover: **Urban** **41.0** %
Current Sub-Dominant Land Cover: **Forest**

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**0-25**	**>100**
Sub-dominant:	**26-50**	**0-25**
Length w / less than 25 ft.:	**8,692.0** ft.	**209.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old):
Type: **None**
Use:
5.2 Bridges and Culverts: **2** **2.1** %
5.3 Bank Armoring: **2,019.1** **21.3** %
Left: **1,478.9** ft. Right: **540.2** ft.
5.4 Channel Straightening: **1,495.1** **15.8** %
5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **9,246.9** ft. **97.6**

	One Side	Both Sides
Road:	**8,397.5** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**849.4** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.
6.2 Development:	**50.0** ft.	**59.9** ft.

6.3 Channel Bars: **Multiple**
6.4 Meander Migration: **Multiple**
6.5 Meander Width: **N/A** Rato: **0.0**
6.6 Wavelength: **N/A** Ratio: **0.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **242.21** ft
7.2 Bank Height: **4** ft
7.3 Ice/Debris Jam Potential: **Multiple**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
1 Low	2 High	2 High	0 N.S.	0 N.S.	2 High	1 Low	0 N.S.	2 High	0 N.S.	1 Low	1 Low	0 N/A	0 N/A	0 N.S.	1 Low	13

Black River

Phase 1 - Reach Summary Report

Basin: **Ottauquechee, Black**
Stream Name: **Unnamed trib to Patch Brook**
Topo Maps: **LUDLOW, MOUNT HOLLY**
Watershed: **Black & Otttauquechee Rivers**
Sub-watershed: **Black River (Connecticut River drainage)**

Reach ID: **M40T5.03S1.01**
SGAT Version: **4.56**
Date Last Edited: **October, 15 2010**
QA Status: **Step 2 done**
Is Reach An Impoundment?: **No**

Step 1. Reach Location **Outlet from Lake Ninevah**

1.1 Reach Description:
1.2 Towns: **Mount Holly, Plymouth**
1.3 Downstream Latitude: **43.475445996**
1.3 Downstream Longitude: **-72.7496037291**

Step 2. Stream Type

2.1 Elevation Upstream: **1,768**
2.1 Elevation Downstream: **1,740**
2.1 Is Gradient Gentle?: **No**
2.2 Valley Length: **1,170.0** ft. **0.22** Miles
2.3 Valley Slope: **2.4**
2.4 Channel Length: **1,221.0** ft. **0.23** Miles
2.5 Channel Slope: **2.29 %**
2.6 Sinuosity: **1.04**
2.7 Watershed Area: **1.7** Square Miles
2.8 Channel Width: **16.7** feet
2.9 Valley Width: **30.0** feet
2.10 Confinement Ratio: **1.8**
2.10 Confinement Type: **Narrowly Confined**
2.11 Reference Stream Type: **B**
Bedform: **Step-Pool**
Sub-Class Slope: **None**
Bed Material: **Cobble**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **None**
3.3 Dominant Geological Mat.: **Till** **81.0** %
3.3 Sub-dom. Geological Mat.: **Alluvial**
3.4 Valley Slope Left: **Ext. Steep**
3.4 Valley Slope Right: **Very Steep**
3.5 Soils
Hydrologic Group: **C** **57.0** %
Flooding: **None/Rare** **82.0** %
Water Table Deep: **1.5** **52.0** %
Water Table Shallow: **0.0** **52.0** %
Erodibility: **Very Severe** **82.0** %

7.4 Comments:
Updated (Oct 2010) based on Phase 2 field data (Sept 2009)

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover:
Current Dominant Land Cover: **Forest** **76.0** %
Current Sub-Dominant Land Cover: **Urban**
4.2 Corridor
Historic Land Cover::
Current Dominant Land Cover: **Forest** **38.0** %
Current Sub-Dominant Land Cover: **Urban**

4.3 Riparian Buffer

	Left Bank	Right Bank
Dominant:	**>100**	**>100**
Sub-dominant:	**None**	**51-100**
Length w / less than 25 ft.:	**0.0** ft.	**0.0** ft.

4.4 Ground Water Inputs: **Abundant**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old):
Type: **None**
Use:
5.2 Bridges and Culverts: **1** **4.1** %
5.3 Bank Armoring: **131.6** **10.8** %
Left: **0.0** ft. Right: **131.6** ft.
5.4 Channel Straightening: **0.0** **0.0** %
5.5 Dredging History: **None**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **58.0** ft. **26.2** ft.
6.3 Channel Bars: **None**
6.4 Meander Migration: **Flood Chute**
6.5 Meander Width: **N/A** Rato: **0.0**
6.6 Wavelength: **N/A** Ratio: **0.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **0** ft
7.2 Bank Height: **No Data** ft
7.3 Ice/Debris Jam Potential: **Multiple**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
1	2	0	0	0	1	0	0	0	1	0	0	0	0	0	1	6
Low	High	N.S.	N.S.	N.S.	Low	N.S.	N.S.	Unk.	Low	N.S.	N.S.	N/A	N/A	N.S.	Low	

Black River

Phase 1 - Reach Summary Report

Basin: **Ottauquechee, Black**
Stream Name: **Patch Brook**
Topo Maps: **LUDLOW, MOUNT HOLLY**
Watershed: **Black & Otttauquechee Rivers**
Sub-watershed: **Black River (Connecticut River drainage)**

Reach ID: **M40T5.04**
SGAT Version: **4.56**
Date Last Edited: **November, 15 2010**
QA Status: **Step 2 done**
Is Reach An Impoundment?: **No**

Step 1. Reach Location **Upper extent of Patch Brook, flows along recreational trail to confluence with Lake Ninevah outlet**

1.1 Reach Description:
1.2 Towns: **Plymouth**
1.3 Downstream Latitude: **43.4756900577**
1.3 Downstream Longitude: **-72.7498439039**

Step 2. Stream Type

2.1 Elevation Upstream: **2,362**
2.1 Elevation Downstream: **1,740**
2.1 Is Gradient Gentle?: **No**
2.2 Valley Length: **10,770.0** ft. **2.04** Miles
2.3 Valley Slope: **5.8**
2.4 Channel Length: **10,776.0** ft. **2.04** Miles
2.5 Channel Slope: **5.77 %**
2.6 Sinuosity: **1.00**
2.7 Watershed Area: **1.5** Square Miles
2.8 Channel Width: **15.5** feet
2.9 Valley Width: **30.0** feet
2.10 Confinement Ratio: **1.9**
2.10 Confinement Type: **Narrowly Confined**
2.11 Reference Stream Type: **B**
Bedform: **Cascade**
Sub-Class Slope: **a**
Bed Material: **Gravel**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **Multiple**
3.3 Dominant Geological Mat.: **Till** **92.0** %
3.3 Sub-dom. Geological Mat.: **Alluvial**
3.4 Valley Slope Left: **Very Steep**
3.4 Valley Slope Right: **Very Steep**
3.5 Soils
Hydrologic Group: **C** **79.0** %
Flooding: **None/Rare** **93.0** %
Water Table Deep: **2.5** **51.0** %
Water Table Shallow: **1.0** **51.0** %
Erodibility: **Very Severe** **92.0** %
7.4 Comments:
Updated (Oct 2010) based on Phase 2 field observations (Sept 2009).

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover:
Current Dominant Land Cover: **Forest** **92.0** %
Current Sub-Dominant Land Cover: **Urban**
4.2 Corridor
Historic Land Cover::
Current Dominant Land Cover: **Forest** **76.0** %
Current Sub-Dominant Land Cover: **Urban**

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**>100**
Sub-dominant:	**0-25**	**0-25**
Length w / less than 25 ft.:	**123.0** ft.	**252.0** ft.

4.4 Ground Water Inputs: **Abundant**

Step 5. Instream Channel Modifications
5.1 Flow Regulation - (old):
Type: **Small Bypass**
Use: **Other**
5.2 Bridges and Culverts: **4** **1.6** %
5.3 Bank Armoring: **155.2** **1.4** %
Left: **77.4** ft. Right: **77.8** ft.
5.4 Channel Straightening: **553.1** **5.1** %
5.5 Dredging History: **None**

Step 6. Floodplain Modifications
6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **48.5** ft. **174.7** ft.
6.3 Channel Bars: **Multiple**
6.4 Meander Migration: **Multiple**
6.5 Meander Width: **N/A** Rato: **0.0**
6.6 Wavelength: **N/A** Ratio: **0.0**

Step 7. Windshield Survey
7.1 Bank Erosion: **510.83** ft
7.2 Bank Height: **2** ft
7.3 Ice/Debris Jam Potential: **Multiple**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
1 **Low**	**0** **N.S.**	**0** **N.S.**	**1** **Low**	**0** **N.S.**	**0** **N.S.**	**1** **Low**	**0** **N.S.**	**0** **Unk.**	**0** **N.S.**	**2** **High**	**2** **High**	**0** **N/A**	**0** **N/A**	**0** **N.S.**	**1** **Low**	**8**

Black River

Phase 1 - Reach Summary Report

Basin:	**Ottauquechee, Black**	Reach ID:	**M41T6.01**
Stream Name:	**Buffalo Brook**	SGAT Version:	**4.56**
Topo Maps:	**LUDLOW**	Date Last Edited:	**November, 15 2010**
Watershed:	**Black & Otttauquechee Rivers**	QA Status:	**Step 2 done**
Sub-watershed:	**Black River (Connecticut River drainage)**	Is Reach An Impoundment?:	**No**

Step 1. Reach Location

1.1 Reach Description: **Through Camp Plymouth; from eastern valley wall of Black River valley to confluence with Echo Lake**

1.2 Towns: **Plymouth**

1.3 Downstream Latitude: **43.4734487003**

1.3 Downstream Longitude: **-72.6992798805**

Step 2. Stream Type

2.1 Elevation Upstream:	**1,095**		
2.1 Elevation Downstream:	**1,061**		
2.1 Is Gradient Gentle?:	**No**		
2.2 Valley Length:	**1,910.0** ft.	**0.36**	Miles
2.3 Valley Slope:	**1.8**		
2.4 Channel Length:	**2,010.0** ft.	**0.38**	Miles
2.5 Channel Slope:	**1.69 %**		
2.6 Sinuosity:	**1.05**		
2.7 Watershed Area:	**5.7** Square Miles		
2.8 Channel Width:	**28.3** feet		
2.9 Valley Width:	**470.0** feet		
2.10 Confinement Ratio:	**16.6**		
2.10 Confinement Type:	**Very Broad**		
2.11 Reference Stream Type:	**C**		
Bedform:	**Riffle-Pool**		
Sub-Class Slope:	**None**		
Bed Material:	**Gravel**		

Step 3. Basin Charateristicts

3.1 Alluvial Fan:	**Yes**	
3.2 Grade Control:	**None**	
3.3 Dominant Geological Mat.:	**Ice-Contact**	**43.0** %
3.3 Sub-dom. Geological Mat.:	**Alluvial**	
3.4 Valley Slope Left:	**Flat**	
3.4 Valley Slope Right:	**Steep**	
3.5 Soils		
Hydrologic Group:	**A**	**43.0** %
Flooding:	**None/Rare**	**57.0** %
Water Table Deep:	**6.0**	**56.0** %
Water Table Shallow:	**6.0**	**56.0** %
Erodibility:	**slight**	**13.0** %

7.4 Comments:

Updated (Oct 2010) based on Phase 2 field based data (Sept 2009).

Step 4. Land Cover - Reach Hydrology

4.1 Watershed

Historic Land Cover:		
Current Dominant Land Cover:	**Forest**	**94.0** %
Current Sub-Dominant Land Cover:	**Urban**	

4.2 Corridor

Historic Land Cover::		
Current Dominant Land Cover:	**Forest**	**61.0** %
Current Sub-Dominant Land Cover:	**Wetland**	

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**0-25**
Sub-dominant:	**26-50**	**>100**
Length w / less than 25 ft.:	**362.0** ft.	**1,811.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old):

Type: **None**

Use:

5.2 Bridges and Culverts:	**2**		**12.4** %	
5.3 Bank Armoring:	**617.1**		**30.7** %	
Left:	**80.3** ft.	Right:	**536.9** ft.	
5.4 Channel Straightening:	**1,580.5**		**78.6** %	
5.5 Dredging History:	**Gravel Mining**			

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **1,274.7** ft. **63.4**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**411.3** ft.
Improved Path:	**574.8** ft.	**288.7** ft.
6.2 Development:	**630.8** ft.	**230.6** ft.

6.3 Channel Bars: **Multiple**

6.4 Meander Migration: **Flood Chute**

6.5 Meander Width: **28 ft.** Rato: **1.0**

6.6 Wavelength: **28 ft.** Ratio: **1.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **982.51** ft

7.2 Bank Height: **3** ft

7.3 Ice/Debris Jam Potential: **Multiple**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	**1** Low	**2** High	**0** N.S.	**1** Low	**2** High	**2** High	**1** Low	**2** High	**2** High	**2** High	**1** Low	**2** High	**2** High	**2** High	**1** Low	**23**

Black River

Phase 1 - Reach Summary Report

Basin: **Ottauquechee, Black**
Stream Name: **Buffalo Brook**
Topo Maps: **LUDLOW**
Watershed: **Black & Otttauquechee Rivers**
Sub-watershed: **Black River (Connecticut River drainage)**

Reach ID: **M41T6.02**
SGAT Version: **4.56**
Date Last Edited: **November, 15 2010**
QA Status: **Step 2 done**
Is Reach An Impoundment?: **No**

Step 1. Reach Location **From Reading Pond confluence to Camp Plymouth**

1.1 Reach Description:
1.2 Towns: **Plymouth**
1.3 Downstream Latitude: **43.4763524457**
1.3 Downstream Longitude: **-72.6933528355**

Step 2. Stream Type

2.1 Elevation Upstream: **1,260**
2.1 Elevation Downstream: **1,095**
2.1 Is Gradient Gentle?: **No**
2.2 Valley Length: **6,340.0** ft. **1.20** Miles
2.3 Valley Slope: **2.6**
2.4 Channel Length: **6,639.0** ft. **1.26** Miles
2.5 Channel Slope: **2.49 %**
2.6 Sinuosity: **1.05**
2.7 Watershed Area: **5.6** Square Miles
2.8 Channel Width: **27.9** feet
2.9 Valley Width: **85.0** feet
2.10 Confinement Ratio: **3.0**
2.10 Confinement Type: **Semi-confined**
2.11 Reference Stream Type: **C**
Bedform: **Step-Pool**
Sub-Class Slope: **b**
Bed Material: **Cobble**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **Multiple**
3.3 Dominant Geological Mat.: **Till** **97.0** %
3.3 Sub-dom. Geological Mat.: **Ice-Contact**
3.4 Valley Slope Left: **Ext. Steep**
3.4 Valley Slope Right: **Ext. Steep**
3.5 Soils
Hydrologic Group: **C** **90.0** %
Flooding: **None/Rare** **100.0** %
Water Table Deep: **6.0** **97.0** %
Water Table Shallow: **6.0** **97.0** %
Erodibility: **Very Severe** **97.0** %
7.4 Comments:
Updated (Oct 2010) based on Phase 2 field-based data (Oct 2009).

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover:
Current Dominant Land Cover: **Forest** **95.0** %
Current Sub-Dominant Land Cover: **Urban**
4.2 Corridor
Historic Land Cover::
Current Dominant Land Cover: **Forest** **61.0** %
Current Sub-Dominant Land Cover: **Crop**

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**>100**
Sub-dominant:	**0-25**	**0-25**
Length w / less than 25 ft.:	**2,041.0** ft.	**1,972.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications
5.1 Flow Regulation - (old):
Type: **None**
Use:
5.2 Bridges and Culverts: **0** **0.0** %
5.3 Bank Armoring: **33.7** **0.5** %
Left: **0.0** ft. Right: **33.7** ft.
5.4 Channel Straightening: **0.0** **0.0** %
5.5 Dredging History: **Gravel Mining**

Step 6. Floodplain Modifications
6.1 Berms & Roads - old: **4,358.2** ft. **65.6**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**3,938.5** ft.	**419.7** ft.
6.2 Development:	**0.0** ft.	**0.0** ft.

6.3 Channel Bars: **Multiple**
6.4 Meander Migration: **Multiple**
6.5 Meander Width: **N/A** Rato: **0.0**
6.6 Wavelength: **N/A** Ratio: **0.0**

Step 7. Windshield Survey
7.1 Bank Erosion: **615.17** ft
7.2 Bank Height: **2** ft
7.3 Ice/Debris Jam Potential: **Debris**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	2 High	0 N.S.	0 N.S.	0 N.S.	0 N.S.	1 Low	2 High	0 N.S.	1 Low	2 High	0 N/A	0 N/A	1 Low	1 Low	10

Black River

Phase 1 - Reach Summary Report

Basin: **Ottauquechee, Black**
Stream Name: **Reading Pond Brook**
Topo Maps: **LUDLOW**
Watershed: **Black & Otttauquechee Rivers**
Sub-watershed: **Black River (Connecticut River drainage)**

Reach ID: **M41T6.02S1.01**
SGAT Version: **4.56**
Date Last Edited: **November, 15 2010**
QA Status: **Step 2 done**
Is Reach An Impoundment?: **No**

Step 1. Reach Location **From Barker Brook confluence d/s to Buffalo Brook confluence**

1.1 Reach Description:
1.2 Towns: **Plymouth**
1.3 Downstream Latitude: **43.4868285113**
1.3 Downstream Longitude: **-72.6812893172**

Step 2. Stream Type

2.1 Elevation Upstream: **1,680**
2.1 Elevation Downstream: **1,260**
2.1 Is Gradient Gentle?: **No**
2.2 Valley Length: **8,350.0** ft. **1.58** Miles
2.3 Valley Slope: **5.0**
2.4 Channel Length: **8,938.0** ft. **1.69** Miles
2.5 Channel Slope: **4.70 %**
2.6 Sinuosity: **1.07**
2.7 Watershed Area: **2.9** Square Miles
2.8 Channel Width: **21.0** feet
2.9 Valley Width: **40.0** feet
2.10 Confinement Ratio: **1.9**
2.10 Confinement Type: **Narrowly Confined**
2.11 Reference Stream Type: **B**
Bedform: **Step-Pool**
Sub-Class Slope: **a**
Bed Material: **Cobble**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **Waterfall**
3.3 Dominant Geological Mat.: **Till** **98.0** %
3.3 Sub-dom. Geological Mat.: **Ice-Contact**
3.4 Valley Slope Left: **Ext. Steep**
3.4 Valley Slope Right: **Ext. Steep**
3.5 Soils
Hydrologic Group: **C** **54.0** %
Flooding: **None/Rare** **100.0** %
Water Table Deep: **3.5** **48.0** %
Water Table Shallow: **2.0** **48.0** %
Erodibility: **Very Severe** **98.0** %

7.4 Comments:
Updated (oct 2010) based on Phase 2 field observations (Sept 2009).

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover:
Current Dominant Land Cover: **Forest** **93.0** %
Current Sub-Dominant Land Cover: **Urban**
4.2 Corridor
Historic Land Cover::
Current Dominant Land Cover: **Forest** **61.0** %
Current Sub-Dominant Land Cover: **Crop**

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**>100**
Sub-dominant:	**0-25**	**0-25**
Length w / less than 25 ft.:	**1,210.0** ft.	**166.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications
5.1 Flow Regulation - (old):
Type: **None**
Use:
5.2 Bridges and Culverts: **0** **0.0** %
5.3 Bank Armoring: **0.0** **0.0** %
Left: **0.0** ft. Right: **0.0** ft.
5.4 Channel Straightening: **0.0** **0.0** %
5.5 Dredging History: **Gravel Mining**

Step 6. Floodplain Modifications
6.1 Berms & Roads - old: **1,465.1** ft. **16.4**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**1,465.1** ft.	**0.0** ft.
6.2 Development:	**0.0** ft.	**0.0** ft.

6.3 Channel Bars: **Multiple**
6.4 Meander Migration: **Multiple**
6.5 Meander Width: **N/A** Rato: **0.0**
6.6 Wavelength: **N/A** Ratio: **0.0**

Step 7. Windshield Survey
7.1 Bank Erosion: **3043.89** ft
7.2 Bank Height: **3** ft
7.3 Ice/Debris Jam Potential: **Debris**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**2**	**2**	**0**	**0**	**2**	**1**	**10**
N.S.	**N.S.**	**Low**	**N.S.**	**N.S.**	**N.S.**	**N.S.**	**Low**	**Low**	**N.S.**	**High**	**High**	**N/A**	**N/A**	**High**	**Low**	

Black River

Phase 1 - Reach Summary Report

Basin: **Ottauquechee, Black**
Stream Name: **Reading Pond Brook**
Topo Maps: **LUDLOW**
Watershed: **Black & Otttauquechee Rivers**
Sub-watershed: **Black River (Connecticut River drainage)**

Reach ID: **M41T6.02S1.02**
SGAT Version: **4.56**
Date Last Edited: **November, 15 2010**
QA Status: **Step 2 done**
Is Reach An Impoundment?: **No**

Step 1. Reach Location **Outlet channel from Reading Pond to confluence Barker Brook**

1.1 Reach Description:
1.2 Towns: **Plymouth, Reading**
1.3 Downstream Latitude: **43.49326456**
1.3 Downstream Longitude: **-72.6569001529**

Step 2. Stream Type

2.1 Elevation Upstream: **1,756**
2.1 Elevation Downstream: **1,680**
2.1 Is Gradient Gentle?: **No**
2.2 Valley Length: **2,140.0** ft. **0.41** Miles
2.3 Valley Slope: **3.6**
2.4 Channel Length: **2,630.0** ft. **0.50** Miles
2.5 Channel Slope: **2.89 %**
2.6 Sinuosity: **1.23**
2.7 Watershed Area: **1.2** Square Miles
2.8 Channel Width: **14.0** feet
2.9 Valley Width: **70.0** feet
2.10 Confinement Ratio: **5.0**
2.10 Confinement Type: **Narrow**
2.11 Reference Stream Type: **C**
Bedform: **Riffle-Pool**
Sub-Class Slope: **b**
Bed Material: **Gravel**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **None**
3.3 Dominant Geological Mat.: **Ice-Contact** **74.0** %
3.3 Sub-dom. Geological Mat.: **Till**
3.4 Valley Slope Left: **Very Steep**
3.4 Valley Slope Right: **Very Steep**
3.5 Soils
Hydrologic Group: **B** **74.0** %
Flooding: **None/Rare** **97.0** %
Water Table Deep: **2.5** **97.0** %
Water Table Shallow: **1.5** **74.0** %
Erodibility: **slight** **22.0** %

7.4 Comments:
Updated (October 2010) with Phase 2 field based observations (Sept 2009).

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover:
Current Dominant Land Cover: **Forest** **92.0** %
Current Sub-Dominant Land Cover: **Urban**

4.2 Corridor
Historic Land Cover::
Current Dominant Land Cover: **Forest** **56.0** %
Current Sub-Dominant Land Cover: **Urban**

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**>100**
Sub-dominant:	**None**	**0-25**
Length w / less than 25 ft.:	**69.0** ft.	**217.0** ft.

4.4 Ground Water Inputs: **Abundant**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old):
Type: **Small Bypass**
Use: **Other**
5.2 Bridges and Culverts: **1** **3.8** %
5.3 Bank Armoring: **54.6** **2.1** %
Left: **54.6** ft. Right: **0.0** ft.
5.4 Channel Straightening: **463.0** **17.6** %
5.5 Dredging History: **Gravel Mining**

Step 6. Floodplain Modifications

6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.

6.2 Development: **0.0** ft. **63.4** ft.
6.3 Channel Bars: **Multiple**
6.4 Meander Migration: **Multiple**
6.5 Meander Width: **N/A** Rato: **0.0**
6.6 Wavelength: **N/A** Ratio: **0.0**

Step 7. Windshield Survey

7.1 Bank Erosion: **606.03** ft
7.2 Bank Height: **2** ft
7.3 Ice/Debris Jam Potential: **Multiple**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 **N.S.**	**1** **Low**	**1** **Low**	**1** **Low**	**0** **N.S.**	**0** **N.S.**	**1** **Low**	**1** **Low**	**0** **Unk.**	**0** **N.S.**	**2** **High**	**2** **High**	**0** **N/A**	**0** **N/A**	**2** **High**	**1** **Low**	**12**

Black River

Phase 1 - Reach Summary Report

Basin: **Ottauquechee, Black**
Stream Name: **Buffalo Brook**
Topo Maps: **LUDLOW**
Watershed: **Black & Otttauquechee Rivers**
Sub-watershed: **Black River (Connecticut River drainage)**

Reach ID: **M41T6.03**
SGAT Version: **4.56**
Date Last Edited: **November, 15 2010**
QA Status: **Step 2 done**
Is Reach An Impoundment?: **No**

Step 1. Reach Location **short reach of broader valley setting upstream of Reading Pond Brook confluence**

1.1 Reach Description:
1.2 Towns: **Plymouth**
1.3 Downstream Latitude: **43.4868961015**
1.3 Downstream Longitude: **-72.6821208875**

Step 2. Stream Type

2.1 Elevation Upstream: **1,280**
2.1 Elevation Downstream: **1,260**
2.1 Is Gradient Gentle?: **No**
2.2 Valley Length: **780.0** ft. **0.15** Miles
2.3 Valley Slope: **2.6**
2.4 Channel Length: **807.0** ft. **0.15** Miles
2.5 Channel Slope: **2.48 %**
2.6 Sinuosity: **1.03**
2.7 Watershed Area: **1.9** Square Miles
2.8 Channel Width: **17.5** feet
2.9 Valley Width: **160.0** feet
2.10 Confinement Ratio: **9.1**
2.10 Confinement Type: **Broad**
2.11 Reference Stream Type: **C**
Bedform: **Step-Pool**
Sub-Class Slope: **b**
Bed Material: **Gravel**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **Yes**
3.2 Grade Control: **Ledge**
3.3 Dominant Geological Mat.: **Ice-Contact** **84.0** %
3.3 Sub-dom. Geological Mat.: **Till**
3.4 Valley Slope Left: **Ext. Steep**
3.4 Valley Slope Right: **Ext. Steep**
3.5 Soils
Hydrologic Group: **B** **85.0** %
Flooding: **None/Rare** **100.0** %
Water Table Deep: **2.5** **84.0** %
Water Table Shallow: **1.5** **84.0** %
Erodibility: **slight** **15.0** %
7.4 Comments:
Updated (Oct 2010) based on Phase 2 field-based observations (Oct 2009).

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover:
Current Dominant Land Cover: **Forest** **96.0** %
Current Sub-Dominant Land Cover: **Crop**
4.2 Corridor
Historic Land Cover::
Current Dominant Land Cover: **Forest** **72.0** %
Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**>100**
Sub-dominant:	**0-25**	**0-25**
Length w / less than 25 ft.:	**127.0** ft.	**150.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications
5.1 Flow Regulation - (old):
Type: **None**
Use:
5.2 Bridges and Culverts: **0** **0.0** %
5.3 Bank Armoring: **0.0** **0.0** %
Left: **0.0** ft. Right: **0.0** ft.
5.4 Channel Straightening: **0.0** **0.0** %
5.5 Dredging History: **Gravel Mining**

Step 6. Floodplain Modifications
6.1 Berms & Roads - old: **442.4** ft. **54.8**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**268.9** ft.	**173.5** ft.
6.2 Development:	**0.0** ft.	**0.0** ft.

6.3 Channel Bars: **Multiple**
6.4 Meander Migration: **Braiding**
6.5 Meander Width: **N/A** Rato: **0.0**
6.6 Wavelength: **N/A** Ratio: **0.0**

Step 7. Windshield Survey
7.1 Bank Erosion: **224.49** ft
7.2 Bank Height: **2** ft
7.3 Ice/Debris Jam Potential: **Shallow**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	2 High	0 N.S.	0 N.S.	0 N.S.	0 N.S.	1 Low	2 High	0 N.E.	1 Low	1 Low	0 N/A	0 N/A	2 High	1 Low	10

Black River

Phase 1 - Reach Summary Report

Basin: **Ottauquechee, Black**
Stream Name: **Buffalo Brook**
Topo Maps: **LUDLOW**
Watershed: **Black & Otttauquechee Rivers**
Sub-watershed: **Black River (Connecticut River drainage)**

Reach ID: **M41T6.04**
SGAT Version: **4.56**
Date Last Edited: **November, 15 2010**
QA Status: **Step 2 done**
Is Reach An Impoundment?: **No**

Step 1. Reach Location **remote, steep, forested reach**

1.1 Reach Description:
1.2 Towns: **Plymouth**
1.3 Downstream Latitude: **43.4889746276**
1.3 Downstream Longitude: **-72.6824286161**

Step 2. Stream Type

2.1 Elevation Upstream: **1,350**
2.1 Elevation Downstream: **1,280**
2.1 Is Gradient Gentle?: **No**
2.2 Valley Length: **1,990.0** ft. **0.38** Miles
2.3 Valley Slope: **3.5**
2.4 Channel Length: **2,052.0** ft. **0.39** Miles
2.5 Channel Slope: **3.41 %**
2.6 Sinuosity: **1.03**
2.7 Watershed Area: **1.9** Square Miles
2.8 Channel Width: **17.3** feet
2.9 Valley Width: **40.0** feet
2.10 Confinement Ratio: **2.3**
2.10 Confinement Type: **Semi-confined**
2.11 Reference Stream Type: **B**
Bedform: **Step-Pool**
Sub-Class Slope: **None**
Bed Material: **Cobble**

Step 3. Basin Charateristicts

3.1 Alluvial Fan: **None**
3.2 Grade Control: **Ledge**
3.3 Dominant Geological Mat.: **Till** **99.0** %
3.3 Sub-dom. Geological Mat.: **Ice-Contact**
3.4 Valley Slope Left: **Ext. Steep**
3.4 Valley Slope Right: **Ext. Steep**
3.5 Soils
Hydrologic Group: **B** **93.0** %
Flooding: **None/Rare** **100.0** %
Water Table Deep: **6.0** **99.0** %
Water Table Shallow: **6.0** **99.0** %
Erodibility: **Very Severe** **99.0** %
7.4 Comments:
Updated (Oct 2010) based on Phase 2 field observations (Oct 2009). Unknown source of "crop" as subdominant land cover / land use (both in corridor and upstream watershed). No evidence of crop in field reconnaissance.

Step 4. Land Cover - Reach Hydrology

4.1 Watershed
Historic Land Cover:
Current Dominant Land Cover: **Forest** **96.0** %
Current Sub-Dominant Land Cover: **Crop**
4.2 Corridor
Historic Land Cover::
Current Dominant Land Cover: **Forest** **61.0** %
Current Sub-Dominant Land Cover: **Crop**

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**>100**
Sub-dominant:	**0-25**	**0-25**
Length w / less than 25 ft.:	**1,484.0** ft.	**383.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications
5.1 Flow Regulation - (old):
Type: **None**
Use:
5.2 Bridges and Culverts: **0** **0.0** %
5.3 Bank Armoring: **53.9** **2.6** %
Left: **0.0** ft. Right: **53.9** ft.
5.4 Channel Straightening: **0.0** **0.0** %
5.5 Dredging History: **None**

Step 6. Floodplain Modifications
6.1 Berms & Roads - old: **1,879.7** ft. **91.6**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**1,879.7** ft.	**0.0** ft.
6.2 Development:	**0.0** ft.	**0.0** ft.

6.3 Channel Bars: **Point**
6.4 Meander Migration: **Multiple**
6.5 Meander Width: **N/A** Rato: **0.0**
6.6 Wavelength: **N/A** Ratio: **0.0**

Step 7. Windshield Survey
7.1 Bank Erosion: **40.64** ft
7.2 Bank Height: **3** ft
7.3 Ice/Debris Jam Potential: **Debris**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0	0	2	0	0	0	0	0	2	0	0	1	0	0	0	1	6
N.S.	N.S.	High	N.S.	N.S.	N.S.	N.S.	N.S.	High	N.S.	N.S.	Low	N/A	N/A	N.S.	Low	

Black River

Phase 1 - Reach Summary Report

Basin:	**Ottauquechee, Black**
Stream Name:	**Buffalo Brook**
Topo Maps:	**LUDLOW**
Watershed:	**Black & Otttauquechee Rivers**
Sub-watershed:	**Black River (Connecticut River drainage)**

Reach ID:	**M41T6.05**
SGAT Version:	**4.56**
Date Last Edited:	**November, 15 2010**
QA Status:	**Step 2 done**
Is Reach An Impoundment?:	**No**

Step 1. Reach Location — **remote, steep, forested reach**

1.1 Reach Description:			
1.2 Towns:	**Plymouth**		
1.3 Downstream Latitude:	**43.4937043763**		
1.3 Downstream Longitude:	**-72.6799444548**		

Step 2. Stream Type

2.1 Elevation Upstream:	**1,580**		
2.1 Elevation Downstream:	**1,350**		
2.1 Is Gradient Gentle?:	**No**		
2.2 Valley Length:	**3,810.0** ft.	**0.72**	Miles
2.3 Valley Slope:	**6.0**		
2.4 Channel Length:	**3,964.0** ft.	**0.75**	Miles
2.5 Channel Slope:	**5.80 %**		
2.6 Sinuosity:	**1.04**		
2.7 Watershed Area:	**1.0** Square Miles		
2.8 Channel Width:	**12.9** feet		
2.9 Valley Width:	**35.0** feet		
2.10 Confinement Ratio:	**2.7**		
2.10 Confinement Type:	**Semi-confined**		
2.11 Reference Stream Type:	**B**		
Bedform:	**Step-Pool**		
Sub-Class Slope:	**a**		
Bed Material:	**Gravel**		

Step 3. Basin Charateristicts

3.1 Alluvial Fan:	**None**	
3.2 Grade Control:	**Multiple**	
3.3 Dominant Geological Mat.:	**Till**	**87.0** %
3.3 Sub-dom. Geological Mat.:	**Ice-Contact**	
3.4 Valley Slope Left:	**Ext. Steep**	
3.4 Valley Slope Right:	**Ext. Steep**	
3.5 Soils		
Hydrologic Group:	**C**	**80.0** %
Flooding:	**None/Rare**	**100.0** %
Water Table Deep:	**3.5**	**59.0** %
Water Table Shallow:	**2.0**	**59.0** %
Erodibility:	**Very Severe**	**99.0** %

7.4 Comments:

Updated (Oct 2010) with field-based observations from Phase 2 (Oct 2009).

Step 4. Land Cover - Reach Hydrology

4.1 Watershed

Historic Land Cover:		
Current Dominant Land Cover:	**Forest**	**95.0** %
Current Sub-Dominant Land Cover:	**Crop**	

4.2 Corridor

Historic Land Cover::		
Current Dominant Land Cover:	**Forest**	**56.0** %
Current Sub-Dominant Land Cover:		

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**>100**
Sub-dominant:	**0-25**	**0-25**
Length w / less than 25 ft.:	**874.0** ft.	**135.0** ft.

4.4 Ground Water Inputs: **Minimal**

Step 5. Instream Channel Modifications

5.1 Flow Regulation - (old):

Type:	**None**			
Use:				
5.2 Bridges and Culverts:	**0**			**0.0** %
5.3 Bank Armoring:	**0.0**			**0.0** %
Left:	**0.0** ft.	Right:		**0.0** ft.
5.4 Channel Straightening:	**0.0**			**0.0** %
5.5 Dredging History:	**None**			

Step 6. Floodplain Modifications

6.1 Berms & Roads - old:	**1,301.8** ft.	**32.8**
	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**1,301.8** ft.	**0.0** ft.
6.2 Development:	**0.0** ft.	**0.0** ft.
6.3 Channel Bars:	**Multiple**	
6.4 Meander Migration:	**Multiple**	
6.5 Meander Width:	**N/A** Rato:	**0.0**
6.6 Wavelength:	**N/A** Ratio:	**0.0**

Step 7. Windshield Survey

7.1 Bank Erosion:	**173.52**	ft
7.2 Bank Height:	**2**	ft
7.3 Ice/Debris Jam Potential:	**Debris**	

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0 N.S.	0 N.S.	2 High	0 N.S.	0 N.S.	0 N.S.	0 N.S.	0 N.S.	2 High	0 N.S.	1 Low	1 Low	0 N/A	0 N/A	0 N.S.	1 Low	7

Black River

Phase 1 - Reach Summary Report

Basin: **Ottauquechee, Black**
Stream Name: **Buffalo Brook**
Topo Maps: **LUDLOW, PLYMOUTH**
Watershed: **Black & Otttauquechee Rivers**
Sub-watershed: **Black River (Connecticut River drainage)**

Reach ID: **M41T6.06**
SGAT Version: **4.56**
Date Last Edited: **October, 15 2010**
QA Status: **Step 2 done**
Is Reach An Impoundment?: **No**

Step 1. Reach Location **remote, steep, forested reach**
1.1 Reach Description:
1.2 Towns: **Plymouth**
1.3 Downstream Latitude: **43.499421758**
1.3 Downstream Longitude: **-72.6685561183**

Step 2. Stream Type
2.1 Elevation Upstream: **1,885**
2.1 Elevation Downstream: **1,580**
2.1 Is Gradient Gentle?: **No**
2.2 Valley Length: **2,370.0** ft. **0.45** Miles
2.3 Valley Slope: **12.9**
2.4 Channel Length: **2,415.0** ft. **0.46** Miles
2.5 Channel Slope: **12.63 %**
2.6 Sinuosity: **1.02**
2.7 Watershed Area: **0.3** Square Miles
2.8 Channel Width: **7.8** feet
2.9 Valley Width: **30.0** feet
2.10 Confinement Ratio: **3.8**
2.10 Confinement Type: **Semi-confined**
2.11 Reference Stream Type: **B**
Bedform: **Cascade**
Sub-Class Slope: **a**
Bed Material: **Bedrock**

Step 3. Basin Charateristicts
3.1 Alluvial Fan: **None**
3.2 Grade Control: **Multiple**
3.3 Dominant Geological Mat.: **Till** **92.0** %
3.3 Sub-dom. Geological Mat.: **Other**
3.4 Valley Slope Left: **Ext. Steep**
3.4 Valley Slope Right: **Ext. Steep**
3.5 Soils
Hydrologic Group: **C** **92.0** %
Flooding: **None/Rare** **100.0** %
Water Table Deep: **6.0** **92.0** %
Water Table Shallow: **6.0** **92.0** %
Erodibility: **Very Severe** **92.0** %
7.4 Comments:
Updated (Oct 2010) with results of Phase 2 field assessment (Oct 2009).

Step 4. Land Cover - Reach Hydrology
4.1 Watershed
Historic Land Cover:
Current Dominant Land Cover: **Forest** **98.0** %
Current Sub-Dominant Land Cover: **Crop**
4.2 Corridor
Historic Land Cover::
Current Dominant Land Cover: **Forest** **96.0** %
Current Sub-Dominant Land Cover:

4.3 Riparian Buffer	Left Bank	Right Bank
Dominant:	**>100**	**>100**
Sub-dominant:	**None**	**0-25**
Length w / less than 25 ft.:	**50.0** ft.	**150.0** ft.

4.4 Ground Water Inputs: **Abundant**

Step 5. Instream Channel Modifications
5.1 Flow Regulation - (old):
Type: **None**
Use:
5.2 Bridges and Culverts: **1** **1.0** %
5.3 Bank Armoring: **33.7** **1.4** %
Left: **18.0** ft. Right: **15.7** ft.
5.4 Channel Straightening: **0.0** **0.0** %
5.5 Dredging History: **Gravel Mining**

Step 6. Floodplain Modifications
6.1 Berms & Roads - old: **0.0** ft. **0.0**

	One Side	Both Sides
Road:	**0.0** ft.	**0.0** ft.
Railroad:	**0.0** ft.	**0.0** ft.
Berm:	**0.0** ft.	**0.0** ft.
Improved Path:	**0.0** ft.	**0.0** ft.
6.2 Development:	**0.0** ft.	**10.6** ft.

6.3 Channel Bars: **None**
6.4 Meander Migration: **Multiple**
6.5 Meander Width: **N/A** Rato: **0.0**
6.6 Wavelength: **N/A** Ratio: **0.0**

Step 7. Windshield Survey
7.1 Bank Erosion: **89.66** ft
7.2 Bank Height: **2** ft
7.3 Ice/Debris Jam Potential: **Multiple**

4.1	4.2	4.3	5.1	5.2	5.3	5.4	5.5	6.1	6.2	6.3	6.4	6.5	6.6	7.1	7.3	Total
0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	1	4
N.S.	N.S.	Low	N.S.	N.S.	N.S.	N.S.	Low	Unk.	N.S.	N.S.	Low	N/A	N/A	N.S.	Low	

Phase 2 Segment Summary Report **Black River**

Stream:	**Black River**	SGAT Version:	**4.56**
Reach:	**M40-0**	Organization:	**South Windsor County Regional Planning Commission**
Segment Length(ft):	**3,131**	Observers:	**KLU, BOS - SMRC**
Rain:	**Yes**	Completion Date:	**8/7/2009**
		Qualtiy Control Status - Consultant:	**Provisional**
		Qualtiy Control Status - Staff:	**Provisional**

Step 0 - Location: **Channel between Echo Lake and Lake Rescue, receiving Patch Brook.**

Step 5 - Notes: **Slight reduction in valley width due to Vt Rt 100 along RB, driveway along LB corridor. Valley type (Broad confinement) and status (unconfined) remain unchanged. Reach receives Patch Brook as RB tributary. Position of confluence was reportedly altered over the years (see Ph2 report). Kingdom Road crosses the reach via a bankfull-constricting bridge. Former bridge in this position was washed out in the 1927 flood (Ward, 1983). Two discrete sections of berms along LB enhance the degree of channel entrenchment and cut off portions of the floodplain. One short section located near the Patch Brook confluence (Patch Bk itself is bermed just upstream of the confluence; sediment "delta" protrudes from Patch Brook). Second longer, higher berm is located spanning Tiny Brook confluence. Upstream flow regulation = run-of-river dam at Amherst Lake (reach M42, ~1 mile upstream). Downstream flow regulation = run-of-river dam at Lake Rescue (reach M39, ~1.1 mile downstream). Reach M40 flows into Round Pond, a small embayment at the north end of Lake Rescue where a large sediment delta has formed over recent decades. Historic straightening and dredging of M40 is inferred due to linear planform and presence of berms. Also anecdotal evidence indicates channel and floodplain management following flood events of 1973 and 1927. Valley width entered in step 1.5 represents an average for the segment. Cross section location had a locally higher valley width. Also, valley width is measured perpendicular to the long-valley axis. To be perpendicular to the channel, cross sections XS-3 and XS-2 were oriented at an angle to the long-valley axis. The departure analysis of the Phase 2 report includes discussion of the upstream natural impoundment (Echo Lake) and the downstream regulated impoundment (Lake Rescue). Effects of these impoundments on reach M40 not possible to characterize based on currently available data. One might expect that upstream impoundment effects could lead to "hungry water" conditions and incision in M40. However, Patch Brook provides a significant source of sediments to M40. Fluctuations in water levels of the downstream Lake Rescue impoundment over historic times may have alternately induced incision (from a drop in base levels) or aggradation (from a rise in base levels). Today, the net result of historic (and post-glacial) channel adjustments and historic channel modifications is a partially incised and entrenched channel in reach M40.**

Step 7 - Narrative: **Minor present adjustments. Reach persists in partly incised and somewhat overwidened state, with entrenchment locally enhanced at discrete sections of berming that cause IRhef > 2.0. Lateral adjustments moderated by rip-rap armoring, berms, tree buffers. Vertical adjustments moderated by impoundments that control local base levels at upstream and downstream ends of the reach (and possibly by armored stream bed).**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	**496**	**6**	**0**	
Road:	**568**	**4**	**460**	**8**
Railroad:	**0**		**0**	
Imp. Path:	**0**		**0**	
Dev.:	**724**		**57**	

1.4 Adjacent Side	Left	Right
Hillside Slope:	**Very Steep**	**Steep**
Continuous w/ Bank:	**Sometimes**	**Never**
Within 1 Bankfull W:	**Sometimes**	**Sometimes**
Texture:	**N.E.**	**N.E.**

1.5 Valley Features

Valley Width (ft):	**440**
Width Determination:	**Estimated**
Confinement Type:	**BD**
In Rock Gorge:	**No**
Human Caused Change in Valley Width?:	**Yes**

1.6 Grade Controls: **None**

Stream: **Black River** Reach: **M40-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**63.90**	2.11 Riffle/Step Spacing:	**610 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**3.30**	2.12 Substrate Composition		Bed:	
2.3 Mean Depth (tf):	**1.80**	Bedrock:	**0.0 %**	Bar:	
2.4 Floodprone Width (ft.):	**650.00**	Boulder:	**3.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**6.10**	Cobble:	**51.0 %**	Stream Type:	**C**
Human Elev FloodPln (ft.):		Coarse Gravel:	**35.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**35.50**	Fine Gravel:	**6.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**10.17**	Sand:	**5.0 %**	Bed Form:	**Plane Bed**
2.8 Incision Ratio:	**1.85**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**2.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**23**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Undercut**

Bank Texture	Left	Right
Upper		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**0.0**	**0.0**
Erosion Height (ft.):	**0.0**	**0.0**
Revetment Type:	**Rip-Rap**	**Rip-Rap**
Revetment Length:	**57.5**	**124.2**

Near Bank Vegetation Type	Left	Right
Dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Sub-dominant:	**Deciduous**	**Deciduous**
Bank Canopy		
Canopy %:	**76-100**	**51-75**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**51-100**
Sub-Dominant	**51-100**	**0-25**
W less than 25	**321**	**991**
Buffer Vegitation Type		
Dominant	**Mixed Trees**	**Mixed Trees**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**Residential**	**Residential**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Black River** Reach: **M40-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**

4.2 Adjacent Wetlands: **Minimal**

4.3 Flow Status: **Moderate**

4.4 # of Debris Jams: **0**

4.5 Flow Regulation Type **None**

Flow Reg. Use:

Impoundments:

Impoundment Loc.:

4.6 Up/Down Strm flow reg.: **Both**

(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs **None**

Field Ditch: Road Ditch:

Other: Tile Drain:

Overland Flow: Urb Strm Wtr Pipe:

4.9 # of Beaver Dams: **0**

Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	**52**	**Yes**	**Yes**	**Yes**	**Yes**	**Scour Below**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid: **1**	Delta: **1**		
Point: **2**	Island: **0**		
Side: **0**	Braiding: **0**	Diagonal: **0**	

5.2 Other Features

Flood chutes: **1**

Neck Cutoff: **0**

Avulsion: **0**

Head Cuts: **0**

Trib Rejuv.: **No**

5.3 Steep Riffles and Head Cuts

Steep Riffles: **0**

5.4 Stream Ford or Animal Crossing: **No**

5.5 Straightening: **Straightening**

Straightening Length (ft.): **3,036**

5.5 Dredging: **Dredging**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.: **8**

6.2 Pool Substrate: **11**

6.3 Pool Variability: **10**

Total Score: **118**

Habitat Rating: **0.59**

Habitat Stream Condition: **Fair**

6.4 Sediment Deposition: **13**

6.5 Channel Flow Status: **16**

6.6 Channel Alteration: **1**

6.7 Channel Sinuosity: **5**

Stream Gradiant Type	Left	Right
6.8 Bank Stability:	**10**	**10**
6.9 Bank Vegetation Protection	**10**	**9**
6.10 Riparian Veg. Zone Width:	**9**	**6**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**	Score	STD	Historic
7.1 Channel Degradation	**7**	**None**	**Yes**
7.2 Channel Aggradation	**13**	**None**	**Yes**
7.3 Widening Channel	**8**	**None**	**Yes**
7.4 Change in Planforml	**10**	**None**	**Yes**
Total Score	**38**		

Geomorphic Rating	**0.47**
Channel Evolution Model	**F**
Channel Evolution Stage	**III**
Geomorphic Condition	**Fair**
Stream Sensitivity	**High**

Phase 2 Segment Summary Report Black River

Stream:	**Buffalo Brook**	SGAT Version:	**4.56**
Reach:	**M41T6.01-A**	Organization:	**South Windsor County Regional Planning Commission**
Segment Length(ft):	**1,361**	Observers:	**KLU, BOS - SMRC**
Rain:	**Yes**	Completion Date:	**9/18/2009**
		Qualtiy Control Status - Consultant:	**Provisional**
		Qualtiy Control Status - Staff:	**Provisional**

Step 0 - Location: **Downstream from Scout Camp Road bridge to the confluence with Echo Lake**

Step 5 - Notes: **Improved paths are gravel park roads at grade. Development includes park buildings. Weak riffle/pool bedform; plane bed is evident especially in upper end of segment. Downstream flow regulation is natural impoundment of Echo Lake. Timber footbridge is a floodprone width constrictor. Historic map (and park history) indicates historic gold placer mining (i.e., gravel mining). Straightening inferred from linear planform. 10 largest on bar value assessed at side bar near upstream end of segment whereas bed value assessed at cross section near mid-point of segment. Bed substrates exhibit fining-downstream sequence.**

Step 7 - Narrative: **Moderate aggradation, especially lower half. Mod to substantial widening w/ localized planform adjustment. Historic incision. Lateral migration moderated by tree buffers & some streambank armoring. Early stage III[F].**

Step 1. Valley and Floodplain

1.1 Segmentation: **Subreach**

1.2 Alluvial Fan: **Yes**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	**0**		**0**	
Road:	**0**		**0**	
Railroad:	**0**		**0**	
Imp. Path:	**575**	**5**	**219**	**4**
Dev.:	**443**		**200**	

1.4 Adjacent Side	Left	Right
Hillside Slope:	**Steep**	**Flat**
Continuous w/ Bank:	**Never**	**Never**
Within 1 Bankfull W:	**Never**	**Never**
Texture:	**N.E.**	**N.E.**

1.5 Valley Features

Valley Width (ft):	**470**
Width Determination:	**Estimated**
Confinement Type:	**VB**
In Rock Gorge:	**No**
Human Caused Change in Valley Width?:	**No**

1.6 Grade Controls: **None**

Stream: **Buffalo Brook** Reach: **M41T6.01-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**32.60**	2.11 Riffle/Step Spacing:	**200 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**1.60**	2.12 Substrate Composition		Bed:	**180 mm**
2.3 Mean Depth (tf):	**0.67**	Bedrock:	**0.0 %**	Bar:	**170 mm**
2.4 Floodprone Width (ft.):	**35.00**	Boulder:	**1.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**4.40**	Cobble:	**49.0 %**	Stream Type:	**F**
Human Elev FloodPln (ft.):		Coarse Gravel:	**33.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**48.66**	Fine Gravel:	**12.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**1.07**	Sand:	**5.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**2.75**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Moderate**	Detritus:	**5.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Sedimented**	# Large Woody Debris:	**10**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Undercut**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**399.6**	**409.8**	Dominant:	**Deciduous**	**Deciduous**
Material Type:	**Gravel**	**Gravel**	Erosion Height (ft.):	**3.6**	**3.2**	Sub-dominant:	**Herbaceous**	**Herbaceous**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**None**	**Rip-Rap**	Bank Canopy		
Lower			Revetment Length:	**0.0**	**55.2**	Canopy %:	**76-100**	**51-75**
Material Type:	**Gravel**	**Gravel**				Mid-Channel Canopy:	**Open**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**0-25**
Sub-Dominant	**26-50**	**>100**
W less than 25	**0**	**0**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Deciduous**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Forest**	**Residential**	Mass Failures		
Sub-dominant	**Residential**	**Forest**	Height		
(Legacy)	Amount	Mean Hieght	Gullies Number	**0**	
Failures	**None**		Gullies Length	**0**	
Gullies	**None**				

Stream: **Buffalo Brook** Reach: **M41T6.01-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **None**
4.2 Adjacent Wetlands: **Minimal**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **0**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs **None**
Field Ditch: Road Ditch:
Other: Tile Drain:
Overland Flow: Urb Strm Wtr Pipe:
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	**39**	**Yes**	**Yes**	**No**	**Yes**	**None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **1** Point: **0** Side: **8**
Diagonal: **1** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features
Flood chutes: **1**
Neck Cutoff: **0** Avulsion: **0**

5.3 Steep Riffles and Head Cuts
Steep Riffles: **3** Head Cuts: **0** Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**
5.5 Straightening: **Straightening**
Straightening Length (ft.): **957**
5.5 Dredging: **Gravel Mining**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.: **6**
6.2 Pool Substrate: **10**
6.3 Pool Variability: **11**
Total Score: **104**
Habitat Rating: **0.52**
Habitat Stream Condition: **Fair**

6.4 Sediment Deposition: **13**
6.5 Channel Flow Status: **8**
6.6 Channel Alteration: **5**
6.7 Channel Sinuosity: **17**

Stream Gradiant Type	Left	Right
6.8 Bank Stability:	**6**	**6**
6.9 Bank Vegetation Protection	**6**	**6**
6.10 Riparian Veg. Zone Width:	**8**	**2**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**	Score	STD	Historic
7.1 Channel Degradation	**3**	**C to F**	**Yes**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**8**	**None**	**No**
7.4 Change in Planforml	**11**	**None**	**No**
Total Score	**33**		

Geomorphic Rating **0.41**
Channel Evolution Model **F**
Channel Evolution Stage **III**
Geomorphic Condition **Fair**
Stream Sensitivity **Extreme**

Phase 2 Segment Summary Report   Black River

Stream: **Buffalo Brook**
Reach: **M41T6.01-B**

Segment Length(ft): **649**
Rain: **Yes**

SGAT Version: **4.56**
Organization: **South Windsor County Regional Planning Commission**
Observers: **KLU - SMRC**
Completion Date: **9/18/2009**
Qualtiy Control Status - Consultant: **Provisional**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **From base bedrock gorge past cabins of Camp Plymouth State Park to Scout Camp Road bridge.**

Step 5 - Notes: **Berms along both banks. State Park cabins along RB. Bankfull-constricting bridge crossing (Scout Camp Road). Sharp approach angle with stepped footer (LB) and cracked, spalling abutment (RB). Downstream flow regulation is natural impoundment of Echo Lake. Channelization suspected given linear planform and berms on either bank. Historic gold placer mining.**

Step 7 - Narrative: **Historic incision leading to partial entrenchment, accentuated by berm installments on both banks. Minor (neglible) lateral adjustments - moderated (under most flows) by erosion-resistance of bed & banks, armoring, tree buffers. However, susceptible to catastrophic erosion in future flood due to partially incised and entrenched condition. Overrode RGA classification to Fair due to human modifications (armoring, berming, straigtening) that have reduced functionality of the reach/floodplain and constrained the reach from adjusting toward a more natural form, despite metrics and feature observations that suggest minor to moderate present (and/or historic) net state of adjustment and/or departure, resulting in an overall ranking in the "Good" quadrant of the RGA. Overrode sensitivity classification to Extreme due to location at marked reduction in valley gradient & confinement ("alluvial fan").**

Step 1. Valley and Floodplain

1.1 Segmentation: **Subreach**

1.2 Alluvial Fan: **Yes**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		411	4
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		69	4
Dev.:	188		30	

1.4 Adjacent Side

	Left	Right
Hillside Slope:	Hilly	Hilly
Continuous w/ Bank:	Never	Sometimes
Within 1 Bankfull W:	Never	Sometimes
Texture:	N.E.	N.E.

1.5 Valley Features

Valley Width (ft): **290**
Width Determination: **Estimated**
Confinement Type: **VB**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **No**

1.6 Grade Controls: **None**

Stream: **Buffalo Brook** Reach: **M41T6.01-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**20.00**	2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**1.40**	2.12 Substrate Composition		Bed:	**N/A**
2.3 Mean Depth (tf):	**1.03**	Bedrock:	**0.0 %**	Bar:	**N/A**
2.4 Floodprone Width (ft.):	**150.00**	Boulder:	**11.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**2.30**	Cobble:	**44.0 %**	Stream Type:	**C**
Human Elev FloodPln (ft.):	**2.50**	Coarse Gravel:	**29.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**19.42**	Fine Gravel:	**10.0 %**	Subclass Slope:	**b**
2.7 Entrenchment Ratio:	**7.50**	Sand:	**6.0 %**	Bed Form:	**Plane Bed**
2.8 Incision Ratio:	**1.64**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**1.79**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**2.0 %**	Reference Stream Type:	**C**
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**4**	Reference Bed Material:	**Cobble**
				Reference Subclass Slope:	**b**
				Reference Bedform:	**Riffle-Pool**

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Gravel**	**Gravel**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Gravel**	**Gravel**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**69.6**	**103.5**
Erosion Height (ft.):	**2.0**	**2.0**
Revetment Type:	**Rip-Rap**	**Rip-Rap**
Revetment Length:	**80.3**	**481.7**

Near Bank Vegetation Type	Left	Right
Dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Sub-dominant:	**Deciduous**	**Deciduous**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**0-25**
Sub-Dominant	**0-25**	**26-50**
W less than 25	**56**	**418**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Deciduous**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Residential**
Sub-dominant	**None**	**Forest**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Buffalo Brook** Reach: **M41T6.01-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **None**
4.2 Adjacent Wetlands: **None**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **0**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs
Field Ditch: **0** Road Ditch: **0**
Other: **0** Tile Drain: **0**
Overland Flow: **1** Urb Strm Wtr Pipe: **0**
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	**15**	**Yes**	**Yes**	**Yes**	**Yes**	**Deposition Above,Deposition Below,Scour Below,Alignment**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **0** Point: **0** Side: **2**
Diagonal: **0** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features
Flood chutes: **0**
Neck Cutoff: **0**
Avulsion: **0**

5.3 Steep Riffles and Head Cuts
Steep Riffles: **0**
Head Cuts: **0**
Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**
5.5 Straightening: **Straightening**
Straightening Length (ft.): **623**
5.5 Dredging: **Gravel Mining**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.: **8**
6.2 Pool Substrate: **11**
6.3 Pool Variability: **10**
Total Score: **109**
Habitat Rating: **0.55**
Habitat Stream Condition: **Fair**

6.4 Sediment Deposition: **14**
6.5 Channel Flow Status: **13**
6.6 Channel Alteration: **6**
6.7 Channel Sinuosity: **5**

Stream Gradiant Type	Left	Right
6.8 Bank Stability:	**7**	**7**
6.9 Bank Vegetation Protection	**9**	**7**
6.10 Riparian Veg. Zone Width:	**10**	**2**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**	Score	STD	Historic
7.1 Channel Degradation	**8**	**None**	**Yes**
7.2 Channel Aggradation	**15**	**None**	**No**
7.3 Widening Channel	**16**	**None**	**No**
7.4 Change in Planforml	**16**	**None**	**Yes**
Total Score	**55**		

Geomorphic Rating **0.69**
Channel Evolution Model **F**
Channel Evolution Stage **II**
Geomorphic Condition **Fair**
Stream Sensitivity **Extreme**

Phase 2 Segment Summary Report   Black River

Stream: **Buffalo Brook**
Reach: **M41T6.02-A**

Segment Length(ft): **1,556**
Rain: **No**

SGAT Version: **4.56**
Organization: **South Windsor County Regional Planning Commission**
Observers: **KLU, BOS - SMRC**
Completion Date: **9/24/2009**
Qualtiy Control Status - Consultant: **Provisional**
Qualtiy Control Status - Staff: **Provisional**
Why Not Assessed: **bedrock gorge**

Step 0 - Location: **Downstream end of reach ending at base of bedrock gorge, Camp Plymouth State Park, east of Scout Camp Road.**

Step 5 - Notes:

Step 7 - Narrative:

Step 1. Valley and Floodplain

1.1 Segmentation: **Subreach**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

	Length (ft) One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	512	12	0	
Dev.:	0		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Extr.Steep	Extr.Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Always	Always
Texture:	Bedrock	Bedrock

1.5 Valley Features

Valley Width (ft): **35**
Width Determination: **Estimated**
Confinement Type: **SC**
In Rock Gorge: **Yes**
Human Caused Change in Valley Width?: **No**

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Waterfall	Mid-segment	4.0	2.0	Yes	
Waterfall	Mid-segment	50.0	48.0	Yes	

Stream: **Buffalo Brook** Reach: **M41T6.02-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):
2.2 Max Depth (ft.):
2.3 Mean Depth (tf):
2.4 Floodprone Width (ft.):
2.5 Aband. Floodpn (ft.):
Human Elev FloodPln (ft.):
2.6 Width/Depth Ratio: **0.00**
2.7 Entrenchment Ratio: **0.00**
2.8 Incision Ratio: **0.00**
Human Elevated Inc. Rat.: **0.00**
2.9 Sinuosity:
2.10 Riffles Type:

2.11 Riffle/Step Spacing:
2.12 Substrate Composition
Bedrock: %
Boulder: %
Cobble: %
Coarse Gravel: %
Fine Gravel: %
Sand: %
Silt and Smaller: %
Silt/Clay Present:
Detritus: %
Large Woody Debris:

2.13 Average Largest Particle on
Bed:
Bar:
2.14 Stream Type
Stream Type:
Bed Material:
Subclass Slope:
Bed Form:
Field Measured Slope:
2.15 Sub-reach Stream Type
Reference Stream Type:
Reference Bed Material:
Reference Subclass Slope:
Reference Bedform:

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Bedrock**	**Bedrock**
Consistency:	**Cohesive**	**Cohesive**
Lower		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**298.8**	**60.8**
Erosion Height (ft.):	**2.0**	**2.0**
Revetment Type:	**None**	**None**
Revetment Length:	**0.0**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Coniferous**	**Coniferous**
Sub-dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**26-50**	**26-50**
W less than 25	**0**	**0**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Coniferous**
Sub-Dominant	**Deciduous**	**Deciduous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**None**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Buffalo Brook** Reach: **M41T6.02-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type	**None**	4.7 Stormwater Inputs	**None**
4.2 Adjacent Wetlands:	**None**	Flow Reg. Use:		Field Ditch:	Road Ditch:
4.3 Flow Status:	**Moderate**	Impoundments:		Other:	Tile Drain:
4.4 # of Debris Jams:	**0**	Impoundment Loc.:		Overland Flow:	Urb Strm Wtr Pipe:
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:	**0**
		(old) Upstrm Flow Reg.:		Affected Length (ft):	**0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**1**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**No**
Mid:	**1**	Delta:	**0**	Flood chutes:	**0**	Avulsion:	**0**	5.5 Straightening:	**None**
Point:	**1**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**0**
Side:	**2**	Braiding:	**0**	Steep Riffles:	**0**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	6.4 Sediment Deposition:	Stream Gradiant Type	Left	Right
6.2 Pool Substrate:	6.5 Channel Flow Status:	6.8 Bank Stability:		
6.3 Pool Variability:	6.6 Channel Alteration:	6.9 Bank Vegetation Protection		
Total Score:	6.7 Channel Sinuosity:	6.10 Riparian Veg. Zone Width:		
Habitat Rating:				
Habitat Stream Condition:				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Score	STD	Historic	
7.1 Channel Degradation				Geomorphic Rating
7.2 Channel Aggradation				Channel Evolution Model
7.3 Widening Channel				Channel Evolution Stage
7.4 Change in Planforml				Geomorphic Condition
Total Score				Stream Sensitivity

Phase 2 Segment Summary Report Black River

Stream:	**Buffalo Brook**	SGAT Version:	**4.56**
Reach:	**M41T6.02-B**	Organization:	**South Windsor County Regional Planning Commission**
Segment Length(ft):	**5,083**	Observers:	**KLU, BOS - SMRC**
Rain:	**No**	Completion Date:	**9/24/2009**
		Qualtiy Control Status - Consultant:	**Provisional**
		Qualtiy Control Status - Staff:	**Provisional**

Step 0 - Location: **Extends nearly one mile downstream from confluence of Reading Pond Brook**

Step 5 - Notes: **Bedrock is exposed along the banks in a few locations; three locations of channel-spanning ledge. Abandoned forest road follows along either bank or both for a majority of the segment length. Generally, the road follows the grade of a terrace on either side of the channel, or is occasionally notched into the valley wall. In a few locations where bedrock creates a valley pinch point, the road climbs the valley wall up and over the bedrock outcrop. Overland flow from road segments. Likely gravel mining associated with historic gold mining.**

Step 7 - Narrative: **Substantial planform adjustments (avulsions, flood chutes) facilitated by abandoned forest road network (removal of trees, concentration of runoff). Minor aggradation. Historic incision leading to stream type departure. Moderate historic widening moderated by erosion-resistance of bed and banks, including some vertical and lateral bedrock controls. Extreme Sens due to Cb to Fb STD.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	**0**		**0**	
Road:	**0**		**0**	
Railroad:	**0**		**0**	
Imp. Path:	**3,427**	**6**	**420**	**7**
Dev.:	**0**		**0**	

1.4 Adjacent Side	Left	Right
Hillside Slope:	**Extr.Steep**	**Extr.Steep**
Continuous w/ Bank:	**Sometimes**	**Sometimes**
Within 1 Bankfull W:	**Sometimes**	**Sometimes**
Texture:	**N.E.**	**N.E.**

1.5 Valley Features

Valley Width (ft):	**85**
Width Determination:	**Estimated**
Confinement Type:	**SC**
In Rock Gorge:	**No**
Human Caused Change in Valley Width?:	**No**

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	**Mid-segment**	**1.0**	**1.0**	**Yes**	
Ledge	**Mid-segment**	**1.0**	**0.0**	**No**	
Ledge	**Mid-segment**	**1.0**	**1.0**	**No**	

Stream: **Buffalo Brook** Reach: **M41T6.02-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**24.40**	2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**1.35**	2.12 Substrate Composition		Bed:	**450 mm**
2.3 Mean Depth (tf):	**0.94**	Bedrock:	**4.0 %**	Bar:	**135 mm**
2.4 Floodprone Width (ft.):	**28.00**	Boulder:	**7.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**5.30**	Cobble:	**36.0 %**	Stream Type:	**F**
Human Elev FloodPln (ft.):		Coarse Gravel:	**38.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**25.96**	Fine Gravel:	**8.0 %**	Subclass Slope:	**b**
2.7 Entrenchment Ratio:	**1.15**	Sand:	**7.0 %**	Bed Form:	**Plane Bed**
2.8 Incision Ratio:	**3.93**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**3.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**62**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Undercut**

Bank Texture	Left	Right
Upper		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**70.1**	**185.6**
Erosion Height (ft.):	**2.0**	**3.0**
Revetment Type:	**None**	**Rip-Rap**
Revetment Length:	**0.0**	**33.7**

Near Bank Vegetation Type	Left	Right
Dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Sub-dominant:	**Deciduous**	**Deciduous**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**0-25**	**0-25**
W less than 25	**2,041**	**1,972**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Coniferous**
Sub-Dominant	**Deciduous**	**Deciduous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**None**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Buffalo Brook** Reach: **M41T6.02-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type	**None**	4.7 Stormwater Inputs			
4.2 Adjacent Wetlands:	**None**	Flow Reg. Use:		Field Ditch:	**0**	Road Ditch:	**1**
4.3 Flow Status:	**Moderate**	Impoundments:		Other:	**0**	Tile Drain:	**0**
4.4 # of Debris Jams:	**5**	Impoundment Loc.:		Overland Flow:	**11**	Urb Strm Wtr Pipe:	**0**
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:			**0**
		(old) Upstrm Flow Reg.:		Affected Length (ft):			**0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**0**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**Yes**
Mid:	**4**	Delta:	**0**	Flood chutes:	**7**	Avulsion:	**3**	5.5 Straightening:	**None**
Point:	**3**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**0**
Side:	**5**	Braiding:	**0**	Steep Riffles:	**0**	Trib Rejuv.:	**No**	5.5 Dredging:	**Gravel Mining**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	**8**	6.4 Sediment Deposition:	**14**	Stream Gradiant Type	Left	Right
6.2 Pool Substrate:	**13**	6.5 Channel Flow Status:	**13**	6.8 Bank Stability:	**8**	**8**
6.3 Pool Variability:	**11**	6.6 Channel Alteration:	**18**	6.9 Bank Vegetation Protection	**10**	**10**
Total Score:	**137**	6.7 Channel Sinuosity:	**6**	6.10 Riparian Veg. Zone Width:	**9**	**9**
Habitat Rating:	**0.69**					
Habitat Stream Condition:	**Good**					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Confined** Score	STD	Historic		
7.1 Channel Degradation	**3**	**C to F**	**Yes**	Geomorphic Rating	**0.44**
7.2 Channel Aggradation	**13**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**11**	**None**	**No**	Channel Evolution Stage	**II**
7.4 Change in Planforml	**8**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score	**35**			Stream Sensitivity	**Extreme**

Phase 2 Segment Summary Report Black River

Stream: **Reading Pond Brook**
Reach: **M41T6.02S1.01-A**

Segment Length(ft): **5,564**
Rain: **Yes**

SGAT Version: **4.56**
Organization: **South Windsor County Regional Planning Commission**
Observers: **KLU, BOS - SMRC**
Completion Date: **9/17/2009**
Qualtiy Control Status - Consultant: **Provisional**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **Downstream segment of reach beginning downstream of Reading Pond Road and ending at confluence with Buffalo Brook**

Step 5 - Notes: **Valley width somewhat narrower in this segment as compared to upstream Segment B. Channel confined by higher terraces ranging in thalweg height from 8 to 18 feet and higher. Fewer discontinuous lower terraces than Segment B - at thalweg heights of 4 to 5 feet, or 2 to 2.5 times the bankfull height. Fewer occurrences of mass failures and bank erosion generally. Four occurrences of bedrock grade controls (waterfalls); few exposures of bedrock along the valley walls. Often fine to medium gravels have accumulated upstream of large boulder steps or entrained LWD in forced bars. A few leaning trees or saplings, suggesting ongoing planform adjustments or localized widening. But overall less actively adjusting than upstream Segment B. Abandoned forest road joins the stream valley from the LB corridor near the downstream end of the segment and crosses at one location to the RB. Uncertain whether the nickpoint observed was in fact a head cut. There appeared to be a little recent incision in the vicinity with erosion evident along both banks in a somewhat straight section of channel. But this location at the head of the segment was not representative of Segment A as a whole. In hind sight, the Segment break could have been located a little bit further downstream. In contrast to the upstream segment B, no rejuvenating tributaries were noted in Segment A; exposed tree roots along the banks were infrequent and weathered; LWD in the channel was weathered and stripped of small, leafed branches; trees leaning into the channel were fairly rare. If it is a headcut, it is likely to "wash out" within a fairly short distance upstream, due to steepness of the channel, and ongoing colluvial processes that are resulting in local sediment production.**

Step 7 - Narrative: **Aggradation and planform adjustments (flood chutes) - localized, forced at entrained LWD or boulder steps. Historic widening; historic incision. Lateral and vertical adjustments moderated by occasional bedrock exposures, coarseness of bed/bank materials, and closely-confining valley walls. Historic incision may be partly historical, partly post-glacial. Extreme sens due to Ba to Fa STD.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**
1.2 Alluvial Fan: **None**
1.3 Corridor Encroachments:

	Length (ft) One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	1,465	7	0	
Dev.:	0		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Extr.Steep	Extr.Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	Mixed	N.E.

1.5 Valley Features
Valley Width (ft): **40**
Width Determination: **Estimated**
Confinement Type: **NC**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **No**

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Waterfall	Mid-segment	9.0	7.0	Yes	
Waterfall	Mid-segment	9.0	6.0	Yes	
Waterfall	Mid-segment	12.0	10.0	No	
Waterfall	Mid-segment	4.0	4.0	Yes	

Stream: **Reading Pond Brook** Reach: **M41T6.02S1.01-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**23.40**	2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.20**	2.12 Substrate Composition		Bed:	**250 mm**
2.3 Mean Depth (tf):	**1.56**	Bedrock:	**0.0 %**	Bar:	**94 mm**
2.4 Floodprone Width (ft.):	**24.00**	Boulder:	**7.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**4.80**	Cobble:	**33.0 %**	Stream Type:	**F**
Human Elev FloodPln (ft.):		Coarse Gravel:	**44.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**15.00**	Fine Gravel:	**4.0 %**	Subclass Slope:	**a**
2.7 Entrenchment Ratio:	**1.03**	Sand:	**12.0 %**	Bed Form:	**Plane Bed**
2.8 Incision Ratio:	**2.18**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**2.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**44**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Undercut**

Bank Texture	Left	Right
Upper		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**368.5**	**793.7**
Erosion Height (ft.):	**2.5**	**3.2**
Revetment Type:	**None**	**None**
Revetment Length:	**0.0**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Sub-dominant:	**Deciduous**	**Deciduous**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**0-25**	**0-25**
W less than 25	**1,210**	**166**
Buffer Vegitation Type		
Dominant	**Mixed Trees**	**Mixed Trees**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**None**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**18.0**
Gullies	**None**	

	Left	Right
Mass Failures	**216.3**	**92.16**
Height	**17.3**	**16.8**
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Reading Pond Brook** Reach: **M41T6.02S1.01-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Abundant**	4.5 Flow Regulation Type	**None**	4.7 Stormwater Inputs			
4.2 Adjacent Wetlands:	**None**	Flow Reg. Use:		Field Ditch:	**0**	Road Ditch:	**0**
4.3 Flow Status:	**Moderate**	Impoundments:		Other:	**0**	Tile Drain:	**0**
4.4 # of Debris Jams:	**4**	Impoundment Loc.:		Overland Flow:	**1**	Urb Strm Wtr Pipe:	**0**
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:	**0**		
		(old) Upstrm Flow Reg.:		Affected Length (ft):	**0**		

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**0**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**Yes**
Mid:	**7**	Delta:	**1**	Flood chutes:	**7**	Avulsion:	**0**	5.5 Straightening:	**None**
Point:	**4**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**1**	Straightening Length (ft.):	**0**
Side:	**8**	Braiding:	**0**	Steep Riffles:	**0**	Trib Rejuv.:	**No**	5.5 Dredging:	**Gravel Mining**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	**11**	6.4 Sediment Deposition:	**13**	Stream Gradiant Type	Left	Right
6.2 Pool Substrate:	**13**	6.5 Channel Flow Status:	**10**	6.8 Bank Stability:	**8**	**7**
6.3 Pool Variability:	**13**	6.6 Channel Alteration:	**18**	6.9 Bank Vegetation Protection	**8**	**7**
Total Score:	**131**	6.7 Channel Sinuosity:	**6**	6.10 Riparian Veg. Zone Width:	**8**	**9**
Habitat Rating:	**0.65**					
Habitat Stream Condition:	**Good**					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Confined** Score	STD	Historic		
7.1 Channel Degradation	**5**	**B to F**	**Yes**	Geomorphic Rating	**0.40**
7.2 Channel Aggradation	**8**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**11**	**None**	**Yes**	Channel Evolution Stage	**III**
7.4 Change in Planforml	**8**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score	**32**			Stream Sensitivity	**Extreme**

Phase 2 Segment Summary Report Black River

Stream:	**Reading Pond Brook**	SGAT Version:	**4.56**
Reach:	**M41T6.02S1.01-B**	Organization:	**South Windsor County Regional Planning Commission**
Segment Length(ft):	**3,374**	Observers:	**KLU, BOS - SMRC**
Rain:	**Yes**	Completion Date:	**9/17/2009**
		Qualtiy Control Status - Consultant:	**Provisional**
		Qualtiy Control Status - Staff:	**Provisional**

Step 0 - Location: **Upstream segment of reach beginning downstream of Reading Pond Road and ending at confluence with Buffalo Brook**

Step 5 - Notes: **Valley walls are defined by high terraces ranging from 7 to 20 feet high (or 3.5 to 10 times bankfull depth). Set of discontinuous lower terraces from 1.5 to 4 feet high (or 1 to 2 times bankfull depth - may represent RAF. One waterfall grade control indexed mid-reach. Couple other exposures of lateral bedrock grade controls. Several mass failures in glacial till are exposed where channel impinges upon the higher terraces. Reference B3a-S/P which is undergoing considerable vertical and lateral adjustments, presumably as a response to the 2006 flood event and sudden breaching of the Reading Pond. Bedform departure is evident in several sections from step/pool to cascade flows around LWD and boulders and large cobbles liberated by mass failures and high bank erosion. Frequent side and point bars forced at debris jams, LWD and detritus; frequent flood chutes and bifurcated channel sections around these obstacles. Width / depth ratio (26) is quite large for a semi-confined, steep-gradient channel, suggesting active widening. Widening is also suggested in several locations by trees freshly uprooted and leaning into the channel from both banks. Evidence of rejuvenating tributaries. Evidence of three possible breached earthen dams and partially excavated terraces - possibly associated with historic gold placer mining.**

Step 7 - Narrative: **Localized active incision overlapping historic incision; significant widening, localized aggradation and planform adjustment. Incision and widening moderated by coarseness of bed substrates, and closely confining, somewhat cohesive valley walls. Colluvial processes contributing sediments and large woody debris, resulting in lesser degree of net incision, perhaps.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	**0**		**0**	
Road:	**0**		**0**	
Railroad:	**0**		**0**	
Imp. Path:	**0**		**0**	
Dev.:	**0**		**0**	

1.4 Adjacent Side	Left	Right
Hillside Slope:	**Extr.Steep**	**Extr.Steep**
Continuous w/ Bank:	**Sometimes**	**Sometimes**
Within 1 Bankfull W:	**Sometimes**	**Sometimes**
Texture:	**Mixed**	**Mixed**

1.5 Valley Features

Valley Width (ft):	**55**
Width Determination:	**Estimated**
Confinement Type:	**SC**
In Rock Gorge:	**No**
Human Caused Change in Valley Width?:	**No**

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Waterfall	**Mid-segment**	**6.0**	**5.0**	**Yes**	

Stream: **Reading Pond Brook** Reach: **M41T6.02S1.01-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**18.50**	2.11 Riffle/Step Spacing:	**10 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**1.80**	2.12 Substrate Composition		Bed:	**250 mm**
2.3 Mean Depth (tf):	**1.18**	Bedrock:	**0.0 %**	Bar:	**100 mm**
2.4 Floodprone Width (ft.):	**38.00**	Boulder:	**10.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**3.20**	Cobble:	**52.0 %**	Stream Type:	**B**
Human Elev FloodPln (ft.):		Coarse Gravel:	**22.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**15.68**	Fine Gravel:	**8.0 %**	Subclass Slope:	**a**
2.7 Entrenchment Ratio:	**2.05**	Sand:	**8.0 %**	Bed Form:	**Step-Pool**
2.8 Incision Ratio:	**1.78**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**5.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**38**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Undercut**

Bank Texture	Left	Right
Upper		
Material Type:	**Mix**	**Mix**
Consistency:	**Cohesive**	**Cohesive**
Lower		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**1,033.8**	**847.8**
Erosion Height (ft.):	**4.7**	**4.3**
Revetment Type:	**None**	**None**
Revetment Length:	**0.0**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Sub-dominant:	**Deciduous**	**Deciduous**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**None**	**None**
W less than 25	**0**	**0**
Buffer Vegitation Type		
Dominant	**Mixed Trees**	**Mixed Trees**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**None**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**13.9**
Gullies	**None**	

	Left	Right
Mass Failures	**364.3**	**264.98**
Height	**13.4**	**15.0**
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Reading Pond Brook** Reach: **M41T6.02S1.01-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Abundant**	4.5 Flow Regulation Type	**None**	4.7 Stormwater Inputs	**None**
4.2 Adjacent Wetlands:	**None**	Flow Reg. Use:		Field Ditch:	Road Ditch:
4.3 Flow Status:	**Moderate**	Impoundments:		Other:	Tile Drain:
4.4 # of Debris Jams:	**3**	Impoundment Loc.:		Overland Flow:	Urb Strm Wtr Pipe:
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:	**0**
		(old) Upstrm Flow Reg.:		Affected Length (ft):	**0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**0**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**No**
Mid:	**3**	Delta:	**1**	Flood chutes:	**9**	Avulsion:	**0**	5.5 Straightening:	**None**
Point:	**3**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**0**
Side:	**5**	Braiding:	**2**	Steep Riffles:	**2**	Trib Rejuv.:	**Yes**	5.5 Dredging:	**Gravel Mining**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	**11**	6.4 Sediment Deposition:	**13**	Stream Gradiant Type	Left	Right
6.2 Pool Substrate:	**13**	6.5 Channel Flow Status:	**10**	6.8 Bank Stability:	**8**	**7**
6.3 Pool Variability:	**13**	6.6 Channel Alteration:	**18**	6.9 Bank Vegetation Protection	**8**	**7**
Total Score:	**131**	6.7 Channel Sinuosity:	**6**	6.10 Riparian Veg. Zone Width:	**8**	**9**
Habitat Rating:	**0.65**					
Habitat Stream Condition:	**Good**					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Confined** Score	STD	Historic		
7.1 Channel Degradation	**7**	**None**	**No**	Geomorphic Rating	**0.36**
7.2 Channel Aggradation	**8**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**6**	**None**	**No**	Channel Evolution Stage	**III**
7.4 Change in Planforml	**8**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score	**29**			Stream Sensitivity	**High**

Phase 2 Segment Summary Report   Black River

Stream:	**Reading Pond Brook**	SGAT Version:	**4.56**
Reach:	**M41T6.02S1.02-A**	Organization:	**South Windsor County Regional Planning Commission**
Segment Length(ft):	**505**	Observers:	**KLU, BOS - SMRC**
Rain:	**Yes**	Completion Date:	**9/4/2009**
		Qualtiy Control Status - Consultant:	**Provisional**
		Qualtiy Control Status - Staff:	**Provisional**

Step 0 - Location: **Downstream segment of reach, located downstream of Reading Pond Road culvert crossing.**

Step 5 - Notes: **Short subreach of alternative reference stream type: Semi-confined, steep gradient B3-S/P channel downstream of the Reading Pond Road culvert, in an otherwise Unconfined, lesser-gradient reach. Segment appears to have undergone recent incision - possibly related to the June 2006 flood. Widening may have been moderated by the close confinement of forested valley walls comprised of glacial till.**

Step 7 - Narrative: **Recent incision overprinted on historic or postglacial incision. Substantial widening; moderate planform adjustment, minor aggradation (transport reach). B to Fb stream type departure.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Subreach**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	**0**		**0**	
Road:	**0**		**0**	
Railroad:	**0**		**0**	
Imp. Path:	**0**		**0**	
Dev.:	**0**		**0**	

1.4 Adjacent Side

	Left	Right
Hillside Slope:	**Extr.Steep**	**Extr.Steep**
Continuous w/ Bank:	**Sometimes**	**Sometimes**
Within 1 Bankfull W:	**Sometimes**	**Sometimes**
Texture:	**N.E.**	**N.E.**

1.5 Valley Features

Valley Width (ft):	**30**
Width Determination:	**Estimated**
Confinement Type:	**SC**
In Rock Gorge:	**No**
Human Caused Change in Valley Width?:	**No**

1.6 Grade Controls: **None**

Stream: **Reading Pond Brook** Reach: **M41T6.02S1.02-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**15.20**	2.11 Riffle/Step Spacing:	**10 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**1.10**	2.12 Substrate Composition		Bed:	**250** mm
2.3 Mean Depth (tf):	**0.57**	Bedrock:	**0.0 %**	Bar:	**N/A** mm
2.4 Floodprone Width (ft.):	**16.00**	Boulder:	**11.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**2.20**	Cobble:	**40.0 %**	Stream Type:	**F**
Human Elev FloodPln (ft.):		Coarse Gravel:	**20.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**26.67**	Fine Gravel:	**15.0 %**	Subclass Slope:	**b**
2.7 Entrenchment Ratio:	**1.05**	Sand:	**14.0 %**	Bed Form:	**Cascade**
2.8 Incision Ratio:	**2.00**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**5.0 %**	Reference Stream Type:	**B**
2.10 Riffles Type:	**Not Applicable**	# Large Woody Debris:	**19**	Reference Bed Material:	**Cobble**
				Reference Subclass Slope:	**None**
				Reference Bedform:	**Step-Pool**

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**80.2**	**42.8**
Erosion Height (ft.):	**3.0**	**3.0**
Revetment Type:	**None**	**None**
Revetment Length:	**0.0**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Herbaceous**	**Herbaceous**
Sub-dominant:	**Deciduous**	**Deciduous**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**None**	**None**
W less than 25	**4**	**63**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Deciduous**
Sub-Dominant	**Coniferous**	**Coniferous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**None**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**7.5**
Gullies	**None**	

	Left	Right
Mass Failures	**22.8**	**47.63**
Height	**6.0**	**9.0**
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Reading Pond Brook**   Reach: **M41T6.02S1.02-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Abundant**	4.5 Flow Regulation Type	**None**	4.7 Stormwater Inputs	**None**
4.2 Adjacent Wetlands:	**None**	Flow Reg. Use:		Field Ditch:	Road Ditch:
4.3 Flow Status:	**Moderate**	Impoundments:		Other:	Tile Drain:
4.4 # of Debris Jams:	**1**	Impoundment Loc.:		Overland Flow:	Urb Strm Wtr Pipe:
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:	**0**
		(old) Upstrm Flow Reg.:		Affected Length (ft):	**0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**1**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**No**
Mid:	**0**	Delta:	**0**	Flood chutes:	**0**	Avulsion:	**0**	5.5 Straightening:	**Straightening**
Point:	**1**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**16**
Side:	**0**	Braiding:	**0**	Steep Riffles:	**1**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	**15**	6.4 Sediment Deposition:	**15**	Stream Gradiant Type	Left	Right
6.2 Pool Substrate:	**15**	6.5 Channel Flow Status:	**13**	6.8 Bank Stability:	**7**	**8**
6.3 Pool Variability:	**16**	6.6 Channel Alteration:	**18**	6.9 Bank Vegetation Protection	**7**	**8**
Total Score:	**160**	6.7 Channel Sinuosity:	**18**	6.10 Riparian Veg. Zone Width:	**10**	**10**
Habitat Rating:	**0.80**					
Habitat Stream Condition:	**Good**					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Confined** Score	STD	Historic		
7.1 Channel Degradation	**5**	**B to F**	**No**	Geomorphic Rating	**0.49**
7.2 Channel Aggradation	**15**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**8**	**None**	**No**	Channel Evolution Stage	**III**
7.4 Change in Planforml	**11**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score	**39**			Stream Sensitivity	**Extreme**

Phase 2 Segment Summary Report Black River

Stream:	**Reading Pond Brook**	SGAT Version:	**4.56**
Reach:	**M41T6.02S1.02-B**	Organization:	**South Windsor County Regional Planning Commission**
Segment Length(ft):	**1,360**	Observers:	**KLU, BOS - SMRC**
Rain:	**Yes**	Completion Date:	**9/4/2009**
		Qualtiy Control Status - Consultant:	**Provisional**
		Qualtiy Control Status - Staff:	**Provisional**

Step 0 - Location: **Middle segment of the reach, located upstream of Reading Pond Road culvert crossing**

Step 5 - Notes: **Given the documented gold mining and logging history in the area, floodplain features within this segment, suggest an abandoned small flow diversion to an adjacent pond, associated with two possibly straightened channel sections - one of which the river has now abandoned as a result of an avulsion. Upstream flow regulation is the former Reading Pond run-of-river dam that breached in June 2006. Reading Pond Road crosses at a bankfull-constricting culvert. Road ditches drain directly to the brook (stormwater inputs).**

Step 7 - Narrative: **Substantial planform adjustments (avulsions, flood chutes) in response to historic incision, and historic planform adjustment.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	**0**		**0**	
Road:	**0**		**0**	
Railroad:	**0**		**0**	
Imp. Path:	**0**		**0**	
Dev.:	**0**		**47**	

1.6 Grade Controls: **None**

1.4 Adjacent Side	Left	Right
Hillside Slope:	**Very Steep**	**Very Steep**
Continuous w/ Bank:	**Sometimes**	**Sometimes**
Within 1 Bankfull W:	**Sometimes**	**Sometimes**
Texture:	**N.E.**	**N.E.**

1.5 Valley Features

Valley Width (ft):	**170**
Width Determination:	**Estimated**
Confinement Type:	**VB**
In Rock Gorge:	**No**
Human Caused Change in Valley Width?:	**No**

Stream: **Reading Pond Brook** Reach: **M41T6.02S1.02-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**15.50**	2.11 Riffle/Step Spacing:	**80 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**1.00**	2.12 Substrate Composition		Bed:	**170 mm**
2.3 Mean Depth (tf):	**0.60**	Bedrock:	**0.0 %**	Bar:	**120 mm**
2.4 Floodprone Width (ft.):	**40.00**	Boulder:	**5.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**1.60**	Cobble:	**29.0 %**	Stream Type:	**C**
Human Elev FloodPln (ft.):		Coarse Gravel:	**58.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**25.83**	Fine Gravel:	**5.0 %**	Subclass Slope:	**b**
2.7 Entrenchment Ratio:	**2.58**	Sand:	**2.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.60**	Silt and Smaller:	**1.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Moderate**	Detritus:	**3.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**15**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**148.2**	**61.6**
Erosion Height (ft.):	**2.0**	**2.0**
Revetment Type:	**Rip-Rap**	**None**
Revetment Length:	**54.6**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Herbaceous**	**Herbaceous**
Sub-dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**0-25**	**0-25**
W less than 25	**64**	**153**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Deciduous**
Sub-Dominant	**Coniferous**	**Coniferous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**None**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**9.5**
Gullies	**None**	

	Left	Right
Mass Failures	**50.5**	
Height	**9.5**	
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Reading Pond Brook** Reach: **M41T6.02S1.02-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Abundant**
4.2 Adjacent Wetlands: **Abundant**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **2**

4.5 Flow Regulation Type **Small Bypass**
Flow Reg. Use: **Other**
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs
Field Ditch: **0** Road Ditch: **2**
Other: **0** Tile Drain: **0**
Overland Flow: **0** Urb Strm Wtr Pipe: **0**
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Instream Culvert	**9**	**Yes**	**Yes**	**Yes**	**Yes**	**Deposition Above,Scour Below**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **1** Point: **8** Side: **5**
Diagonal: **0** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features
Flood chutes: **5**
Neck Cutoff: **0** Avulsion: **2**

5.3 Steep Riffles and Head Cuts
Steep Riffles: **2**
Head Cuts: **0** Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**
5.5 Straightening: **Straightening**
Straightening Length (ft.): **447**
5.5 Dredging: **Gravel Mining**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.: **11**
6.2 Pool Substrate: **13**
6.3 Pool Variability: **13**
Total Score: **137**
Habitat Rating: **0.69**
Habitat Stream Condition: **Good**

6.4 Sediment Deposition: **13**
6.5 Channel Flow Status: **13**
6.6 Channel Alteration: **10**
6.7 Channel Sinuosity: **15**

Stream Gradiant Type	Left	Right
6.8 Bank Stability:	**7**	**8**
6.9 Bank Vegetation Protection	**7**	**7**
6.10 Riparian Veg. Zone Width:	**10**	**10**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**	Score	STD	Historic
7.1 Channel Degradation	**8**	**None**	**Yes**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**13**	**None**	**No**
7.4 Change in Planforml	**6**	**None**	**No**
Total Score	**40**		

Geomorphic Rating **0.50**
Channel Evolution Model **F**
Channel Evolution Stage **IV**
Geomorphic Condition **Fair**
Stream Sensitivity **Very High**

Phase 2 Segment Summary Report   Black River

Stream:	Reading Pond Brook	SGAT Version:	4.56
Reach:	M41T6.02S1.02-C	Organization:	South Windsor County Regional Planning Commission
Segment Length(ft):	765	Observers:	KLU, BOS - SMRC
Rain:	Yes	Completion Date:	9/4/2009
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **Uppermost segment of the reach beginning at the outlet from Reading Pond and extending 765 feet downstream.**

Step 5 - Notes: **Upstream flow regulation is the previously dammed Reading Pond. Dam breached during a June 2006 storm, and the pond is now significantly smaller in aerial extent. "Other" constriction in Step 4.8 is a breached stone dam located near the upstream end of the reach in close proximity to an old stone foundation (possible mill?). This breached dam is a second structure located approx 350 ft downstream of the dam which until June 2006 controlled the level of Reading Pond.**

Step 7 - Narrative: **Active incision (related to 2006 flood and dam release) perhaps overprinted on historic incision due to historic impoundment effects (Reading Pond). Moderate widening and minor to moderate planform adjustment (flood chutes, bifurcations).**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		16	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Very Steep	Very Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	N.E.	N.E.

1.5 Valley Features	
Valley Width (ft):	75
Width Determination:	Estimated
Confinement Type:	NW
In Rock Gorge:	No
Human Caused Change in Valley Width?:	No

1.6 Grade Controls: **None**

Stream:	**Reading Pond Brook**	Reach:	**M41T6.02S1.02-C**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**17.70**	2.11 Riffle/Step Spacing:	**220 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**1.10**	2.12 Substrate Composition		Bed:	**180 mm**
2.3 Mean Depth (tf):	**0.59**	Bedrock:	**0.0 %**	Bar:	**100 mm**
2.4 Floodprone Width (ft.):	**22.50**	Boulder:	**4.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**3.40**	Cobble:	**30.0 %**	Stream Type:	**F**
Human Elev FloodPln (ft.):		Coarse Gravel:	**36.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**30.00**	Fine Gravel:	**12.0 %**	Subclass Slope:	**b**
2.7 Entrenchment Ratio:	**1.27**	Sand:	**16.0 %**	Bed Form:	**Plane Bed**
2.8 Incision Ratio:	**3.09**	Silt and Smaller:	**2.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Moderate**	Detritus:	**5.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**28**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Undercut**

Bank Texture			Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper	Left	Right	Erosion Length (ft.):	**207.9**	**65.4**	Dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Material Type:	**Mix**	**Mix**	Erosion Height (ft.):	**2.9**	**2.0**	Sub-dominant:	**Deciduous**	**Deciduous**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**None**	**None**	Bank Canopy		
Lower			Revetment Length:	**0.0**	**0.0**	Canopy %:	**76-100**	**76-100**
Material Type:	**Mix**	**Mix**				Mid-Channel Canopy:	**Closed**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**None**	**None**
W less than 25	**0**	**0**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Deciduous**
Sub-Dominant	**Coniferous**	**Coniferous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**None**
(Legacy)	Amount	Mean Hieght
Failures	**One**	**9.0**
Gullies	**None**	

	Left	Right
Mass Failures		**30.49**
Height		**9.0**
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Reading Pond Brook** Reach: **M41T6.02S1.02-C**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**
4.2 Adjacent Wetlands: **Minimal**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **3**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs **None**
Field Ditch: Road Ditch:
Other: Tile Drain:
Overland Flow: Urb Strm Wtr Pipe:
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Other	**16**	**Yes**	**Yes**	**Yes**	**Yes**	**Deposition Above,Scour Below**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **1** Point: **3** Side: **1**
Diagonal: **1** Delta: **0** Island: **1** Braiding: **2**

5.2 Other Features
Flood chutes: **2**
Neck Cutoff: **0**
Avulsion: **0**

5.3 Steep Riffles and Head Cuts
Steep Riffles: **1**
Head Cuts: **0**
Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**
5.5 Straightening: **None**
Straightening Length (ft.): **0**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.: **11**
6.2 Pool Substrate: **13**
6.3 Pool Variability: **13**
Total Score: **137**
Habitat Rating: **0.69**
Habitat Stream Condition: **Good**

6.4 Sediment Deposition: **13**
6.5 Channel Flow Status: **13**
6.6 Channel Alteration: **10**
6.7 Channel Sinuosity: **15**

Stream Gradiant Type	Left	Right
6.8 Bank Stability:	**7**	**8**
6.9 Bank Vegetation Protection	**7**	**7**
6.10 Riparian Veg. Zone Width:	**10**	**10**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**	Score	STD	Historic
7.1 Channel Degradation	**3**	**C to F**	**No**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**11**	**None**	**No**
7.4 Change in Planforml	**10**	**None**	**No**
Total Score	**37**		

Geomorphic Rating **0.46**
Channel Evolution Model **F**
Channel Evolution Stage **II**
Geomorphic Condition **Fair**
Stream Sensitivity **Extreme**

Phase 2 Segment Summary Report   Black River

Stream:	**Buffalo Brook**	SGAT Version:	**4.56**
Reach:	**M41T6.03-0**	Organization:	**South Windsor County Regional Planning Commission**
Segment Length(ft):	**807**	Observers:	**KLU, BOS - SMRC**
Rain:	**No**	Completion Date:	**10/22/2009**
		Qualtiy Control Status - Consultant:	**Provisional**
		Qualtiy Control Status - Staff:	**Provisional**

Step 0 - Location: **Short reach of lesser gradient just above the confluence with Reading Pond Brook.**

Step 5 - Notes: **Indexed as an "alluvial fan" following protocols to capture the marked decrease in valley gradient, and valley confinement. Bedrock is occasionally exposed along the right valley wall; one occurrence of channel-spanning ledge. Given the history of gold mining in the area, it is possible that gravel mining occurred in this reach in the late 1800s, leading to possible incision. Headwater migration of incision was likely arrested at the channel-spanning exposure of bedrock. Degree of incision is less pronounced in the upstream third of the reach, possibly due to moderation by the bedrock exposures. May also reflect overprinting of aggradational processes from upstream sediment sources at this local decrease in gradient (and therefore decrease in sediment transport capacity). Abandoned forest road (Improved Path) crosses the channel at a ford.**

Step 7 - Narrative: **Minor to moderate planform adjustment (meander migration, one bifurcation). Susceptible to catastrophic erosion in flood event due to incised and entrenched channel status. Extreme sens due to Cb to Fb STD.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **Yes**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	**0**		**0**	
Road:	**0**		**0**	
Railroad:	**0**		**0**	
Imp. Path:	**269**	**4**	**174**	**4**
Dev.:	**0**		**0**	

1.4 Adjacent Side	Left	Right
Hillside Slope:	**Extr.Steep**	**Extr.Steep**
Continuous w/ Bank:	**Never**	**Sometimes**
Within 1 Bankfull W:	**Sometimes**	**Sometimes**
Texture:	**N.E.**	**N.E.**

1.5 Valley Features

Valley Width (ft):	**160**
Width Determination:	**Estimated**
Confinement Type:	**BD**
In Rock Gorge:	**No**
Human Caused Change in Valley Width?:	**No**

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	**Mid-segment**	**1.0**	**0.0**	**No**	

Stream: **Buffalo Brook** Reach: **M41T6.03-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**16.80**	2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**1.40**	2.12 Substrate Composition		Bed:	
2.3 Mean Depth (tf):	**1.07**	Bedrock:	**0.0 %**	Bar:	
2.4 Floodprone Width (ft.):	**27.00**	Boulder:	**5.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**3.30**	Cobble:	**41.0 %**	Stream Type:	**F**
Human Elev FloodPln (ft.):		Coarse Gravel:	**45.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**15.70**	Fine Gravel:	**6.0 %**	Subclass Slope:	**b**
2.7 Entrenchment Ratio:	**1.61**	Sand:	**3.0 %**	Bed Form:	**Plane Bed**
2.8 Incision Ratio:	**2.36**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**3.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**0**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Mix**	**Mix**
Consistency:	**Cohesive**	**Cohesive**
Lower		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**90.2**	**134.3**
Erosion Height (ft.):	**2.0**	**2.0**
Revetment Type:	**None**	**None**
Revetment Length:	**0.0**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Deciduous**	**Deciduous**
Sub-dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**0-25**	**0-25**
W less than 25	**127**	**150**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Deciduous**
Sub-Dominant	**Coniferous**	**Coniferous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**None**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Buffalo Brook**   Reach: **M41T6.03-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type	**None**	4.7 Stormwater Inputs			
4.2 Adjacent Wetlands:	**None**	Flow Reg. Use:		Field Ditch:	**0**	Road Ditch:	**0**
4.3 Flow Status:	**Moderate**	Impoundments:		Other:	**0**	Tile Drain:	**0**
4.4 # of Debris Jams:	**0**	Impoundment Loc.:		Overland Flow:	**1**	Urb Strm Wtr Pipe:	**0**
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:			**0**
		(old) Upstrm Flow Reg.:		Affected Length (ft):			**0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**0**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**Yes**
Mid:	**1**	Delta:	**0**	Flood chutes:	**0**	Avulsion:	**0**	5.5 Straightening:	**None**
Point:	**1**	Island:	**1**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**0**
Side:	**2**	Braiding:	**1**	Steep Riffles:	**0**	Trib Rejuv.:	**No**	5.5 Dredging:	**Gravel Mining**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	**8**	6.4 Sediment Deposition:	**15**	Stream Gradiant Type	Left	Right
6.2 Pool Substrate:	**11**	6.5 Channel Flow Status:	**16**	6.8 Bank Stability:	**7**	**7**
6.3 Pool Variability:	**10**	6.6 Channel Alteration:	**16**	6.9 Bank Vegetation Protection	**7**	**7**
Total Score:	**126**	6.7 Channel Sinuosity:	**6**	6.10 Riparian Veg. Zone Width:	**8**	**8**
Habitat Rating:	**0.63**					
Habitat Stream Condition:	**Fair**					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Unconfined** Score	STD	Historic		
7.1 Channel Degradation	**5**	**C to F**	**Yes**	Geomorphic Rating	**0.57**
7.2 Channel Aggradation	**15**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**15**	**None**	**No**	Channel Evolution Stage	**II**
7.4 Change in Planforml	**11**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score	**46**			Stream Sensitivity	**Extreme**

Phase 2 Segment Summary Report Black River

Stream: **Buffalo Brook**
Reach: **M41T6.04-0**

Segment Length(ft): **2,052**
Rain: **No**

SGAT Version: **4.56**
Organization: **South Windsor County Regional Planning Commission**
Observers: **KLU, BOS - SMRC**
Completion Date: **10/22/2009**
Qualtiy Control Status - Consultant: **Provisional**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **Remote reach downstream of forest road leading west from terminus of Reading Pond Road, and upstream from Reading Pond Brook confluence.**

Step 5 - Notes: **Improved path is abandoned forest road which follows along one side or the other of the channel for nearly the entire length. Often, the road has been cut into the valley wall. In other cases, it follows a discontinuous terrace at grade; occasionally, the road appears to have been excavated below the terrace level. Three road crossings were indexed within the reach. Some sections of the old road serve as flood chutes during high flows. The former road grade serves to concentrate stormwater runoff and convey it to the river channel at locations of flood chute returns or channel crossings. At the downstream end of the reach, the road segment has been eroded to function as an active part of a bifurcated channel that extends into the next downstream reach. Several tributaries join the channel in this reach. Roads were observed along the banks of two of the larger tributaries. These road networks may be associated with historic logging activity and /or gold placer mining.**

Step 7 - Narrative: **Minor present adjustment. Evidence of historic widening (slightly bent trees). Historic planform adjustment as evidenced by eroded, short sections of forest road (avulsions).**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

	Length (ft) One	Height	Length (ft) Both	Height
Berm:	**0**		**0**	
Road:	**0**		**0**	
Railroad:	**0**		**0**	
Imp. Path:	**1,880**	**2**	**0**	
Dev.:	**0**		**0**	

1.4 Adjacent Side	Left	Right
Hillside Slope:	**Extr.Steep**	**Extr.Steep**
Continuous w/ Bank:	**Sometimes**	**Sometimes**
Within 1 Bankfull W:	**Sometimes**	**Sometimes**
Texture:	**N.E.**	**N.E.**

1.5 Valley Features

Valley Width (ft): **40**
Width Determination: **Estimated**
Confinement Type: **SC**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **No**

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	**Mid-segment**	**1.0**	**1.0**	**Yes**	
Ledge	**Mid-segment**	**1.0**	**0.0**	**No**	

Stream: **Buffalo Brook** Reach: **M41T6.04-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**12.50**	2.11 Riffle/Step Spacing:	**45 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**1.30**	2.12 Substrate Composition		Bed:	
2.3 Mean Depth (tf):	**0.87**	Bedrock:	**0.0 %**	Bar:	
2.4 Floodprone Width (ft.):	**24.00**	Boulder:	**10.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**1.30**	Cobble:	**46.0 %**	Stream Type:	**B**
Human Elev FloodPln (ft.):		Coarse Gravel:	**35.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**14.37**	Fine Gravel:	**8.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**1.92**	Sand:	**1.0 %**	Bed Form:	**Step-Pool**
2.8 Incision Ratio:	**1.00**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**5.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**8**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**0.0**	**40.6**
Erosion Height (ft.):	**0.0**	**3.0**
Revetment Type:	**None**	**Rip-Rap**
Revetment Length:	**0.0**	**53.9**

Near Bank Vegetation Type	Left	Right
Dominant:	**Deciduous**	**Deciduous**
Sub-dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**0-25**	**0-25**
W less than 25	**1,484**	**383**
Buffer Vegitation Type		
Dominant	**Coniferous**	**Deciduous**
Sub-Dominant	**Deciduous**	**Coniferous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**None**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Buffalo Brook** Reach: **M41T6.04-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Abundant**	4.5 Flow Regulation Type	**None**	4.7 Stormwater Inputs			
4.2 Adjacent Wetlands:	**None**	Flow Reg. Use:		Field Ditch:	**0**	Road Ditch:	**0**
4.3 Flow Status:	**Moderate**	Impoundments:		Other:	**0**	Tile Drain:	**0**
4.4 # of Debris Jams:	**3**	Impoundment Loc.:		Overland Flow:	**5**	Urb Strm Wtr Pipe:	**0**
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:			**0**
		(old) Upstrm Flow Reg.:		Affected Length (ft):			**0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**0**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**Yes**
Mid:	**0**	Delta:	**0**	Flood chutes:	**1**	Avulsion:	**1**	5.5 Straightening:	**None**
Point:	**1**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**0**
Side:	**0**	Braiding:	**1**	Steep Riffles:	**0**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	**13**	6.4 Sediment Deposition:	**15**	Stream Gradiant Type	Left	Right
6.2 Pool Substrate:	**15**	6.5 Channel Flow Status:	**13**	6.8 Bank Stability:	**10**	**9**
6.3 Pool Variability:	**13**	6.6 Channel Alteration:	**16**	6.9 Bank Vegetation Protection	**10**	**9**
Total Score:	**159**	6.7 Channel Sinuosity:	**18**	6.10 Riparian Veg. Zone Width:	**9**	**9**
Habitat Rating:	**0.80**					
Habitat Stream Condition:	**Good**					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Confined** Score	STD	Historic		
7.1 Channel Degradation	**16**	**None**	**No**	Geomorphic Rating	**0.70**
7.2 Channel Aggradation	**16**	**None**	**No**	Channel Evolution Model	**D**
7.3 Widening Channel	**16**	**None**	**Yes**	Channel Evolution Stage	**IIc**
7.4 Change in Planforml	**8**	**None**	**Yes**	Geomorphic Condition	**Good**
Total Score	**56**			Stream Sensitivity	**Moderate**

Phase 2 Segment Summary Report Black River

Stream: **Buffalo Brook**
Reach: **M41T6.05-A**

Segment Length(ft): **2,458**
Rain: **No**

SGAT Version: **4.56**
Organization: **South Windsor County Regional Planning Commission**
Observers: **KLU, BOS - SMRC**
Completion Date: **10/22/2009**
Qualtiy Control Status - Consultant: **Provisional**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **Downstream segment of remote reach downstream of forest road leading west from terminus of Reading Pond Road, and upstream from Reading Pond Brook confluence.**

Step 5 - Notes: **Valley confinement varies from Narrowly-confined to Narrow, but overall is dominantly Semi-confined. Improved path is mostly abandoned forest road that follows the channel in the downstream half of the segment. Less than 25 ft buffer was indexed along these improved path sections. Abandoned forest road fords the channel in three locations. The road appears to have been installed at grade on occasional terraces and along the base of the valley wall to either side of the channel. The road height above the channel varies but averages 2.5 feet above the thalweg. Over the years, the river appears to have avulsed to flow in the path of the road. In some locations evidence of the road has been eroded away. In other locations the former road grade has been eroded to form a flood chute.**

Step 7 - Narrative: **Significant planform adjustment and channel widening probably ocurring episodically during flood events. Minor aggradation due to steepness of gradient and semi-confined valley setting. Moderate historic incision, probably moderated by shallow bedrock.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

	Length (ft)	One Height	Both Height
Berm:	0		0
Road:	0		0
Railroad:	0		0
Imp. Path:	1,302	3	0
Dev.:	0		0

1.4 Adjacent Side	Left	Right
Hillside Slope:	Extr.Steep	Extr.Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	N.E.	N.E.

1.5 Valley Features

Valley Width (ft): **35**
Width Determination: **Estimated**
Confinement Type: **SC**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **No**

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	1.0	0.0	No	
Ledge	Mid-segment	1.0	0.0	No	
Waterfall	Mid-segment	4.0	3.0	Yes	

Stream: **Buffalo Brook** Reach: **M41T6.05-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**31.90**	2.11 Riffle/Step Spacing:	**45 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**1.10**	2.12 Substrate Composition		Bed:	**65** mm
2.3 Mean Depth (tf):	**0.58**	Bedrock:	**0.0 %**	Bar:	**N/A** mm
2.4 Floodprone Width (ft.):	**48.00**	Boulder:	**1.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**1.70**	Cobble:	**14.0 %**	Stream Type:	**B**
Human Elev FloodPln (ft.):		Coarse Gravel:	**56.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**55.00**	Fine Gravel:	**22.0 %**	Subclass Slope:	**a**
2.7 Entrenchment Ratio:	**1.50**	Sand:	**5.0 %**	Bed Form:	**Step-Pool**
2.8 Incision Ratio:	**1.55**	Silt and Smaller:	**2.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**5.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**25**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**64.9**	**108.7**
Erosion Height (ft.):	**3.0**	**2.4**
Revetment Type:	**None**	**None**
Revetment Length:	**0.0**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Deciduous**	**Deciduous**
Sub-dominant:	**Herbaceous**	**Herbaceous**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**0-25**	**0-25**
W less than 25	**874**	**135**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Deciduous**
Sub-Dominant	**Coniferous**	**Coniferous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**None**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Buffalo Brook** Reach: **M41T6.05-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type	**None**	4.7 Stormwater Inputs	
4.2 Adjacent Wetlands:	**None**	Flow Reg. Use:		Field Ditch: **0**	Road Ditch: **0**
4.3 Flow Status:	**Moderate**	Impoundments:		Other: **0**	Tile Drain: **0**
4.4 # of Debris Jams:	**4**	Impoundment Loc.:		Overland Flow: **4**	Urb Strm Wtr Pipe: **0**
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:	**0**
		(old) Upstrm Flow Reg.:		Affected Length (ft):	**0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**0**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**Yes**
Mid:	**1**	Delta:	**0**	Flood chutes:	**5**	Avulsion:	**2**	5.5 Straightening:	**None**
Point:	**1**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**0**
Side:	**0**	Braiding:	**1**	Steep Riffles:	**0**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	**11**	6.4 Sediment Deposition:	**15**	Stream Gradiant Type	Left	Right
6.2 Pool Substrate:	**15**	6.5 Channel Flow Status:	**10**	6.8 Bank Stability:	**8**	**8**
6.3 Pool Variability:	**11**	6.6 Channel Alteration:	**16**	6.9 Bank Vegetation Protection	**9**	**9**
Total Score:	**148**	6.7 Channel Sinuosity:	**18**	6.10 Riparian Veg. Zone Width:	**9**	**9**
Habitat Rating:	**0.74**					
Habitat Stream Condition:	**Good**					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Confined** Score	STD	Historic		
7.1 Channel Degradation	**11**	**None**	**Yes**	Geomorphic Rating	**0.45**
7.2 Channel Aggradation	**15**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**5**	**None**	**No**	Channel Evolution Stage	**IV**
7.4 Change in Planforml	**5**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score	**36**			Stream Sensitivity	**High**

Phase 2 Segment Summary Report Black River

Stream: **Buffalo Brook**
Reach: **M41T6.05-B**

Segment Length(ft): **1,506**
Rain: **No**

SGAT Version: **4.56**
Organization: **South Windsor County Regional Planning Commission**
Observers: **KLU, BOS - SMRC**
Completion Date: **10/22/2009**
Qualtiy Control Status - Consultant: **Provisional**
Qualtiy Control Status - Staff: **Provisional**
Why Not Assessed: **bedrock gorge**

Step 0 - Location: **Upstream segment of remote reach downstream of forest road leading west from terminus of Reading Pond Road, and upstream from Reading Pond Brook confluence.**

Step 5 - Notes:

Step 7 - Narrative:

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Extr.Steep	Extr.Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Always	Always
Texture:	Bedrock	Bedrock

1.5 Valley Features

Valley Width (ft): **15**
Width Determination: **Estimated**
Confinement Type: **NC**
In Rock Gorge: **Yes**
Human Caused Change in Valley Width?: **No**

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Waterfall	Mid-segment	100.0	99.0	Yes	

Stream: **Buffalo Brook** Reach: **M41T6.05-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):		2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on			
2.2 Max Depth (ft.):		2.12 Substrate Composition		Bed:			
2.3 Mean Depth (tf):		Bedrock:	**%**	Bar:			
2.4 Floodprone Width (ft.):		Boulder:	**%**	2.14 Stream Type			
2.5 Aband. Floodpn (ft.):		Cobble:	**%**	Stream Type:			
Human Elev FloodPln (ft.):		Coarse Gravel:	**%**	Bed Material:			
2.6 Width/Depth Ratio:	**0.00**	Fine Gravel:	**%**	Subclass Slope:			
2.7 Entrenchment Ratio:	**0.00**	Sand:	**%**	Bed Form:			
2.8 Incision Ratio:	**0.00**	Silt and Smaller:	**%**	Field Measured Slope:			
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:		2.15 Sub-reach Stream Type			
2.9 Sinuosity:		Detritus:	**0.0 %**	Reference Stream Type:	**A**		
2.10 Riffles Type:		# Large Woody Debris:	**9**	Reference Bed Material:	**Bedrock**		
				Reference Subclass Slope:	**None**		
				Reference Bedform:	**Cascade**		

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**0.0**	**0.0**	Dominant:	**Deciduous**	**Deciduous**
Material Type:	**Bedrock**	**Bedrock**	Erosion Height (ft.):	**0.0**	**0.0**	Sub-dominant:	**Coniferous**	**Coniferous**
Consistency:	**Cohesive**	**Cohesive**	Revetment Type:	**None**	**None**	Bank Canopy		
Lower			Revetment Length:	**0.0**	**0.0**	Canopy %:	**76-100**	**76-100**
Material Type:	**Bedrock**	**Bedrock**				Mid-Channel Canopy:	**Closed**	
Consistency:	**Cohesive**	**Cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**None**	**None**
W less than 25	**0**	**0**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Deciduous**
Sub-Dominant	**Coniferous**	**Coniferous**

3.3 Riparian Corridor

Corridor Land	Left	Right		Left	Right
Dominant	**Forest**	**Forest**	Mass Failures		
Sub-dominant	**None**	**None**	Height		
(Legacy)	Amount	Mean Hieght	Gullies Number	**0**	
Failures	**None**		Gullies Length	**0**	
Gullies	**None**				

Stream: **Buffalo Brook** Reach: **M41T6.05-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**
4.2 Adjacent Wetlands: **None**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **2**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs **None**
Field Ditch: Road Ditch:
Other: Tile Drain:
Overland Flow: Urb Strm Wtr Pipe:
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **0** Delta: **0**
Point: **0** Island: **0**
Side: **0** Braiding: **0**
Diagonal: **0**

5.2 Other Features
Flood chutes: **3**
Neck Cutoff: **0**
Avulsion: **0**

5.3 Steep Riffles and Head Cuts
Steep Riffles: **0**
Head Cuts: **0**
Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**
5.5 Straightening: **None**
Straightening Length (ft.): **0**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score:
Habitat Rating:
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type	Left	Right
6.8 Bank Stability:		
6.9 Bank Vegetation Protection		
6.10 Riparian Veg. Zone Width:		

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Score	STD	Historic
7.1 Channel Degradation			
7.2 Channel Aggradation			
7.3 Widening Channel			
7.4 Change in Planforml			
Total Score			

Geomorphic Rating
Channel Evolution Model
Channel Evolution Stage
Geomorphic Condition
Stream Sensitivity

Phase 2 Segment Summary Report Black River

Stream: **Buffalo Brook**
Reach: **M41T6.06-0**
Segment Length(ft): **2,415**
Rain: **No**

SGAT Version: **4.56**
Organization: **South Windsor County Regional Planning Commission**
Observers: **KLU, BOS - SMRC**
Completion Date: **10/22/2009**
Qualtiy Control Status - Consultant: **Provisional**
Qualtiy Control Status - Staff: **Provisional**
Why Not Assessed: **bedrock gorge**

Step 0 - Location: **Remote reach beginning near culvert crossing of forest road leading west from terminus of Reading Pond Road.**

Step 5 - Notes: **Essentially a bedrock gorge. Steep bedrock slopes closely confine the channel. Overall Semi-confined, although there are some sections of Narrowly-confined. Occasional sections of alluvial veneer over bedrock. One perched culvert crosses the channel near the upstream end of the reach (gravel forest road). Overland flow stormwater input from this road to the channel at the culvert crossing. Upper end of the reach has a somewhat lesser gradient and more relaxed valley confinement. Some limited wetlands in vicinity of the culvert crossing. Three fords within the reach, including one collapsed timber bridge (very old), and two apparent former logging roads. One apparent breached earthen dam and spoil piles possibly associated with historic gold mining in the area. Since the channel was classified as a bedrock gorge, RGA and RHA were not completed, consistent with protocols.**

Step 7 - Narrative:

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		11	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Extr.Steep	Extr.Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Always	Always
Texture:	Bedrock	Bedrock

1.5 Valley Features

Valley Width (ft): **30**
Width Determination: **Estimated**
Confinement Type: **SC**
In Rock Gorge: **Yes**
Human Caused Change in Valley Width?: **No**

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Ledge	Mid-segment	1.0	0.0	Yes	
Waterfall	Mid-segment	5.0	4.0	Yes	
Waterfall	Mid-segment	4.0	4.0	No	
Waterfall	Mid-segment	160.0	159.0	Yes	
Waterfall	Mid-segment	60.0	59.0	Yes	

Stream: **Buffalo Brook** Reach: **M41T6.06-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):		2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on	
2.2 Max Depth (ft.):		2.12 Substrate Composition		Bed:	**N/A**
2.3 Mean Depth (tf):		Bedrock:	**%**	Bar:	**N/A**
2.4 Floodprone Width (ft.):		Boulder:	**%**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):		Cobble:	**%**	Stream Type:	
Human Elev FloodPln (ft.):		Coarse Gravel:	**%**	Bed Material:	
2.6 Width/Depth Ratio:	**0.00**	Fine Gravel:	**%**	Subclass Slope:	
2.7 Entrenchment Ratio:	**0.00**	Sand:	**%**	Bed Form:	
2.8 Incision Ratio:	**0.00**	Silt and Smaller:	**%**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:		2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**0.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Not Applicable**	# Large Woody Debris:	**32**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Bedrock**	**Bedrock**
Consistency:	**Cohesive**	**Cohesive**
Lower		
Material Type:	**Bedrock**	**Bedrock**
Consistency:	**Cohesive**	**Cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**46.8**	**42.9**
Erosion Height (ft.):	**2.0**	**2.5**
Revetment Type:	**Rip-Rap**	**Rip-Rap**
Revetment Length:	**18.0**	**15.7**

Near Bank Vegetation Type	Left	Right
Dominant:	**Deciduous**	**Deciduous**
Sub-dominant:	**Bare**	**Bare**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**None**	**0-25**
W less than 25	**50**	**150**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Deciduous**
Sub-Dominant	**Coniferous**	**Coniferous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**None**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Buffalo Brook** Reach: **M41T6.06-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Abundant**
4.2 Adjacent Wetlands: **Minimal**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **5**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs
Field Ditch: **0** Road Ditch: **0**
Other: **0** Tile Drain: **0**
Overland Flow: **1** Urb Strm Wtr Pipe: **0**
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Instream Culvert	**3.9**	**Yes**	**Yes**	**Yes**	**Yes**	**Scour Below,Alignment**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **0** Point: **0** Side: **0**
Diagonal: **0** Delta: **0** Island: **0** Braiding: **1**

5.2 Other Features
Flood chutes: **1**
Neck Cutoff: **0** Avulsion: **0**
5.3 Steep Riffles and Head Cuts
Head Cuts: **0**
Steep Riffles: **0** Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **Yes**
5.5 Straightening: **None**
Straightening Length (ft.): **0**
5.5 Dredging: **Gravel Mining**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score:
Habitat Rating:
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type Left Right
6.8 Bank Stability:
6.9 Bank Vegetation Protection
6.10 Riparian Veg. Zone Width:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type Score STD Historic
7.1 Channel Degradation
7.2 Channel Aggradation
7.3 Widening Channel
7.4 Change in Planforml
Total Score

Geomorphic Rating
Channel Evolution Model
Channel Evolution Stage
Geomorphic Condition
Stream Sensitivity

Phase 2 Segment Summary Report Black River

Stream: **Patch Brook**
Reach: **M40T5.01-A**

Segment Length(ft): **397**
Rain: **No**

SGAT Version: **4.56**
Organization: **South Windsor County Regional Planning Commission**
Observers: **KLU, BOS - SMRC**
Completion Date: **9/10/2009**
Qualtiy Control Status - Consultant: **Provisional**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **From point between Library Rd bridge and Rt 100 bridge, downstream to confluence with Black River.**

Step 5 - Notes: **Dublin Rd and Kingdom Rd in the LB corridor encroach upon the floodplain and slightly reduce the available valley width; no significant change in confinement status (Unconfined). Gravel/cobble berm along the RB at a thalweg height ranging from 3 to 6 feet (IRhef = 3, average), downstream of Route 100 bridge crossing. Floodplain still available along the LB (IRraf = 1.5). Historic channelization is inferred due to linear planform, and based on historic maps which indicate position of the Patch Brook confluence was relocated over time. Historic dredging is inferred due to berms along RB and berms in main stem near confluence. Downstream flow regulation is dam at Lake Rescue which influences base level of Round Pond at northern extent of Lake Rescue and approx 0.5 mile downstream from confluence of Patch Brook.**

Step 7 - Narrative: **Moderate planform adjustment, minor to moderate widening and aggradation. Historic incision. Sensitivity upgraded to Extreme due to "alluvial fan" setting.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Valley Width**
1.2 Alluvial Fan: **Yes**
1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	199	5	0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		81	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Hilly	Hilly
Continuous w/ Bank:	Never	Never
Within 1 Bankfull W:	Never	Never
Texture:	N.E.	N.E.

1.5 Valley Features
Valley Width (ft): **160**
Width Determination: **Estimated**
Confinement Type: **BD**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **Yes**

1.6 Grade Controls: **None**

Stream:	**Patch Brook**	Reach:	**M40T5.01-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**25.20**	2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**1.90**	2.12 Substrate Composition		Bed:	
2.3 Mean Depth (tf):	**1.43**	Bedrock:	**0.0 %**	Bar:	
2.4 Floodprone Width (ft.):	**310.00**	Boulder:	**4.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**2.90**	Cobble:	**48.0 %**	Stream Type:	**C**
Human Elev FloodPln (ft.):		Coarse Gravel:	**29.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**17.62**	Fine Gravel:	**17.0 %**	Subclass Slope:	**b**
2.7 Entrenchment Ratio:	**12.30**	Sand:	**2.0 %**	Bed Form:	**Plane Bed**
2.8 Incision Ratio:	**1.53**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**3.0 %**	Reference Stream Type:	**C**
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**0**	Reference Bed Material:	**Cobble**
				Reference Subclass Slope:	**b**
				Reference Bedform:	**Riffle-Pool**

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Gravel**	**Gravel**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**96.2**	**177.2**
Erosion Height (ft.):	**3.0**	**3.0**
Revetment Type:	**Rip-Rap**	**Rip-Rap**
Revetment Length:	**52.2**	**55.4**

Near Bank Vegetation Type	Left	Right
Dominant:	**Deciduous**	**Deciduous**
Sub-dominant:	**Shrubs/Sapling**	**Bare**
Bank Canopy		
Canopy %:	**76-100**	**26-50**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**0-25**
Sub-Dominant	**26-50**	**>100**
W less than 25	**154**	**152**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Deciduous**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Residential**
Sub-dominant	**Commercial**	**Forest**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Patch Brook** Reach: **M40T5.01-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **None**
4.2 Adjacent Wetlands: **None**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **0**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **Down Stream**
(old) Upstrm Flow Reg.: **Run-of-river Dam**

4.7 Stormwater Inputs **None**
Field Ditch: Road Ditch:
Other: Tile Drain:
Overland Flow: Urb Strm Wtr Pipe:
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	**39**	**Yes**	**Yes**	**No**	**Yes**	**None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **0** Point: **1** Side: **0**
Diagonal: **0** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features
Flood chutes: **0**
Neck Cutoff: **0**
Avulsion: **0**
5.3 Steep Riffles and Head Cuts
Steep Riffles: **0**
Head Cuts: **0**
Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**
5.5 Straightening: **Straightening**
Straightening Length (ft.): **282**
5.5 Dredging: **Dredging**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.: **8**
6.2 Pool Substrate: **13**
6.3 Pool Variability: **8**
Total Score: **90**
Habitat Rating: **0.45**
Habitat Stream Condition: **Fair**

6.4 Sediment Deposition: **13**
6.5 Channel Flow Status: **10**
6.6 Channel Alteration: **3**
6.7 Channel Sinuosity: **5**

Stream Gradiant Type	Left	Right
6.8 Bank Stability:	**6**	**4**
6.9 Bank Vegetation Protection	**5**	**4**
6.10 Riparian Veg. Zone Width:	**2**	**9**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**	Score	STD	Historic
7.1 Channel Degradation	**8**	**None**	**Yes**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**13**	**None**	**No**
7.4 Change in Planforml	**8**	**None**	**No**
Total Score	**42**		

Geomorphic Rating **0.52**
Channel Evolution Model **F**
Channel Evolution Stage **III**
Geomorphic Condition **Fair**
Stream Sensitivity **Extreme**

Phase 2 Segment Summary Report **Black River**

Stream: **Patch Brook**
Reach: **M40T5.01-B**

Segment Length(ft): **764**
Rain: **No**

SGAT Version: **4.56**
Organization: **South Windsor County Regional Planning Commission**
Observers: **KLU, BOS - SMRC**
Completion Date: **9/10/2009**
Qualtiy Control Status - Consultant: **Provisional**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **From just above Dublin Road bridge crossing, downstream to point between Library Rd bridge and Rt 100 bridge.**

Step 5 - Notes: **This segment was indexed as an “alluvial fan” in accordance with protocols to capture the reduced valley gradient and reduced confinement. Dublin Road has been elevated above the floodplain and now forms a berm along the RB of the channel upstream of the crossing and in the LB corridor downstream of the crossing. The road has reduced the valley width, but confinement status of the channel (Unconfined) is unchanged. The Dublin Road bridge crossing reportedly was washed out in the 1973 flood and a large cobble / earthen berm is now present along the LB of the channel at a thalweg height of 12.5 feet on the upstream approach to this Dublin Road bridge. Stepped footers of the LB abutment supporting this bridge are being scoured by the channel. The Dublin Rd bridge crossing and the Library Rd crossing are bankfull constrictors. Upstream flow regulation is the small diversion originating in Segment D; flow is returned to the channel from the "canal" within this segment B, just downstream of the Dublin Rd bridge crossing.**

Step 7 - Narrative: **Minor to moderate widening (modified by tree buffers, armoring). Minor aggradation. Historic planform adjustment (channelization) and historic incision / entrenchment. Extreme sens due to Cb to Fb STD.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**

1.2 Alluvial Fan: **Yes**

1.3 Corridor Encroachments:

	Length (ft) One	Height	Both	Height
Berm:	62	13	0	
Road:	285	7	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	208		161	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Very Steep	Very Steep
Continuous w/ Bank:	Never	Sometimes
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	N.E.	N.E.

1.5 Valley Features

Valley Width (ft): **130**
Width Determination: **Estimated**
Confinement Type: **NW**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **Yes**

1.6 Grade Controls: **None**

Stream: **Patch Brook** Reach: **M40T5.01-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**33.30**	2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**1.80**	2.12 Substrate Composition		Bed:	**N/A**
2.3 Mean Depth (tf):	**1.40**	Bedrock:	**0.0 %**	Bar:	**N/A**
2.4 Floodprone Width (ft.):	**38.00**	Boulder:	**7.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**6.70**	Cobble:	**54.0 %**	Stream Type:	**F**
Human Elev FloodPln (ft.):		Coarse Gravel:	**22.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**23.79**	Fine Gravel:	**7.0 %**	Subclass Slope:	**b**
2.7 Entrenchment Ratio:	**1.14**	Sand:	**10.0 %**	Bed Form:	**Plane Bed**
2.8 Incision Ratio:	**3.72**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**2.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**4**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Gravel**	**Gravel**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**142.8**	**268.0**
Erosion Height (ft.):	**5.0**	**3.2**
Revetment Type:	**Multiple**	**Multiple**
Revetment Length:	**235.5**	**277.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Sub-dominant:	**Deciduous**	**Deciduous**
Bank Canopy		
Canopy %:	**51-75**	**51-75**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**0-25**	**0-25**
Sub-Dominant	**51-100**	**>100**
W less than 25		
Buffer Vegitation Type		
Dominant	**Shrubs/Sapling**	**Mixed Trees**
Sub-Dominant	**Mixed Trees**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Shrubs/Sapling**	**Forest**
Sub-dominant	**Commercial**	**Residential**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length		

Stream: **Patch Brook** Reach: **M40T5.01-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**
4.2 Adjacent Wetlands: **None**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **0**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **Up Stream**
(old) Upstrm Flow Reg.: **Diversion**

4.7 Stormwater Inputs
Field Ditch: **0** Road Ditch: **0**
Other: **0** Tile Drain: **0**
Overland Flow: **0** Urb Strm Wtr Pipe: **1**
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	**29**	**Yes**	**Yes**	**Yes**	**Yes**	**Deposition Above,Scour Above,Scour Below,Alignment**
Bridge	**16**	**Yes**	**Yes**	**Yes**	**Yes**	**Deposition Above**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **0** Point: **0** Side: **0**
Diagonal: **0** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features
Flood chutes: **0**
Neck Cutoff: **0** Avulsion: **0**
5.3 Steep Riffles and Head Cuts
Steep Riffles: **0** Head Cuts: **0** Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**
5.5 Straightening: **Straightening**
Straightening Length (ft.): **560**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.: **8**
6.2 Pool Substrate: **13**
6.3 Pool Variability: **8**
Total Score: **85**
Habitat Rating: **0.43**
Habitat Stream Condition: **Fair**

6.4 Sediment Deposition: **13**
6.5 Channel Flow Status: **11**
6.6 Channel Alteration: **3**
6.7 Channel Sinuosity: **3**

Stream Gradiant Type	Left	Right
6.8 Bank Stability:	**7**	**5**
6.9 Bank Vegetation Protection	**3**	**2**
6.10 Riparian Veg. Zone Width:	**1**	**8**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**	Score	STD	Historic
7.1 Channel Degradation	**3**	**C to F**	**Yes**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**11**	**None**	**No**
7.4 Change in Planforml	**13**	**None**	**Yes**
Total Score	**40**		

Geomorphic Rating **0.50**
Channel Evolution Model **F**
Channel Evolution Stage **II**
Geomorphic Condition **Fair**
Stream Sensitivity **Extreme**

Phase 2 Segment Summary Report **Black River**

Stream: **Patch Brook**
Reach: **M40T5.01-C**

Segment Length(ft): **1,449**
Rain: **No**

SGAT Version: **4.56**
Organization: **South Windsor County Regional Planning Commission**
Observers: **KLU, BOS - SMRC**
Completion Date: **9/10/2009**
Qualtiy Control Status - Consultant: **Provisional**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **Approx 1400 ft segment above Dublin Road bridge crossing**

Step 5 - Notes: **Moderately high terraces (6 to 8 feet thalweg height) and a set of much higher terraces (15 to 25 feet high) along the RB comprised of glaciofluvial sediments define a natural valley width that ranges between 80 and 130 feet wide, or 2.9 to 4.6 times the channel width. Upstream flow regulation is small diversion that directs a small portion of flow to "canal" along west side of Dublin Road and returns water to downstream Segment B.**

Step 7 - Narrative: **Moderate widening and planform adjustment (flood chutes, bifurcations); minor localized aggradation. Historic incision.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	**0**		**0**	
Road:	**15**	**7**	**0**	
Railroad:	**0**		**0**	
Imp. Path:	**0**		**0**	
Dev.:	**72**		**0**	

1.4 Adjacent Side

	Left	Right
Hillside Slope:	**Steep**	**Steep**
Continuous w/ Bank:	**Sometimes**	**Sometimes**
Within 1 Bankfull W:	**Sometimes**	**Sometimes**
Texture:	**N.E.**	**N.E.**

1.5 Valley Features

Valley Width (ft): **100**
Width Determination: **Estimated**
Confinement Type: **SC**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **No**

1.6 Grade Controls: **None**

Stream: **Patch Brook** Reach: **M40T5.01-C**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**38.50**	2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**1.40**	2.12 Substrate Composition		Bed:	
2.3 Mean Depth (tf):	**1.02**	Bedrock:	**0.0 %**	Bar:	
2.4 Floodprone Width (ft.):	**75.00**	Boulder:	**10.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**2.00**	Cobble:	**60.0 %**	Stream Type:	**C**
Human Elev FloodPln (ft.):		Coarse Gravel:	**13.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**37.75**	Fine Gravel:	**6.0 %**	Subclass Slope:	**b**
2.7 Entrenchment Ratio:	**1.95**	Sand:	**11.0 %**	Bed Form:	**Plane Bed**
2.8 Incision Ratio:	**1.43**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**3.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**27**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**145.9**	**338.2**
Erosion Height (ft.):	**3.0**	**5.8**
Revetment Type:	**Other**	**None**
Revetment Length:	**140.8**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Herbaceous**	**Herbaceous**
Sub-dominant:	**Deciduous**	**Deciduous**
Bank Canopy		
Canopy %:	**51-75**	**51-75**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**0-25**
Sub-Dominant	**None**	**>100**
W less than 25	**73**	**1,173**
Buffer Vegitation Type		
Dominant	**Mixed Trees**	**Deciduous**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**Residential**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Phase 2 Segment Summary Report — Black River

Stream: **Patch Brook** Reach: **M40T5.01-C**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type	**None**	4.7 Stormwater Inputs	**None**
4.2 Adjacent Wetlands:	**None**	Flow Reg. Use:		Field Ditch:	Road Ditch:
4.3 Flow Status:	**Moderate**	Impoundments:		Other:	Tile Drain:
4.4 # of Debris Jams:	**1**	Impoundment Loc.:		Overland Flow:	Urb Strm Wtr Pipe:
		4.6 Up/Down Strm flow reg.:	**Up Stream**	4.9 # of Beaver Dams:	**0**
		(old) Upstrm Flow Reg.:	**Diversion**	Affected Length (ft):	**0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**0**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**No**
Mid:	**0**	Delta:	**0**	Flood chutes:	**4**	Avulsion:	**0**	5.5 Straightening:	**None**
Point:	**1**	Island:	**2**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**0**
Side:	**1**	Braiding:	**2**	Steep Riffles:	**0**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	**10**	6.4 Sediment Deposition:	**15**	Stream Gradiant Type	Left	Right
6.2 Pool Substrate:	**15**	6.5 Channel Flow Status:	**10**	6.8 Bank Stability:	**7**	**6**
6.3 Pool Variability:	**8**	6.6 Channel Alteration:	**16**	6.9 Bank Vegetation Protection	**6**	**6**
Total Score:	**121**	6.7 Channel Sinuosity:	**6**	6.10 Riparian Veg. Zone Width:	**10**	**6**
Habitat Rating:	**0.61**					
Habitat Stream Condition:	**Fair**					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Confined** Score	STD	Historic		
7.1 Channel Degradation	**10**	**None**	**Yes**	Geomorphic Rating	**0.55**
7.2 Channel Aggradation	**13**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**10**	**None**	**No**	Channel Evolution Stage	**III**
7.4 Change in Planforml	**11**	**None**	**No**	Geomorphic Condition	**Fair**
Total Score	**44**			Stream Sensitivity	**High**

Phase 2 Segment Summary Report **Black River**

Stream:	**Patch Brook**	SGAT Version:	**4.56**
Reach:	**M40T5.01-D**	Organization:	**South Windsor County Regional Planning Commission**
Segment Length(ft):	**1,382**	Observers:	**KLU, BOS - SMRC**
Rain:	**No**	Completion Date:	**9/10/2009**
		Qualtiy Control Status - Consultant:	**Provisional**
		Qualtiy Control Status - Staff:	**Provisional**

Step 0 - Location: **East of Dublin Road.**

Step 5 - Notes: **Generally valley walls are comprised of coarse-grained glaciofluvial terraces between 2 and 4 times the channel width, and ranging in height from a thalweg height of 10 to 12 feet, or 5 to 6 times the thalweg depth of the channel. Straightening of the channel is apparent from the linear planform with abandoned meanders on either side of the straightened channel. Near the upper end of the segment, a small bypass channel has been constructed historically to convey a portion of the flow from Patch Brook to a culvert under Dublin Road and into a constructed channel that flows somewhat parallel to Patch Brook, but on the far side of residential homes to the west of Dublin Road. This “canal”, as it is known locally, returns to the Patch Brook approximately 3000 feet downstream in Segment B. This diversion channel was constructed historically to support operations at Tyson Furnace**

Step 7 - Narrative: **Historic incision; early widening. Historic planform adjustment (straightening). Lateral adjustments moderated by coarseness of bed/bank material of glaciofluvial origin and regenerating tree buffers.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	**0**		**0**	
Road:	**234**	**7**	**0**	
Railroad:	**0**		**0**	
Imp. Path:	**0**		**0**	
Dev.:	**0**		**0**	

1.4 Adjacent Side	Left	Right
Hillside Slope:	**Steep**	**Steep**
Continuous w/ Bank:	**Sometimes**	**Sometimes**
Within 1 Bankfull W:	**Sometimes**	**Sometimes**
Texture:	**N.E.**	**N.E.**

1.5 Valley Features	
Valley Width (ft):	**65**
Width Determination:	**Estimated**
Confinement Type:	**SC**
In Rock Gorge:	**No**
Human Caused Change in Valley Width?:	**Yes**

1.6 Grade Controls: **None**

Stream: **Patch Brook** Reach: **M40T5.01-D**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**23.80**	2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.00**	2.12 Substrate Composition		Bed:	**N/A**
2.3 Mean Depth (tf):	**1.18**	Bedrock:	**0.0 %**	Bar:	**N/A**
2.4 Floodprone Width (ft.):	**30.00**	Boulder:	**21.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**5.10**	Cobble:	**41.0 %**	Stream Type:	**F**
Human Elev FloodPln (ft.):		Coarse Gravel:	**19.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**20.17**	Fine Gravel:	**6.0 %**	Subclass Slope:	**b**
2.7 Entrenchment Ratio:	**1.26**	Sand:	**13.0 %**	Bed Form:	**Plane Bed**
2.8 Incision Ratio:	**2.55**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**3.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**6**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**769.7**	**506.8**
Erosion Height (ft.):	**3.3**	**2.7**
Revetment Type:	**Rip-Rap**	**None**
Revetment Length:	**46.6**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Deciduous**	**Deciduous**
Sub-dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**None**	**51-100**
W less than 25	**0**	**381**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Deciduous**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**None**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Patch Brook**   Reach: **M40T5.01-D**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type	**Small Bypass**	4.7 Stormwater Inputs	**None**
4.2 Adjacent Wetlands:	**None**	Flow Reg. Use:	**Other**	Field Ditch:	Road Ditch:
4.3 Flow Status:	**Moderate**	Impoundments:		Other:	Tile Drain:
4.4 # of Debris Jams:	**1**	Impoundment Loc.:		Overland Flow:	Urb Strm Wtr Pipe:
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:	**0**
		(old) Upstrm Flow Reg.:		Affected Length (ft):	**0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**0**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**No**
Mid:	**0**	Delta:	**0**	Flood chutes:	**3**	Avulsion:	**0**	5.5 Straightening:	**Straightening**
Point:	**0**	Island:	**1**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**888**
Side:	**0**	Braiding:	**1**	Steep Riffles:	**0**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	**13**	6.4 Sediment Deposition:	**16**	Stream Gradiant Type	Left	Right
6.2 Pool Substrate:	**18**	6.5 Channel Flow Status:	**11**	6.8 Bank Stability:	**3**	**3**
6.3 Pool Variability:	**11**	6.6 Channel Alteration:	**6**	6.9 Bank Vegetation Protection	**3**	**3**
Total Score:	**110**	6.7 Channel Sinuosity:	**5**	6.10 Riparian Veg. Zone Width:	**9**	**9**
Habitat Rating:	**0.55**					
Habitat Stream Condition:	**Fair**					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Confined** Score	STD	Historic		
7.1 Channel Degradation	**3**	**C to F**	**Yes**	Geomorphic Rating	**0.55**
7.2 Channel Aggradation	**15**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**13**	**None**	**No**	Channel Evolution Stage	**III**
7.4 Change in Planforml	**13**	**None**	**Yes**	Geomorphic Condition	**Fair**
Total Score	**44**			Stream Sensitivity	**Extreme**

Phase 2 Segment Summary Report Black River

Stream:	**Patch Brook**	SGAT Version:	**4.56**
Reach:	**M40T5.02-A**	Organization:	**South Windsor County Regional Planning Commission**
Segment Length(ft):	**1,240**	Observers:	**KLU, BOS - SMRC**
Rain:	**No**	Completion Date:	**9/10/2009**
		Qualtiy Control Status - Consultant:	**Provisional**
		Qualtiy Control Status - Staff:	**Provisional**

Step 0 - Location: **1200 feet downstream of Tatro Road bridge, east of Dublin Road**

Step 5 - Notes: **Valley widths have been reduced somewhat by the encroachment of the Dublin Road, resulting in a modified valley width that varies between 30 and 75 feet, or 1.1 to 2.7 times the measured bankfull width. Uncertain degree of historic incision versus postglacial; reported degree of incision may be overstated. But some degree of historic incision is indicated by the stepped footers on Tatro Road bridge crossing (and upstream Dublin Road crossing), and the history of straightening and berming. It is also possible that the degree of incision at cross section site for Segment A has been influenced locally by the presence and later breaching of ahistoric mill dam – which apparently was located approximately 180 feet upstream according to historic maps. No signs of current incision (headcuts, rejuvenating tribs, eroding banks, and scour along both banks in the straightaways). Flow regulation in downstream segment is diversion (small) established historically for hydropower (see Phase 2 report). Tatro Road bridge is bankfull constrictor. Remnants of former earthen/ stone dam (Old Abutments) are floodprone constrictor.**

Step 7 - Narrative: **Historic incision (perhaps less than indicated; some postglacial). Historic planform adjustment (channelization). Minor aggradation. Possible B to Fb to B STD historically.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Subreach**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	**112**	**4**	**0**	
Road:	**1,031**	**9**	**165**	**7**
Railroad:	**0**		**0**	
Imp. Path:	**0**		**0**	
Dev.:	**54**		**155**	

1.4 Adjacent Side	Left	Right
Hillside Slope:	**Steep**	**Very Steep**
Continuous w/ Bank:	**Sometimes**	**Sometimes**
Within 1 Bankfull W:	**Always**	**Always**
Texture:	**N.E.**	**N.E.**

1.5 Valley Features

Valley Width (ft):	**40**
Width Determination:	**Estimated**
Confinement Type:	**NC**
In Rock Gorge:	**No**
Human Caused Change in Valley Width?:	**Yes**

1.6 Grade Controls: **None**

Stream:	**Patch Brook**	Reach:	**M40T5.02-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**28.00**	2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.40**	2.12 Substrate Composition		Bed:	**N/A**
2.3 Mean Depth (tf):	**1.60**	Bedrock:	**0.0 %**	Bar:	**N/A**
2.4 Floodprone Width (ft.):	**44.00**	Boulder:	**9.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**6.40**	Cobble:	**40.0 %**	Stream Type:	**B**
Human Elev FloodPln (ft.):		Coarse Gravel:	**30.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**17.50**	Fine Gravel:	**5.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**1.57**	Sand:	**16.0 %**	Bed Form:	**Plane Bed**
2.8 Incision Ratio:	**2.67**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**5.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**7**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right	Bank Erosion	Left	Right	Near Bank Vegetation Type	Left	Right
Upper			Erosion Length (ft.):	**108.1**	**0.0**	Dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**	Erosion Height (ft.):	**4.3**	**0.0**	Sub-dominant:	**Deciduous**	**Deciduous**
Consistency:	**Non-cohesive**	**Non-cohesive**	Revetment Type:	**Rip-Rap**	**Rip-Rap**	Bank Canopy		
Lower			Revetment Length:	**46.4**	**265.8**	Canopy %:	**76-100**	**76-100**
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**				Mid-Channel Canopy:	**Closed**	
Consistency:	**Non-cohesive**	**Non-cohesive**						

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**51-100**
Sub-Dominant	**0-25**	**0-25**
W less than 25	**539**	**504**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Deciduous**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Residential**
Sub-dominant	**None**	**Forest**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Patch Brook** Reach: **M40T5.02-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**
4.2 Adjacent Wetlands: **None**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **0**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **Down Stream**
(old) Upstrm Flow Reg.: **Diversion**

4.7 Stormwater Inputs **None**
Field Ditch: Road Ditch:
Other: Tile Drain:
Overland Flow: Urb Strm Wtr Pipe:
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	**12.8**	**Yes**	**Yes**	**Yes**	**Yes**	**Deposition Above,Scour Below**
Old Abutment	**42**	**Yes**	**Yes**	**No**	**Yes**	**None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **0** Point: **0** Side: **2**
Diagonal: **0** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features
Flood chutes: **1**
Neck Cutoff: **0**
Avulsion: **0**

5.3 Steep Riffles and Head Cuts
Head Cuts: **0**
Steep Riffles: **0**
Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**
5.5 Straightening: **Straightening**
Straightening Length (ft.): **1,210**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.: **13**
6.2 Pool Substrate: **13**
6.3 Pool Variability: **11**
Total Score: **128**
Habitat Rating: **0.64**
Habitat Stream Condition: **Fair**

6.4 Sediment Deposition: **15**
6.5 Channel Flow Status: **15**
6.6 Channel Alteration: **8**
6.7 Channel Sinuosity: **8**

Stream Gradiant Type	Left	Right
6.8 Bank Stability:	**8**	**8**
6.9 Bank Vegetation Protection	**10**	**8**
6.10 Riparian Veg. Zone Width:	**8**	**3**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**	Score	STD	Historic
7.1 Channel Degradation	**3**	**Other**	**Yes**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**16**	**None**	**No**
7.4 Change in Planforml	**13**	**None**	**Yes**
Total Score	**45**		

Geomorphic Rating **0.56**
Channel Evolution Model **F**
Channel Evolution Stage **II**
Geomorphic Condition **Fair**
Stream Sensitivity **High**

Phase 2 Segment Summary Report   Black River

Stream:	**Patch Brook**	SGAT Version:	**4.56**
Reach:	**M40T5.02-B**	Organization:	**South Windsor County Regional Planning Commission**
Segment Length(ft):	**871**	Observers:	**KLU, BOS - SMRC**
Rain:	**No**	Completion Date:	**9/10/2009**
		Qualtiy Control Status - Consultant:	**Provisional**
		Qualtiy Control Status - Staff:	**Provisional**

Step 0 - Location: **From Dublin Road bridge crossing downstream nearly to Tatro Road crossing.**

Step 5 - Notes: **Natural valley width varies from 5 to greater than 10 times the channel width (Narrow to Very Broad). Historic encroachment of Dublin Road within the RB corridor has reduced the valley width to a degree, to approximately 3 to 7 times the channel width, averaging a Narrow confinement. However, the valley type (Unconfined) remained unchanged. Actual channel position does not match VHD (see Phase 2 report). Channel has been straightened along the Dublin Road; windrowing and berming are apparent. A cobble/gravel berm is present along the LB ranging from a thalweg height of 9.7 feet (near the Dublin Road bridge crossing) to 3 feet at its downstream end, where a 4-foot berm is also present along the RB for a short length. This LB berm effectively cuts off the river's access to the floodplain along the LB corridor, resulting in a Cb to F vertical stream type departure. A Human-elevated Floodplain incision ratio (IRHEF) of 4.0 was estimated. Historic straightening w/ windrowing is inferred due to linear planform and berms.**

Step 7 - Narrative: **Minor widening, aggradation, and planform adjustment. Extensive historic channelization (planform adjustment). Historic incision and berm/road encroachment leading to entrenchment and vertical stream type departure from Cb to Fb. Extreme sens due to STD.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Subreach**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

	Length (ft) One	Height	Both	Height
Berm:	**370**	**9**	**73**	**3**
Road:	**593**	**8**	**48**	**7**
Railroad:	**0**		**0**	
Imp. Path:	**0**		**0**	
Dev.:	**0**		**17**	

1.4 Adjacent Side	Left	Right
Hillside Slope:	**Very Steep**	**Extr.Steep**
Continuous w/ Bank:	**Sometimes**	**Sometimes**
Within 1 Bankfull W:	**Sometimes**	**Sometimes**
Texture:	**N.E.**	**N.E.**

1.5 Valley Features

Valley Width (ft):	**120**
Width Determination:	**Estimated**
Confinement Type:	**NW**
In Rock Gorge:	**No**

Human Caused Change in Valley Width?: **Yes**

1.6 Grade Controls: **None**

Stream: **Patch Brook** Reach: **M40T5.02-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**24.10**	2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.40**	2.12 Substrate Composition		Bed:	**N/A**
2.3 Mean Depth (tf):	**1.53**	Bedrock:	**0.0 %**	Bar:	**N/A**
2.4 Floodprone Width (ft.):	**33.00**	Boulder:	**22.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**4.10**	Cobble:	**39.0 %**	Stream Type:	**F**
Human Elev FloodPln (ft.):	**9.70**	Coarse Gravel:	**24.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**15.75**	Fine Gravel:	**10.0 %**	Subclass Slope:	**b**
2.7 Entrenchment Ratio:	**1.37**	Sand:	**5.0 %**	Bed Form:	**Plane Bed**
2.8 Incision Ratio:	**1.71**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**4.04**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**2.0 %**	Reference Stream Type:	**C**
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**5**	Reference Bed Material:	**Cobble**
				Reference Subclass Slope:	**b**
				Reference Bedform:	**Step-Pool**

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Gravel**	**Gravel**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**0.0**	**0.0**
Erosion Height (ft.):	**0.0**	**0.0**
Revetment Type:	**Rip-Rap**	**Rip-Rap**
Revetment Length:	**287.1**	**393.4**

Near Bank Vegetation Type	Left	Right
Dominant:	**Deciduous**	**Deciduous**
Sub-dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Bank Canopy		
Canopy %:	**76-100**	**51-75**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**0-25**
Sub-Dominant	**51-100**	**26-50**
W less than 25	**33**	**503**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Deciduous**
Sub-Dominant	**None**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Residential**
Sub-dominant	**Residential**	**Forest**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Phase 2 Segment Summary Report **Black River**

Stream: **Patch Brook** Reach: **M40T5.02-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Abundant**	4.5 Flow Regulation Type	**None**	4.7 Stormwater Inputs	**None**
4.2 Adjacent Wetlands:	**None**	Flow Reg. Use:		Field Ditch:	Road Ditch:
4.3 Flow Status:	**Moderate**	Impoundments:		Other:	Tile Drain:
4.4 # of Debris Jams:	**0**	Impoundment Loc.:		Overland Flow:	Urb Strm Wtr Pipe:
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:	**0**
		(old) Upstrm Flow Reg.:		Affected Length (ft):	**0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**0**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**No**
Mid:	**0**	Delta:	**0**	Flood chutes:	**1**	Avulsion:	**0**	5.5 Straightening:	**With Windrowing**
Point:	**0**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**753**
Side:	**1**	Braiding:	**0**	Steep Riffles:	**0**	Trib Rejuv.:	**No**	5.5 Dredging:	**Dredging**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	**13**	6.4 Sediment Deposition:	**15**	Stream Gradiant Type	Left	Right
6.2 Pool Substrate:	**13**	6.5 Channel Flow Status:	**15**	6.8 Bank Stability:	**8**	**8**
6.3 Pool Variability:	**11**	6.6 Channel Alteration:	**8**	6.9 Bank Vegetation Protection	**10**	**8**
Total Score:	**128**	6.7 Channel Sinuosity:	**8**	6.10 Riparian Veg. Zone Width:	**8**	**3**
Habitat Rating:	**0.64**					
Habitat Stream Condition:	**Fair**					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Unconfined** Score	STD	Historic		
7.1 Channel Degradation	**3**	**C to F**	**Yes**	Geomorphic Rating	**0.61**
7.2 Channel Aggradation	**15**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**16**	**None**	**No**	Channel Evolution Stage	**II**
7.4 Change in Planforml	**15**	**None**	**Yes**	Geomorphic Condition	**Fair**
Total Score	**49**			Stream Sensitivity	**Extreme**

Phase 2 Segment Summary Report **Black River**

Stream:	**Patch Brook**	SGAT Version:	**4.56**
Reach:	**M40T5.03-A**	Organization:	**South Windsor County Regional Planning Commission**
Segment Length(ft):	**1,856**	Observers:	**KLU, BOS - SMRC**
Rain:	**No**	Completion Date:	**9/10/2009**
		Qualtiy Control Status - Consultant:	**Provisional**
		Qualtiy Control Status - Staff:	**Provisional**

Step 0 - Location: **From bedrock gorge southwest of Patch Rd intersection with Dublin Rd to Dublin Rd bridge crossing.**

Step 5 - Notes: **An alluvial fan was indexed in this segment to capture the marked reduction in natural valley confinement. Human encroachments along the left bank (Dublin Road and high gravel berms) have reduced the available valley width and lead to a stream type departure. Channel straightening with windrowing in the downstream half is inferred due to the linear planform and presence of berms. A residence is located in the RB floodplain at the downstream end of the segment. Due to modifications of the floodplain and berm construction, the location and elevation of the "recently-abandoned floodplain" were not easily discerned. Between the berm and a terrace along Dublin Road there is a low spot at an elevation of 2 feet above the thalweg. It is very possible that this area was excavated in the past to produce gravel and cobble material for construction of the berm. This area may also have been occupied by floodwaters during an avulsion of the channel and may represent a historic flood chute. The terrace to the north of this flood chute along Dublin Road was likely graded at some time during flood recovery efforts and may not represent the natural, abandoned floodplain elevation. Therefore, the IRraf value (of 3.7) may be overstated for this cross section location. Based on quick measurements, low bank heights (RAF) were approximately 2.9 times the measured bankfull depth in locations upstream of the cross section, closer to the short bedrock gorge. Upstream flow regulation is Lake Ninevah dam. Stream ford is ATV trail crossing.**

Step 7 - Narrative: **Minor localized aggradation. Major historic planform adjustment and incision (with degree of entrenchment enhanced by berms) - leading to vertical stream type departure from Ca to Fa. Widening moderated by steepness of slope, coarseness of boundary material, forested buffers. Still, susceptible to catastrophic erosion in future flood due to incised and entrenched channel status.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Subreach**

1.2 Alluvial Fan: **Yes**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	**687**	**7**	**0**	
Road:	**1,213**	**9**	**0**	
Railroad:	**0**		**0**	
Imp. Path:	**0**		**0**	
Dev.:	**50**		**0**	

1.4 Adjacent Side

	Left	Right
Hillside Slope:	**Very Steep**	**Extr.Steep**
Continuous w/ Bank:	**Never**	**Sometimes**
Within 1 Bankfull W:	**Sometimes**	**Sometimes**
Texture:	**N.E.**	**N.E.**

1.5 Valley Features

Valley Width (ft):	**100**
Width Determination:	**Estimated**
Confinement Type:	**NW**
In Rock Gorge:	**No**
Human Caused Change in Valley Width?:	**Yes**

1.6 Grade Controls: **None**

Stream: **Patch Brook** Reach: **M40T5.03-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**27.13**	2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**1.90**	2.12 Substrate Composition		Bed:	**N/A**
2.3 Mean Depth (tf):	**1.26**	Bedrock:	**0.0 %**	Bar:	**N/A**
2.4 Floodprone Width (ft.):	**39.00**	Boulder:	**15.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**7.00**	Cobble:	**36.0 %**	Stream Type:	**F**
Human Elev FloodPln (ft.):	**8.00**	Coarse Gravel:	**25.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**21.53**	Fine Gravel:	**12.0 %**	Subclass Slope:	**a**
2.7 Entrenchment Ratio:	**1.44**	Sand:	**12.0 %**	Bed Form:	**Plane Bed**
2.8 Incision Ratio:	**3.68**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**4.21**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**2.0 %**	Reference Stream Type:	**C**
2.10 Riffles Type:	**Eroded**	# Large Woody Debris:	**15**	Reference Bed Material:	**Cobble**
				Reference Subclass Slope:	**a**
				Reference Bedform:	**Step-Pool**

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Moderate**

Bank Texture	Left	Right
Upper		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**0.0**	**101.6**
Erosion Height (ft.):	**0.0**	**4.0**
Revetment Type:	**None**	**Rip-Rap**
Revetment Length:	**0.0**	**47.8**

Near Bank Vegetation Type	Left	Right
Dominant:	**Deciduous**	**Deciduous**
Sub-dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**0-25**	**>100**
Sub-Dominant	**26-50**	**0-25**
W less than 25	**1,414**	**209**
Buffer Vegitation Type		
Dominant	**Mixed Trees**	**Mixed Trees**
Sub-Dominant	**Herbaceous**	**Herbaceous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**Hay**	**Residential**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Patch Brook** Reach: **M40T5.03-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **None**
4.2 Adjacent Wetlands: **None**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **2**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs
Field Ditch: **0** Road Ditch: **1**
Other: **0** Tile Drain: **0**
Overland Flow: **0** Urb Strm Wtr Pipe: **0**
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	**14.4**	**Yes**	**Yes**	**Yes**	**Yes**	**Deposition Above,Alignment**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **0** Point: **0** Side: **0**
Diagonal: **0** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features
Flood chutes: **3**
Neck Cutoff: **0** Avulsion: **0**
5.3 Steep Riffles and Head Cuts
Steep Riffles: **0** Head Cuts: **0** Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **Yes**
5.5 Straightening: **With Windrowing**
Straightening Length (ft.): **1,328**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.: **8**
6.2 Pool Substrate: **13**
6.3 Pool Variability: **10**
Total Score: **114**
Habitat Rating: **0.57**
Habitat Stream Condition: **Fair**

6.4 Sediment Deposition: **15**
6.5 Channel Flow Status: **10**
6.6 Channel Alteration: **8**
6.7 Channel Sinuosity: **5**

Stream Gradiant Type	Left	Right
6.8 Bank Stability:	**9**	**8**
6.9 Bank Vegetation Protection	**7**	**7**
6.10 Riparian Veg. Zone Width:	**5**	**9**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**	Score	STD	Historic
7.1 Channel Degradation	**3**	**C to F**	**Yes**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**14**	**None**	**Yes**
7.4 Change in Planforml	**11**	**None**	**Yes**
Total Score	**41**		

Geomorphic Rating **0.51**
Channel Evolution Model **F**
Channel Evolution Stage **II**
Geomorphic Condition **Fair**
Stream Sensitivity **Extreme**

Phase 2 Segment Summary Report Black River

Stream:	**Patch Brook**	SGAT Version:	**4.56**
Reach:	**M40T5.03-B**	Organization:	**South Windsor County Regional Planning Commission**
Segment Length(ft):	**7,623**	Observers:	**KLU, BOS - SMRC**
Rain:	**Yes**	Completion Date:	**10/29/2009**
		Qualtiy Control Status - Consultant:	**Provisional**
		Qualtiy Control Status - Staff:	**Provisional**

Step 0 - Location: **Along south side of Patch Road from Townsend Barn Rd bridge crossing downstream to bedrock gorge southwest of junction with Dublin Rd.**

Step 5 - Notes: **Patch Brook Road encroaches within the valley, along LB, and is elevated above the brook (cut into the left valley wall) at heights generally ranging from 6 to 15 feet (or 3 to nearly 8 times the bankfull depth of the channel). In one location mid-segment, where the height of the road is approximately 3.5 times the bankfull depth, presence of a short berm (between the road and the channel) and left-bank armoring suggests that the river may have avulsed in a past flood to wash out a section of the Patch Brook Road and temporarily occupy a small floodplain on the far side of the road. Encroachment by the road has resulted in human-modication of the valley width, such that the floodplain is now generally less than two channel widths (i.e., Narrowly-Confined). The natural valley width, prior to the road, was probably not much wider (between 1.5 to 2.5 times the channel width, or Narrowly-Confined to Semi-Confined valley type). No significant change in the reference stream type (Ba-S/P) is inferred as a result of the road encroachment. 21 cross culverts were indexed, most often 16 or 18 inches in diameter, but a few of 12- to 14-inch diameter and a few 2 feet in diameter. Often fine sand and gravels obstructed culvert inlets and culvert outlets were unstable (no headers). Road sediment was observed directly entering the channel at the outlet of several culverts. A few additional locations of direct sediment runoff by overland flow were indexed along the reach. Remnants of a possible instream dam were noted near the upstream end of the reach in the vicinity of historic mills depicted on the Beers Atlas (1869). This dam appears to have been breached long ago (perhaps in the 1927 flood or prior events). Upstream flow regulation is Lake Ninevah dam; outlet channel for this lake joins Patch Brook just above the upstream end of the reach. Townsend Barn Road bridge crosses the channel at the upstream end of the reach; bankfull-constrictor.**

Step 7 - Narrative: **Negligible active adjustment. Minor historic incision, Widening, planform adjustment. Lateral & vertical adjustments likely moderated by coarseness & erosion resistance of bed and bank materials, bedrock grade controls, and forested buffers.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Subreach**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

	Length (ft) One	Height	Both	Height
Berm:	162	7	0	
Road:	7,185	8	0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		60	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Extr.Steep	Extr.Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	Mixed	Mixed

1.5 Valley Features

Valley Width (ft):	**35**
Width Determination:	**Estimated**
Confinement Type:	**NC**
In Rock Gorge:	**No**
Human Caused Change in Valley Width?:	**Yes**

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Waterfall	Mid-segment	20.0	19.0	Yes	

Stream: **Patch Brook** Reach: **M40T5.03-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**19.40**	2.11 Riffle/Step Spacing:	**40 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**2.20**	2.12 Substrate Composition		Bed:	**450 mm**
2.3 Mean Depth (tf):	**1.27**	Bedrock:	**0.0 %**	Bar:	**N/A mm**
2.4 Floodprone Width (ft.):	**31.00**	Boulder:	**45.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**2.70**	Cobble:	**34.0 %**	Stream Type:	**B**
Human Elev FloodPln (ft.):		Coarse Gravel:	**16.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**15.28**	Fine Gravel:	**2.0 %**	Subclass Slope:	**a**
2.7 Entrenchment Ratio:	**1.60**	Sand:	**3.0 %**	Bed Form:	**Step-Pool**
2.8 Incision Ratio:	**1.23**	Silt and Smaller:	**0.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**2.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**39**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**18.2**	**122.4**
Erosion Height (ft.):	**3.0**	**4.3**
Revetment Type:	**Rip-Rap**	**Multiple**
Revetment Length:	**1,478.9**	**492.4**

Near Bank Vegetation Type	Left	Right
Dominant:	**Deciduous**	**Deciduous**
Sub-dominant:	**Shrubs/Sapling**	**Coniferous**
Bank Canopy		
Canopy %:	**51-75**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**0-25**	**>100**
Sub-Dominant	**26-50**	**None**
W less than 25	**7,278**	**0**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Deciduous**
Sub-Dominant	**Coniferous**	**Coniferous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**None**
(Legacy)	Amount	Mean Hieght
Failures	**One**	**15.0**
Gullies	**None**	

	Left	Right
Mass Failures		**34.6**
Height		**15.0**
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Patch Brook** Reach: **M40T5.03-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Abundant**
4.2 Adjacent Wetlands: **Minimal**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **2**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs
Field Ditch: **0** Road Ditch: **18**
Other: **0** Tile Drain: **0**
Overland Flow: **2** Urb Strm Wtr Pipe: **0**
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	**12**	**Yes**	**Yes**	**Yes**	**Yes**	**None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **2** Point: **0** Side: **0**
Diagonal: **1** Delta: **0** Island: **3** Braiding: **3**

5.2 Other Features
Flood chutes: **6**
Neck Cutoff: **0** Avulsion: **0** Head Cuts: **0** Trib Rejuv.: **No**

5.3 Steep Riffles and Head Cuts
Steep Riffles: **0**

5.4 Stream Ford or Animal Crossing: **Yes**
5.5 Straightening: **Straightening**
Straightening Length (ft.): **167**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.: **13**
6.2 Pool Substrate: **15**
6.3 Pool Variability: **13**
Total Score: **144**
Habitat Rating: **0.72**
Habitat Stream Condition: **Good**

6.4 Sediment Deposition: **15**
6.5 Channel Flow Status: **11**
6.6 Channel Alteration: **13**
6.7 Channel Sinuosity: **18**

Stream Gradiant Type	Left	Right
6.8 Bank Stability:	**10**	**9**
6.9 Bank Vegetation Protection	**7**	**8**
6.10 Riparian Veg. Zone Width:	**2**	**10**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**	Score	STD	Historic
7.1 Channel Degradation	**13**	**None**	**Yes**
7.2 Channel Aggradation	**15**	**None**	**Yes**
7.3 Widening Channel	**13**	**None**	**Yes**
7.4 Change in Planforml	**13**	**None**	**Yes**
Total Score	**54**		

Geomorphic Rating **0.68**
Channel Evolution Model **F**
Channel Evolution Stage **V**
Geomorphic Condition **Good**
Stream Sensitivity **Moderate**

Phase 2 Segment Summary Report Black River

Stream:	**Patch Brook**	SGAT Version:	**4.56**
Reach:	**M40T5.04-A**	Organization:	**South Windsor County Regional Planning Commission**
Segment Length(ft):	**623**	Observers:	**KLU, BOS - SMRC**
Rain:	**No**	Completion Date:	**9/11/2009**
		Qualtiy Control Status - Consultant:	**Provisional**
		Qualtiy Control Status - Staff:	**Provisional**
		Why Not Assessed:	**wetland**

Step 0 - Location: **Wetland segment from Patch Road culvert downstream to reach break.**

Step 5 - Notes: **Segment is dominated by wetland conditions. Slight reduction in valley width due to encroachment of Patch Brook Rd (gravel) along LB. No change in valley type (Very Broad) or confinement status (Unconfined). Beaver activity. Short section of straightening is associated with culvert under Patch Brook Road (in upstream Segment B).**

Step 7 - Narrative:

Step 1. Valley and Floodplain

1.1 Segmentation: **Flow Status**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	**0**		**0**	
Road:	**0**		**0**	
Railroad:	**0**		**0**	
Imp. Path:	**0**		**0**	
Dev.:	**0**		**0**	

1.4 Adjacent Side	Left	Right
Hillside Slope:	**Steep**	**Steep**
Continuous w/ Bank:	**Never**	**Never**
Within 1 Bankfull W:	**Never**	**Never**
Texture:	**N.E.**	**N.E.**

1.5 Valley Features

Valley Width (ft):	**290**
Width Determination:	**Estimated**
Confinement Type:	**VB**
In Rock Gorge:	**No**
Human Caused Change in Valley Width?:	**Yes**

1.6 Grade Controls: **None**

Stream: **Patch Brook** Reach: **M40T5.04-A**

Step 2. Stream Channel

2.1Bankfull Width (ft.):		2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on	
2.2 Max Depth (ft.):		2.12 Substrate Composition		Bed:	
2.3 Mean Depth (tf):		Bedrock:	%	Bar:	
2.4 Floodprone Width (ft.):		Boulder:	%	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):		Cobble:	%	Stream Type:	
Human Elev FloodPln (ft.):		Coarse Gravel:	%	Bed Material:	
2.6 Width/Depth Ratio:	**0.00**	Fine Gravel:	%	Subclass Slope:	
2.7 Entrenchment Ratio:	**0.00**	Sand:	%	Bed Form:	
2.8 Incision Ratio:	**0.00**	Silt and Smaller:	%	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:		2.15 Sub-reach Stream Type	
2.9 Sinuosity:		Detritus:	%	Reference Stream Type:	
2.10 Riffles Type:		# Large Woody Debris:		Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Moderate**

Bank Texture	Left	Right
Upper		
Material Type:	**Mix**	**Mix**
Consistency:	**Cohesive**	**Cohesive**
Lower		
Material Type:	**Mix**	**Mix**
Consistency:	**Cohesive**	**Cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**0.0**	**0.0**
Erosion Height (ft.):	**0.0**	**0.0**
Revetment Type:	**None**	**None**
Revetment Length:	**0.0**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Herbaceous**	**Herbaceous**
Sub-dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Bank Canopy		
Canopy %:	**1-25**	**1-25**
Mid-Channel Canopy:	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**51-100**	**None**
W less than 25	**0**	**0**
Buffer Vegitation Type		
Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**
Sub-Dominant	**Deciduous**	**Deciduous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**
Sub-dominant	**None**	**None**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Patch Brook** Reach: **M40T5.04-A**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Abundant**
4.2 Adjacent Wetlands: **Abundant**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **0**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs **None**
Field Ditch: Road Ditch:
Other: Tile Drain:
Overland Flow: Urb Strm Wtr Pipe:
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **0** Point: **0** Side: **0**
Diagonal: **0** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features
Flood chutes: **0**
Neck Cutoff: **0**
Avulsion: **0**

5.3 Steep Riffles and Head Cuts
Steep Riffles: **0**
Head Cuts: **0**
Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**
5.5 Straightening: **Straightening**
Straightening Length (ft.): **41**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:
6.2 Pool Substrate:
6.3 Pool Variability:
Total Score:
Habitat Rating:
Habitat Stream Condition:

6.4 Sediment Deposition:
6.5 Channel Flow Status:
6.6 Channel Alteration:
6.7 Channel Sinuosity:

Stream Gradiant Type	Left	Right
6.8 Bank Stability:		
6.9 Bank Vegetation Protection		
6.10 Riparian Veg. Zone Width:		

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	Score	STD	Historic
7.1 Channel Degradation			
7.2 Channel Aggradation			
7.3 Widening Channel			
7.4 Change in Planforml			
Total Score			

Geomorphic Rating
Channel Evolution Model
Channel Evolution Stage
Geomorphic Condition
Stream Sensitivity

Phase 2 Segment Summary Report Black River

Stream:	Patch Brook	SGAT Version:	4.56
Reach:	M40T5.04-B	Organization:	South Windsor County Regional Planning Commission
Segment Length(ft):	2,427	Observers:	KLU, BOS - SMRC
Rain:	No	Completion Date:	9/11/2009
		Qualtiy Control Status - Consultant:	Provisional
		Qualtiy Control Status - Staff:	Provisional

Step 0 - Location: **East of Unknown Soldier Road, from old gravel pits downstream to Patch Brook Rd culvert.**

Step 5 - Notes: **Valley walls are comprised of terraces ranging in height from 4 to 10 feet (or approximately 2.5 to 6 times the thalweg height). The valley defined by these terraces ranges in width from 45 to more than 250 feet. Low-bank heights along the channel were generally less than in upstream Segment C, ranging from approximately 1.2 to 1.6 times the thalweg height. Incision appeared historic in nature. Near the downstream end of the segment was a short section of moderately-steep, narrowly-confined bedrock gorge. This section of B2-step/pool channel underlain by bedrock was indexed as a vertical grade control, but was not segmented due to its short overall length (less than 75 feet). Between the bedrock outcroppings was a short, linear section of channel confined between a left-bank terrace with a thalweg height of approximately 7 feet and a right-bank terrace approx 15 feet above the thalweg. The channel had access to a narrow floodplain approximately 20 to 30 feet wide between these two terraces. A cross section measured here (XS-1) indicated an incision ratio of 1.3 and an entrenchment ratio of 1.8. This gravel-dominated Bc-riffle/pool channel was not characteristic of the segment as a whole, but was not segmented due to its very short length. The linear nature of the channel and its unusual setting suggested historic channel modifications - possibly associated with the history of iron ore mining in the region. Proximity to the upstream bedrock gorge suggests possible mill dam operations. A black smith shop and saw mill were noted in the vicinity on the 1869 Beers Atlas of Windsor County (near the Patch Brook Road crossing).**

Step 7 - Narrative: **Moderate aggradation. Historic incision.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Subreach**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	49		74	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Steep	Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	N.E.	N.E.

1.5 Valley Features

Valley Width (ft):	80
Width Determination:	Estimated
Confinement Type:	NW
In Rock Gorge:	No
Human Caused Change in Valley Width?:	No

1.6 Grade Controls:

Type	Location	Total Height	Total Height Above Water	Photo Taken?	GPS Taken?
Waterfall	Mid-segment	8.0	8.0	Yes	
Ledge	Mid-segment	1.0	1.0	No	

Stream: **Patch Brook** Reach: **M40T5.04-B**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**14.70**	2.11 Riffle/Step Spacing:	**50 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**1.70**	2.12 Substrate Composition		Bed:	**35 mm**
2.3 Mean Depth (tf):	**1.21**	Bedrock:	**0.0 %**	Bar:	**44 mm**
2.4 Floodprone Width (ft.):	**55.00**	Boulder:	**0.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**2.00**	Cobble:	**0.0 %**	Stream Type:	**C**
Human Elev FloodPln (ft.):		Coarse Gravel:	**44.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**12.15**	Fine Gravel:	**30.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**3.74**	Sand:	**25.0 %**	Bed Form:	**Riffle-Pool**
2.8 Incision Ratio:	**1.18**	Silt and Smaller:	**1.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Moderate**	Detritus:	**2.0 %**	Reference Stream Type:	**C**
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**12**	Reference Bed Material:	**Gravel**
				Reference Subclass Slope:	**None**
				Reference Bedform:	**Riffle-Pool**

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Mix**	**Mix**
Consistency:	**Cohesive**	**Cohesive**
Lower		
Material Type:	**Mix**	**Mix**
Consistency:	**Cohesive**	**Cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**160.1**	**42.3**
Erosion Height (ft.):	**2.0**	**2.0**
Revetment Type:	**None**	**None**
Revetment Length:	**0.0**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Herbaceous**	**Herbaceous**
Sub-dominant:	**Deciduous**	**Deciduous**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**None**	**0-25**
W less than 25	**56**	**185**
Buffer Vegitation Type		
Dominant	**Deciduous**	**Deciduous**
Sub-Dominant	**Coniferous**	**Coniferous**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**Residential**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Patch Brook** Reach: **M40T5.04-B**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type	**Small Withdrawal**	4.7 Stormwater Inputs	**None**
4.2 Adjacent Wetlands:	**Minimal**	Flow Reg. Use:	**Other**	Field Ditch:	Road Ditch:
4.3 Flow Status:	**Moderate**	Impoundments:		Other:	Tile Drain:
4.4 # of Debris Jams:	**6**	Impoundment Loc.:		Overland Flow:	Urb Strm Wtr Pipe:
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:	**0**
		(old) Upstrm Flow Reg.:		Affected Length (ft):	**0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Instream Culvert	**3.5**	**Yes**	**Yes**	**Yes**	**Yes**	**Scour Below**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**3**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**No**
Mid:	**6**	Delta:	**1**	Flood chutes:	**3**	Avulsion:	**0**	5.5 Straightening:	**Straightening**
Point:	**20**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**512**
Side:	**16**	Braiding:	**0**	Steep Riffles:	**0**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	**10**	6.4 Sediment Deposition:	**13**	Stream Gradiant Type	Left	Right
6.2 Pool Substrate:	**11**	6.5 Channel Flow Status:	**11**	6.8 Bank Stability:	**8**	**9**
6.3 Pool Variability:	**11**	6.6 Channel Alteration:	**15**	6.9 Bank Vegetation Protection	**8**	**9**
Total Score:	**140**	6.7 Channel Sinuosity:	**16**	6.10 Riparian Veg. Zone Width:	**10**	**9**
Habitat Rating:	**0.70**					
Habitat Stream Condition:	**Good**					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**	Score	STD	Historic		
7.1 Channel Degradation	**13**	**None**	**Yes**	Geomorphic Rating	**0.69**
7.2 Channel Aggradation	**11**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**16**	**None**	**No**	Channel Evolution Stage	**II**
7.4 Change in Planforml	**15**	**None**	**Yes**	Geomorphic Condition	**Good**
Total Score	**55**			Stream Sensitivity	**High**

Phase 2 Segment Summary Report **Black River**

Stream:	**Patch Brook**	SGAT Version:	**4.56**
Reach:	**M40T5.04-C**	Organization:	**South Windsor County Regional Planning Commission**
Segment Length(ft):	**2,297**	Observers:	**KLU, BOS - SMRC**
Rain:	**No**	Completion Date:	**9/11/2009**
		Qualtiy Control Status - Consultant:	**Provisional**
		Qualtiy Control Status - Staff:	**Provisional**

Step 0 - Location: **East of Unknown Soldier Road from above the Catamount Trail bridge crossing downstream to vicinity of old gravel pits.**

Step 5 - Notes: **subreach of slightly lesser gradient than upstream Segment D, but located in a Semi-confined to Narrow confinement setting. Valley walls are comprised of terraces ranging in height from 5 to 7 feet (or approximately 3 to 5 times the thalweg height). The valley defined by these terraces ranges in width from 15 to 80 feet. Low-bank heights along the channel generally increased with distance downstream, ranging from approximately 1.2 to 1.7 times the thalweg height. Incision appeared historic in nature. small flow diversion consisting of a 4-inch black flex hose leading from the channel to a nearby impoundment. The intake in the channel is a PVC pipe connected by a Fernco fitting to a flexible hose. The hose was traced through the woods to a narrow pond impounded by a horse-shoe shaped earthen dam approximately 8 feet high and 270 feet long. A culvert was located at the downstream end of the pond and apparently drains the pond. The exact outlet location of the culvert could not be located, although seepage was evident at the base of the dam along a majority of its length. A return channel joins the main Patch Brook channel approximately 650 feet downstream of the intake location. While the VHD indicates that Patch Brook flows through this pond, actual conditions on the ground indicate that the Patch Brook flows alongside the pond between 100 and 150 feet to the east (and 5 to 15 feet lower in elevation). Catamount Trail timber bridge is bankfull constrictor. Overland flow from the trail enters the stream at this crossing. Additional ford crossing in the segment appears to be from an old logging access.**

Step 7 - Narrative: **Minor aggradation and planform adjustment. Historic incision.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Subreach**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	**0**		**0**	
Road:	**0**		**0**	
Railroad:	**0**		**0**	
Imp. Path:	**0**		**0**	
Dev.:	**0**		**46**	

1.4 Adjacent Side	Left	Right
Hillside Slope:	**Very Steep**	**Very Steep**
Continuous w/ Bank:	**Sometimes**	**Sometimes**
Within 1 Bankfull W:	**Sometimes**	**Sometimes**
Texture:	**N.E.**	**N.E.**

1.5 Valley Features	
Valley Width (ft):	**30**
Width Determination:	**Estimated**
Confinement Type:	**SC**
In Rock Gorge:	**No**
Human Caused Change in Valley Width?:	**No**

1.6 Grade Controls: **None**

Stream: **Patch Brook** Reach: **M40T5.04-C**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**12.48**	2.11 Riffle/Step Spacing:	**25 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**1.40**	2.12 Substrate Composition		Bed:	**170 mm**
2.3 Mean Depth (tf):	**0.92**	Bedrock:	**0.0 %**	Bar:	**83 mm**
2.4 Floodprone Width (ft.):	**30.00**	Boulder:	**5.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**2.30**	Cobble:	**27.0 %**	Stream Type:	**C**
Human Elev FloodPln (ft.):		Coarse Gravel:	**35.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**13.57**	Fine Gravel:	**16.0 %**	Subclass Slope:	**b**
2.7 Entrenchment Ratio:	**2.40**	Sand:	**14.0 %**	Bed Form:	**Step-Pool**
2.8 Incision Ratio:	**1.64**	Silt and Smaller:	**3.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Moderate**	Detritus:	**3.0 %**	Reference Stream Type:	**C**
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**35**	Reference Bed Material:	**Gravel**
				Reference Subclass Slope:	**b**
				Reference Bedform:	**Step-Pool**

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Mix**	**Mix**
Consistency:	**Cohesive**	**Cohesive**
Lower		
Material Type:	**Mix**	**Mix**
Consistency:	**Cohesive**	**Cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**259.9**	**48.5**
Erosion Height (ft.):	**2.4**	**4.0**
Revetment Type:	**Other**	**Other**
Revetment Length:	**39.5**	**36.6**

Near Bank Vegetation Type	Left	Right
Dominant:	**Herbaceous**	**Herbaceous**
Sub-dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**None**	**None**
W less than 25	**0**	**0**
Buffer Vegitation Type		
Dominant	**Mixed Trees**	**Mixed Trees**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**None**
(Legacy)	Amount	Mean Hieght
Failures	**Multiple**	**6.5**
Gullies	**None**	

	Left	Right
Mass Failures		**61.47**
Height		**6.5**
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Patch Brook**   Reach: **M40T5.04-C**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**
4.2 Adjacent Wetlands: **Minimal**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **15**

4.5 Flow Regulation Type **Small Bypass**
Flow Reg. Use: **Other**
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs
Field Ditch: **0**   Road Ditch: **0**
Other: **0**   Tile Drain: **0**
Overland Flow: **1**   Urb Strm Wtr Pipe: **0**
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	**5**	**Yes**	**Yes**	**Yes**	**Yes**	**Deposition Above,Alignment**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **4**   Point: **7**   Side: **7**
Diagonal: **2**   Delta: **0**   Island: **3**   Braiding: **0**

5.2 Other Features
Flood chutes: **7**
Neck Cutoff: **0**
Avulsion: **0**

5.3 Steep Riffles and Head Cuts
Steep Riffles: **0**
Head Cuts: **0**
Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **Yes**
5.5 Straightening: **None**
Straightening Length (ft.): **0**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.: **10**
6.2 Pool Substrate: **11**
6.3 Pool Variability: **11**
Total Score: **140**
Habitat Rating: **0.70**
Habitat Stream Condition: **Good**

6.4 Sediment Deposition: **13**
6.5 Channel Flow Status: **11**
6.6 Channel Alteration: **15**
6.7 Channel Sinuosity: **16**

Stream Gradiant Type	Left	Right
6.8 Bank Stability:	**8**	**9**
6.9 Bank Vegetation Protection	**8**	**9**
6.10 Riparian Veg. Zone Width:	**10**	**9**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**	Score	STD	Historic
7.1 Channel Degradation	**8**	**None**	**Yes**
7.2 Channel Aggradation	**15**	**None**	**No**
7.3 Widening Channel	**18**	**None**	**No**
7.4 Change in Planforml	**15**	**None**	**No**
Total Score	**56**		

Geomorphic Rating **0.70**
Channel Evolution Model **F**
Channel Evolution Stage **II**
Geomorphic Condition **Good**
Stream Sensitivity **High**

Phase 2 Segment Summary Report Black River

Stream: **Patch Brook**
Reach: **M40T5.04-D**

Segment Length(ft): **851**
Rain: **Yes**

SGAT Version: **4.56**
Organization: **South Windsor County Regional Planning Commission**
Observers: **KLU, BOS - SMRC**
Completion Date: **9/3/2009**
Qualtiy Control Status - Consultant: **Provisional**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **East of Unknown Soldier class 4 road, from downstream of Unknown Soldier bridge crossing to a point upstream from the Catamount Trail bridge crossing.**

Step 5 - Notes: **Generally the river channel as depicted on the VHD does not match up well with the actual planform (as measured with the GPS on assessment dates in Sept 2009). The channel is actually more sinuous than that depicted by the VHD. Subreach of somewhat lesser gradient in an unconfined setting, with typical valley widths ranging from 100 feet to more than 200 feet. Good floodplain connection. A natural reduction in valley confinement and gradient (from approximately 10% in Segment E to 4.4% in Segment D) may be contributing to the minor degree of aggradation and planform adjustment. Lateral and vertical adjustments are probably moderated by the dense, young-growth forest cover, and erosion resistance of glacial till parent material in the bed and banks of the channel. Also, limited degree of sediment from upstream sources. Lots of LWD recruitment and a frequent spacing of channel-spanning debris jams. Entrained woody material contributes to pool formation. Generally closed canopy – offering shading and ample organic material and detritus**

Step 7 - Narrative: **Minor aggradation and planform adjustment. Lateral / vertical adjustment moderated by erosion resistance of bed and bank sediments.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Subreach**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		0	

1.4 Adjacent Side	Left	Right
Hillside Slope:	Very Steep	Very Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	Mixed	Mixed

1.5 Valley Features

Valley Width (ft): **250**
Width Determination: **Estimated**
Confinement Type: **VB**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **No**

1.6 Grade Controls: **None**

Stream: **Patch Brook**   Reach: **M40T5.04-D**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**10.98**	2.11 Riffle/Step Spacing:	**70 ft.**	2.13 Average Largest Particle on		
2.2 Max Depth (ft.):	**1.30**	2.12 Substrate Composition		Bed:	**125**	**mm**
2.3 Mean Depth (tf):	**0.94**	Bedrock:	**0.0 %**	Bar:	**29**	**mm**
2.4 Floodprone Width (ft.):	**200.00**	Boulder:	**3.0 %**	2.14 Stream Type		
2.5 Aband. Floodpn (ft.):	**1.50**	Cobble:	**41.0 %**	Stream Type:	**C**	
Human Elev FloodPln (ft.):		Coarse Gravel:	**33.0 %**	Bed Material:	**Gravel**	
2.6 Width/Depth Ratio:	**11.68**	Fine Gravel:	**10.0 %**	Subclass Slope:	**a**	
2.7 Entrenchment Ratio:	**18.21**	Sand:	**6.0 %**	Bed Form:	**Riffle-Pool**	
2.8 Incision Ratio:	**1.15**	Silt and Smaller:	**7.0 %**	Field Measured Slope:		
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type		
2.9 Sinuosity:	**Moderate**	Detritus:	**2.0 %**	Reference Stream Type:	**C**	
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**45**	Reference Bed Material:	**Gravel**	
				Reference Subclass Slope:	**a**	
				Reference Bedform:	**Riffle-Pool**	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Steep**

Bank Texture	Left	Right
Upper		
Material Type:	**Mix**	**Mix**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Gravel**	**Gravel**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**0.0**	**0.0**
Erosion Height (ft.):	**0.0**	**0.0**
Revetment Type:	**None**	**None**
Revetment Length:	**0.0**	**0.0**

Near Bank Vegetation Type	Left	Right
Dominant:	**Herbaceous**	**Herbaceous**
Sub-dominant:	**Deciduous**	**Deciduous**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**None**	**None**
W less than 25	**0**	**0**
Buffer Vegitation Type		
Dominant	**Mixed Trees**	**Mixed Trees**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**None**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Patch Brook** Reach: **M40T5.04-D**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps:	**Minimal**	4.5 Flow Regulation Type	**None**	4.7 Stormwater Inputs	**None**
4.2 Adjacent Wetlands:	**Abundant**	Flow Reg. Use:		Field Ditch:	Road Ditch:
4.3 Flow Status:	**Moderate**	Impoundments:		Other:	Tile Drain:
4.4 # of Debris Jams:	**8**	Impoundment Loc.:		Overland Flow:	Urb Strm Wtr Pipe:
		4.6 Up/Down Strm flow reg.:	**None**	4.9 # of Beaver Dams:	**0**
		(old) Upstrm Flow Reg.:		Affected Length (ft):	**0**

4.8 Channel Constrictions: **None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types		Diagonal:	**0**	5.2 Other Features		Neck Cutoff:	**0**	5.4 Stream Ford or Animal Crossing:	**No**
Mid:	**4**	Delta:	**0**	Flood chutes:	**1**	Avulsion:	**0**	5.5 Straightening:	**None**
Point:	**8**	Island:	**0**	5.3 Steep Riffles and Head Cuts		Head Cuts:	**0**	Straightening Length (ft.):	**0**
Side:	**2**	Braiding:	**0**	Steep Riffles:	**0**	Trib Rejuv.:	**No**	5.5 Dredging:	**None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.:	**10**	6.4 Sediment Deposition:	**13**	Stream Gradiant Type	Left	Right
6.2 Pool Substrate:	**11**	6.5 Channel Flow Status:	**11**	6.8 Bank Stability:	**8**	**9**
6.3 Pool Variability:	**11**	6.6 Channel Alteration:	**15**	6.9 Bank Vegetation Protection	**8**	**9**
Total Score:	**140**	6.7 Channel Sinuosity:	**16**	6.10 Riparian Veg. Zone Width:	**10**	**9**
Habitat Rating:	**0.70**					
Habitat Stream Condition:	**Good**					

Step 7. Rapid Geomorphic Assessment Data

Confinement Type	**Unconfined** Score	STD	Historic		
7.1 Channel Degradation	**16**	**None**	**No**	Geomorphic Rating	**0.76**
7.2 Channel Aggradation	**13**	**None**	**No**	Channel Evolution Model	**F**
7.3 Widening Channel	**18**	**None**	**No**	Channel Evolution Stage	**I**
7.4 Change in Planforml	**14**	**None**	**No**	Geomorphic Condition	**Good**
Total Score	**61**			Stream Sensitivity	**High**

Phase 2 Segment Summary Report Black River

Stream:	**Patch Brook**	SGAT Version:	**4.56**
Reach:	**M40T5.04-E**	Organization:	**South Windsor County Regional Planning Commission**
Segment Length(ft):	**4,578**	Observers:	**KLU, BOS - SMRC**
Rain:	**Yes**	Completion Date:	**9/3/2009**
		Qualtiy Control Status - Consultant:	**Provisional**
		Qualtiy Control Status - Staff:	**Provisional**

Step 0 - Location: **From upstream reach break to downstream of the Unknown Soldier Rd (class 4) bridge crossing.**

Step 5 - Notes: **Colluvial processes leading to disorganized bed structure (cascade), with some sections of step/pool (subdominant bedform). Valley confinement varies from Semi-confined to Narrowly-confined, but dominated by Semi-confined. Cross section happened to be located in Narrowly-confined spot. Timber bridge on stone abutments at Unknown Soldier Rd crossing is bankfull constrictor. Overland flow from road joins channel at this crossing. Two fords in the reach: one log crossing for footpath, and one upstream trail crossing.**

Step 7 - Narrative: **Minor localized widening; minor planform adjustment.**

Step 1. Valley and Floodplain

1.1 Segmentation: **Channel Dimensions**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	0		55	

1.4 Adjacent Side	Left	Right
Hillside Slope:	**Very Steep**	**Very Steep**
Continuous w/ Bank:	**Sometimes**	**Sometimes**
Within 1 Bankfull W:	**Sometimes**	**Sometimes**
Texture:	**Mixed**	**Mixed**

1.5 Valley Features	
Valley Width (ft):	**20**
Width Determination:	**Estimated**
Confinement Type:	**SC**
In Rock Gorge:	**No**
Human Caused Change in Valley Width?:	**No**

1.6 Grade Controls: **None**

Stream: **Patch Brook** Reach: **M40T5.04-E**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**9.10**	2.11 Riffle/Step Spacing:		2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**1.80**	2.12 Substrate Composition		Bed:	**N/A**
2.3 Mean Depth (tf):	**0.81**	Bedrock:	**0.0 %**	Bar:	**N/A**
2.4 Floodprone Width (ft.):	**17.00**	Boulder:	**17.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**1.80**	Cobble:	**27.0 %**	Stream Type:	**B**
Human Elev FloodPln (ft.):		Coarse Gravel:	**25.0 %**	Bed Material:	**Gravel**
2.6 Width/Depth Ratio:	**11.23**	Fine Gravel:	**16.0 %**	Subclass Slope:	**a**
2.7 Entrenchment Ratio:	**1.87**	Sand:	**1.0 %**	Bed Form:	**Cascade**
2.8 Incision Ratio:	**1.00**	Silt and Smaller:	**14.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**5.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Not Applicable**	# Large Woody Debris:	**67**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Moderate**

Bank Texture	Left	Right
Upper		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**0.0**	**0.0**
Erosion Height (ft.):	**0.0**	**0.0**
Revetment Type:	**Other**	**Other**
Revetment Length:	**37.9**	**41.2**

Near Bank Vegetation Type	Left	Right
Dominant:	**Deciduous**	**Deciduous**
Sub-dominant:	**Coniferous**	**Coniferous**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**None**	**None**
W less than 25	**66**	**66**
Buffer Vegitation Type		
Dominant	**Mixed Trees**	**Mixed Trees**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**None**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Patch Brook** Reach: **M40T5.04-E**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Abundant**
4.2 Adjacent Wetlands: **Minimal**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **7**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **None**
(old) Upstrm Flow Reg.:

4.7 Stormwater Inputs
Field Ditch: **0** Road Ditch: **0**
Other: **0** Tile Drain: **0**
Overland Flow: **2** Urb Strm Wtr Pipe: **0**
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	**5**	**Yes**	**Yes**	**Yes**	**Yes**	**None**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **2** Point: **0** Side: **0**
Diagonal: **0** Delta: **0** Island: **3** Braiding: **0**

5.2 Other Features
Flood chutes: **5**
Neck Cutoff: **0** Avulsion: **0** Head Cuts: **0** Trib Rejuv.: **No**
5.3 Steep Riffles and Head Cuts
Steep Riffles: **0**

5.4 Stream Ford or Animal Crossing: **Yes**
5.5 Straightening: **None**
Straightening Length (ft.): **0**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.: **10**
6.2 Pool Substrate: **11**
6.3 Pool Variability: **11**
Total Score: **140**
Habitat Rating: **0.70**
Habitat Stream Condition: **Good**

6.4 Sediment Deposition: **13**
6.5 Channel Flow Status: **11**
6.6 Channel Alteration: **15**
6.7 Channel Sinuosity: **16**

Stream Gradiant Type	Left	Right
6.8 Bank Stability:	**8**	**9**
6.9 Bank Vegetation Protection	**8**	**9**
6.10 Riparian Veg. Zone Width:	**10**	**9**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**	Score	STD	Historic
7.1 Channel Degradation	**18**	**None**	**No**
7.2 Channel Aggradation	**16**	**None**	**No**
7.3 Widening Channel	**15**	**None**	**No**
7.4 Change in Planforml	**16**	**None**	**No**
Total Score	**65**		

Geomorphic Rating **0.81**
Channel Evolution Model **F**
Channel Evolution Stage **I**
Geomorphic Condition **Good**
Stream Sensitivity **Moderate**

Phase 2 Segment Summary Report   Black River

Stream: **Unnamed trib to Patch Brook**
Reach: **M40T5.03S1.01-0**

Segment Length(ft): **1,221**
Rain: **No**

SGAT Version: **4.56**
Organization: **South Windsor County Regional Planning Commission**
Observers: **KLU, BOS - SMRC**
Completion Date: **9/11/2009**
Qualtiy Control Status - Consultant: **Provisional**
Qualtiy Control Status - Staff: **Provisional**

Step 0 - Location: **Outlet from Lake Ninevah, crossing under Loop Road (pvt) at Mount Holly / Plymouth town line.**

Step 5 - Notes: **Semi- to Narrowly-confined by moderately sloping valley walls comprised of glacial till. Joins the Patch Brook in a wetlands upstream of the Townsend Barn Road. The downstream end (~125 feet) of the Lake Ninevah outlet channel is also characterized by wetland conditions and backwater effects from this wetland. Bedform is transitional from S/P to R/P with distance downstream and decreasing gradient on approach to wetlands. Loop Road, a private gravel road, crosses the channel near its mid-point via a timber frame bridge on laid-up-stone foundation. The span of this bridge is bankfull constricting. Upstream flow regulation is Lake Ninevah run-of-river dam. Current use: recreational; historic use: hydroelectric. Records reviewed at VTDEC indicate that historically, lake levels were lowered in the Fall of each year resulting in increased flows to outlet channel (and downstream Patch Brook).**

Step 7 - Narrative: **Negligible.**

Step 1. Valley and Floodplain

1.1 Segmentation: **None**

1.2 Alluvial Fan: **None**

1.3 Corridor Encroachments:

Length (ft)	One	Height	Both	Height
Berm:	0		0	
Road:	0		0	
Railroad:	0		0	
Imp. Path:	0		0	
Dev.:	58		26	

1.4 Adjacent Side

	Left	Right
Hillside Slope:	Very Steep	Extr.Steep
Continuous w/ Bank:	Sometimes	Sometimes
Within 1 Bankfull W:	Sometimes	Sometimes
Texture:	N.E.	N.E.

1.5 Valley Features

Valley Width (ft): **30**
Width Determination: **Estimated**
Confinement Type: **NC**
In Rock Gorge: **No**
Human Caused Change in Valley Width?: **No**

1.6 Grade Controls: **None**

Stream: **Unnamed trib to Patch Brook** Reach: **M40T5.03S1.01-0**

Step 2. Stream Channel

2.1Bankfull Width (ft.):	**17.00**	2.11 Riffle/Step Spacing:	**120 ft.**	2.13 Average Largest Particle on	
2.2 Max Depth (ft.):	**1.30**	2.12 Substrate Composition		Bed:	**350 mm**
2.3 Mean Depth (tf):	**0.84**	Bedrock:	**0.0 %**	Bar:	**N/A mm**
2.4 Floodprone Width (ft.):	**26.00**	Boulder:	**15.0 %**	2.14 Stream Type	
2.5 Aband. Floodpn (ft.):	**1.30**	Cobble:	**40.0 %**	Stream Type:	**B**
Human Elev FloodPln (ft.):		Coarse Gravel:	**4.0 %**	Bed Material:	**Cobble**
2.6 Width/Depth Ratio:	**20.24**	Fine Gravel:	**7.0 %**	Subclass Slope:	**None**
2.7 Entrenchment Ratio:	**1.53**	Sand:	**21.0 %**	Bed Form:	**Step-Pool**
2.8 Incision Ratio:	**1.00**	Silt and Smaller:	**13.0 %**	Field Measured Slope:	
Human Elevated Inc. Rat.:	**0.00**	Silt/Clay Present:	**No**	2.15 Sub-reach Stream Type	
2.9 Sinuosity:	**Low**	Detritus:	**5.0 %**	Reference Stream Type:	
2.10 Riffles Type:	**Complete**	# Large Woody Debris:	**2**	Reference Bed Material:	
				Reference Subclass Slope:	
				Reference Bedform:	

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: **Moderate**

Bank Texture	Left	Right
Upper		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type:	**Boulder/Cobble**	**Boulder/Cobble**
Consistency:	**Non-cohesive**	**Non-cohesive**

Bank Erosion	Left	Right
Erosion Length (ft.):	**0.0**	**0.0**
Erosion Height (ft.):	**0.0**	**0.0**
Revetment Type:	**None**	**Rip-Rap**
Revetment Length:	**0.0**	**131.6**

Near Bank Vegetation Type	Left	Right
Dominant:	**Shrubs/Sapling**	**Shrubs/Sapling**
Sub-dominant:	**Herbaceous**	**Herbaceous**
Bank Canopy		
Canopy %:	**76-100**	**76-100**
Mid-Channel Canopy:	**Closed**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**>100**	**>100**
Sub-Dominant	**None**	**51-100**
W less than 25	**0**	**0**
Buffer Vegitation Type		
Dominant	**Mixed Trees**	**Mixed Trees**
Sub-Dominant	**Shrubs/Sapling**	**Shrubs/Sapling**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Forest**	**Forest**
Sub-dominant	**None**	**Residential**
(Legacy)	Amount	Mean Hieght
Failures	**None**	
Gullies	**None**	

	Left	Right
Mass Failures		
Height		
Gullies Number	**0**	
Gullies Length	**0**	

Stream: **Unnamed trib to Patch Brook** Reach: **M40T5.03S1.01-0**

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps: **Minimal**
4.2 Adjacent Wetlands: **Abundant**
4.3 Flow Status: **Moderate**
4.4 # of Debris Jams: **2**

4.5 Flow Regulation Type **None**
Flow Reg. Use:
Impoundments:
Impoundment Loc.:
4.6 Up/Down Strm flow reg.: **Up Stream**
(old) Upstrm Flow Reg.: **Run-of-river Dam**

4.7 Stormwater Inputs **None**
Field Ditch: Road Ditch:
Other: Tile Drain:
Overland Flow: Urb Strm Wtr Pipe:
4.9 # of Beaver Dams: **0**
Affected Length (ft): **0**

4.8 Channel Constrictions:

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Problems
Bridge	**7**	**Yes**	**Yes**	**Yes**	**Yes**	**Alignment**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types
Mid: **0** Point: **0** Side: **0**
Diagonal: **0** Delta: **0** Island: **0** Braiding: **0**

5.2 Other Features
Flood chutes: **1**
Neck Cutoff: **0** Avulsion: **0**
5.3 Steep Riffles and Head Cuts
Steep Riffles: **0** Head Cuts: **0** Trib Rejuv.: **No**

5.4 Stream Ford or Animal Crossing: **No**
5.5 Straightening: **None**
Straightening Length (ft.): **0**
5.5 Dredging: **None**

Step 6. Rapid Habitat Assessment Data

6.1 Epifaunal Substrate - Avl.: **15**
6.2 Pool Substrate: **13**
6.3 Pool Variability: **11**
Total Score: **148**
Habitat Rating: **0.74**
Habitat Stream Condition: **Good**

6.4 Sediment Deposition: **15**
6.5 Channel Flow Status: **10**
6.6 Channel Alteration: **16**
6.7 Channel Sinuosity: **15**

Stream Gradiant Type	Left	Right
6.8 Bank Stability:	**8**	**8**
6.9 Bank Vegetation Protection	**9**	**9**
6.10 Riparian Veg. Zone Width:	**10**	**9**

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**	Score	STD	Historic
7.1 Channel Degradation	**18**	**None**	**No**
7.2 Channel Aggradation	**16**	**None**	**No**
7.3 Widening Channel	**18**	**None**	**No**
7.4 Change in Planforml	**16**	**None**	**No**
Total Score	**68**		

Geomorphic Rating **0.85**
Channel Evolution Model **F**
Channel Evolution Stage **I**
Geomorphic Condition **Reference**
Stream Sensitivity **Moderate**

APPENDIX B

Bridge and Culvert Assessment Summary Reports

VERMONT

Stream Geomorphic Assessment

VT DEC

Agency of Natural Resouces

Vermont.gov

November, 07

Bridge Summary Report

Black River

General Information

SgaID	**990048000014121**	Local SgaID		VOBCIT struct_num	
Observers	**K.Underwood, B.O'Shea**	Assessment Date	**00/03/2009**	Project Name	**Black River**
Town	**Plymouth**	Latitude	**43.49342**	Longitude	**-72.75667**
Location	**1.1 mile north of Jct w/ Patch Brook Rd**			Reach VTID	**M40T5.04**
Road Name	**UNKNOWN SOLDIER RD**	Road Type	**Gravel**	Stream Name	**Patch Brook**
High Flow Stage	**No**	Channel Width	**9.1**		

Bridge Information

Bridge Width	**9.1**	Material	**Timber**
Bridge Clearance	**2.5**	Number of bridge piers/arches	
Bridge/Arch Span	**5**		
		Skewed to roadway?	**No**

Geomorphic Information

General

Floodplain filled by roadway approaches	**Not Significant**	Structure is located at significant break in valley slope	**Yes**

Upstream

Obstructions at the opening of the structure	**None**	Estimated distance avulsion would follow road	
Steep riffle present immediately upstream of structure	**No**	Angle of stream flow approaching structure	**Mild Bend**
If channel avulses, stream will	**Cross Road**		

Downstream

Pool present immediately downstream of structure	**No**
Downstream bank heights are substantially higher than upstream bank heights	**No**
Pool Depth at point of streamflow entry	**No**

	Upstream	Downstream	In Structure
Dominant Bed Material	**Cobble**	**Cobble**	**Boulder**
Bedrock Present	**No**	**No**	**No**
Type of Sediment Deposits	**None**	**None**	**None**
Elevation of sediment deposits >= 1/2 bankfull	**No**	**No**	**No**
Bank Erosion	**None**	**None**	
Hard Bank Armoring	**Intact**	**Intact**	
Stream bed scour causing undermining around or under structure	**None**	**None**	
Beaver Dam near Structure	**No**	**No**	
Beaver Dam distance (ft.)			

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	**Deciduous Forest**	**Deciduous Forest**	
Dominant Vegetation Type - Right	**Deciduous Forest**	**Deciduous Forest**	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

	Upstream	Downstream
Vegitation Band - Left	**No**	**No**
Vegitation Band -Right	**No**	**No**

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	**None**	**Deer - Scat**	**None**

Other Information

Spatial location data collected with GPS?	**Yes**	Photos taken?	**Yes**

Comments **TRANS_RDS layer shows incorrect path of road and location of crossing as compared to 1994 ortho and GPS waypoints from assessment date. Structure span measured at approx bankfull elevation between stone abutments. Span measured at bridge elevation = 11.7 ft.**

Bridge Summary Report

Black River

General Information

SgaID	990000000114123	Local SgaID		VOBCIT struct_num	
Observers	K.Underwood, B.O'Shea	Assessment Date	00/03/2009	Project Name	Black River
Town	Plymouth	Latitude	43.48644	Longitude	-72.75201
Location	On Catamount Trail, 550 East of Unknown Soldier Rd; 3500 ft upstream of Patch Brook Rd crossing.			Reach VTID	M40T5.04
Road Name		Road Type	Trail	Stream Name	Patch Brook
High Flow Stage	No	Channel Width	12.5		

Bridge Information

Bridge Width	5	Material	Timber
Bridge Clearance	2.2	Number of bridge piers/arches	
Bridge/Arch Span	5		
		Skewed to roadway?	No

Geomorphic Information

General

Floodplain filled by roadway approaches	Not Significant	Structure is located at significant break in valley slope	Yes

Upstream

Obstructions at the opening of the structure	Wood debris	Estimated distance avulsion would follow road	
Steep riffle present immediately upstream of structure	No	Angle of stream flow approaching structure	Sharp Bend
If channel avulses, stream will	Cross Road		

Downstream

Pool present immediately downstream of structure	Yes
Downstream bank heights are substantially higher than upstream bank heights	No
Pool Depth at point of streamflow entry	No

	Upstream	Downstream	In Structure
Dominant Bed Material	Cobble	Boulder	Boulder
Bedrock Present	No	No	No
Type of Sediment Deposits	Side	None	None
Elevation of sediment deposits >= 1/2 bankfull	No	No	No
Bank Erosion	None	None	
Hard Bank Armoring	Intact	Intact	
Stream bed scour causing undermining around or under structure	None	None	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)			

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Mixed Forest	Mixed Forest	
Dominant Vegetation Type - Right	Mixed Forest	Mixed Forest	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

	Upstream	Downstream
Vegitation Band - Left	Yes	Yes
Vegitation Band -Right	Yes	Yes

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	None	None	None

Other Information

Spatial location data collected with GPS?	Yes	Photos taken?	Yes

Comments **Wooden planks (partially collapsed) over boulder abutments. Apparent ford on upstream side of crossing. Stormwater runoff from trail to right-bank upstream, conveying sands / silts into stream. Wood debris obstructions = collapsing bridge timbers. Armoring = stone abutments.**

Stream Geomorphic Assessment

VERMONT

VT DEC

Agency of Natural Resouces

Vermont.gov

November. 07

Culvert Summary Report

Black River

General Information

SgaID	**600015000014121**	Local SgaID		VOBCIT struct_num	
Observers	**K.Underwood, B.O'Shea**	Assessment Date	**00/11/2009**	Project Name	**Black River**
Town	**Plymouth**	Latitude	**43.47725**	Longitude	**-72.75146**
Location	**910 ft northwest of Jct w/ Townsend Barn Rd**			Reach VTID	**M40T5.04**
Road Name	**PATCH BROOK RD**	Road Type	**Gravel**	Stream Name	**Patch Brook**
High Flow Stage	**No**	Channel Width			**14.7**

Culvert Information

Culvert Length	**24**	Material	**Steel Corrugated**
Culvert Height	**3.5**	Number of culverts	**1**
Culvert Width	**3.5**	Culvert Overflow Pipe	**No**
		Skewed to roadway?	**No**

Geomorphic Information

General

Floodplain filled by roadway approaches	**Partially**	Structure is located at significant break in valley slope	**No**
		Culvert slope as compared with channel slope is significantly	**Same**

Upstream

Obstructions at the opening of the structure	**None**	Estimated distance avulsion would follow road	
Steep riffle present immediately upstream of structure	**No**	Angle of stream flow approaching structure	**Mild Bend**
If channel avulses, stream will	**Cross Road**		

Downstream

Pool present immediately downstream of structure	**Yes**	Water depth in culvert (at outlet)	**1.3**
Downstream bank heights are substantially higher than upstream bank heights	**No**	Culvert outlet invert	**Entirely Backwatered**
Stepped Footers	**1.3 ft.**	Backwater Length (measured from outlet)	**24**
Maximum pool depth	**2 ft.**	Backwater Length (measured from outlet)	**0**

	Upstream	Downstream	In Structure
Dominant Bed Material	**Gravel**	**Gravel**	**Gravel**
Bedrock Present	**No**	**No**	
Type of Sediment Deposits	**None**	**Point**	**None**
Material Present throughout			**No**
Elevation of sediment deposits >= 1/2 bankfull	**No**	**No**	**No**
Bank Erosion	**Low**	**None**	
Hard Bank Armoring	**None**	**None**	
Stream bed scour causing undermining around or under structure	**None**	**None**	
Beaver Dam near Structure	**No**	**No**	
Beaver Dam distance (ft.)			

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	**Mixed Forest**	**Shrub/Sapling**	
Dominant Vegetation Type - Right	**Mixed Forest**	**Shrub/Sapling**	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

	Upstream	Downstream
Vegitation Band - Left	**Yes**	**Yes**
Vegitation Band -Right	**Yes**	**Yes**

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	**None**	**None**	**None**

Other Information

Spatial location data collected with GPS? **Yes** Photos taken? **Yes**

Comments **Wetland downstream of culvert.**

Stream Geomorphic Assessment

VERMONT

VT DEC

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November, 07

Bridge Summary Report

Black River

General Information

SgaID	**700000000214123**	Local SgaID		VOBCIT struct_num	
Observers	**K.Underwood, B.O'Shea**	Assessment Date	**00/11/2009**	Project Name	**Black River**
Town	**Plymouth**	Latitude	**43.4736**	Longitude	**-72.74955**
Location	**185 ft southwest of Jct w/ Townsend Barn Rd**			Reach VTID	**M40T5.03S1.01**
Road Name	**LOOP RD (PVT)**	Road Type	**Gravel**	Stream Name	**Unnamed trib to Patch Bk (Lake Ninevah outlet)**
High Flow Stage	**No**			Channel Width	**17**

Bridge Information

Bridge Width	**12.5**	Material	**Timber**
Bridge Clearance	**3.3**	Number of bridge piers/arches	
Bridge/Arch Span	**7**		
		Skewed to roadway?	**No**

Geomorphic Information

General

Floodplain filled by roadway approaches	**Entirely**	Structure is located at significant break in valley slope	**No**

Upstream

Obstructions at the opening of the structure	**None**	Estimated distance avulsion would follow road	
Steep riffle present immediately upstream of structure	**No**	Angle of stream flow approaching structure	**Naturally Straight**
If channel avulses, stream will	**Cross Road**		

Downstream

Pool present immediately downstream of structure	**No**
Downstream bank heights are substantially higher than upstream bank heights	**No**
Pool Depth at point of streamflow entry	**No**

	Upstream	Downstream	In Structure
Dominant Bed Material	**Cobble**	**Cobble**	**Cobble**
Bedrock Present	**No**	**No**	**No**
Type of Sediment Deposits	**None**	**None**	**None**
Elevation of sediment deposits >= 1/2 bankfull	**No**	**No**	**No**
Bank Erosion	**None**	**None**	
Hard Bank Armoring	**Intact**	**Intact**	
Stream bed scour causing undermining around or under structure	**None**	**None**	
Beaver Dam near Structure	**No**	**No**	
Beaver Dam distance (ft.)			

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	**Mixed Forest**	**Mixed Forest**	
Dominant Vegetation Type - Right	**Mixed Forest**	**Mixed Forest**	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

	Upstream	Downstream
Vegitation Band - Left	**Yes**	**Yes**
Vegitation Band -Right	**Yes**	**Yes**

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	**None**	**Deer - Tracks**	**None**

Other Information

Spatial location data collected with GPS?	**Yes**	Photos taken?	**Yes**

Comments **Structure is on the town line with Mount Holly. Timber deck on stone abutments.**

VERMONT

Stream Geomorphic Assessment

VT DEC

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November. 07

Bridge Summary Report

Black River

General Information

SgaID	**400026000014121**	Local SgaID		VOBCIT struct_num	
Observers	**K.Underwood, B.O'Shea**	Assessment Date	**00/29/2009**	Project Name	**Black River**
Town	**Plymouth**	Latitude	**43.47587**	Longitude	**-72.74855**
Location	**100 ft south of Jct w/ Patch Brook Rd**			Reach VTID	**M40T5.03**
Road Name	**TOWNSEND BARN RD**	Road Type	**Gravel**	Stream Name	**Patch Brook**
High Flow Stage	**No**			Channel Width	**19.4**

Bridge Information

Bridge Width	**17.5**	Material	**Concrete**
Bridge Clearance	**10**	Number of bridge piers/arches	
Bridge/Arch Span	**12**		
		Skewed to roadway?	**No**

Geomorphic Information

General

Floodplain filled by roadway approaches	**Entirely**	Structure is located at significant break in valley slope	**Yes**

Upstream

Obstructions at the opening of the structure	**None**	Estimated distance avulsion would follow road	
Steep riffle present immediately upstream of structure	**No**	Angle of stream flow approaching structure	**Mild Bend**
If channel avulses, stream will	**Unsure**		

Downstream

Pool present immediately downstream of structure	**No**
Downstream bank heights are substantially higher than upstream bank heights	**No**
Pool Depth at point of streamflow entry	**Yes**

	Upstream	Downstream	In Structure
Dominant Bed Material	**Cobble**	**Cobble**	**Cobble**
Bedrock Present	**No**	**No**	**No**
Type of Sediment Deposits	**None**	**None**	**None**
Elevation of sediment deposits >= 1/2 bankfull	**No**	**No**	**No**
Bank Erosion	**None**	**None**	
Hard Bank Armoring	**Intact**	**Intact**	
Stream bed scour causing undermining around or under structure	**Footers**	**Footers**	
Beaver Dam near Structure	**No**	**No**	
Beaver Dam distance (ft.)			

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	**Deciduous Forest**	**Deciduous Forest**	
Dominant Vegetation Type - Right	**Deciduous Forest**	**Deciduous Forest**	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

Vegitation Band - Left	**Yes**	**No**	
Vegitation Band -Right	**Yes**	**Yes**	

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	**None**	**None**	**None**

Other Information

Spatial location data collected with GPS?	**Yes**	Photos taken?	**Yes**

Comments **From bc_localinventorytable_points.shp, structure number = 990026001614121**

Bridge Summary Report

Black River

General Information

SgaID	**400015000114121**	Local SgaID		VOBCIT struct_num	
Observers	**K.Underwood, B.O'Shea**	Assessment Date	**00/10/2009**	Project Name	**Black River**
Town	**Plymouth**	Latitude	**43.47548**	Longitude	**-72.71668**
Location	**1000 ft East of Jct w/ Davis Road**			Reach VTID	**M40T5.03**
Road Name	**DUBLIN RD**	Road Type	**Paved**	Stream Name	**Patch Brook**
High Flow Stage	**No**	Channel Width	**27.1**		

Bridge Information

Bridge Width	**18.9**	Material	**Concrete**
Bridge Clearance	**7.5**	Number of bridge piers/arches	
Bridge/Arch Span	**14.4**		
		Skewed to roadway?	**Yes**

Geomorphic Information

General

Floodplain filled by roadway approaches	**Partially**	Structure is located at significant break in valley slope	**Yes**

Upstream

Obstructions at the opening of the structure	**Sediment**	Estimated distance avulsion would follow road	**1000**
Steep riffle present immediately upstream of structure	**Yes**	Angle of stream flow approaching structure	**Sharp Bend**
If channel avulses, stream will	**Follow Road**		

Downstream

Pool present immediately downstream of structure	**No**
Downstream bank heights are substantially higher than upstream bank heights	**No**
Pool Depth at point of streamflow entry	**Yes**

	Upstream	Downstream	In Structure
Dominant Bed Material	**Cobble**	**Cobble**	**Cobble**
Bedrock Present	**No**	**No**	**Yes**
Type of Sediment Deposits	**None**	**None**	**None**
Elevation of sediment deposits >= 1/2 bankfull	**No**	**No**	**No**
Bank Erosion	**None**	**None**	
Hard Bank Armoring	**Intact**	**Intact**	
Stream bed scour causing undermining around or under structure	**Footers**	**None**	
Beaver Dam near Structure	**No**	**No**	
Beaver Dam distance (ft.)			

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	**Shrub/Sapling**	**Deciduous Forest**	
Dominant Vegetation Type - Right	**Shrub/Sapling**	**Road Embankment**	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

	Upstream	Downstream
Vegitation Band - Left	**No**	**Yes**
Vegitation Band -Right	**No**	**No**

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	**None**	**None**	**None**

Other Information

Spatial location data collected with GPS?	**Yes**	Photos taken?	**Yes**

Comments **Apparent boulder grade control immediately upstream of structure. Left-bank high berm and channel relocation downstream. Stepped footers both banks. Structure number in bc_localinvertorytable_points.shp = 990015001414121**

VERMONT

Stream Geomorphic Assessment

VT DEC

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November. 07

Bridge Summary Report

Black River

General Information

SgaID	**400036000014121**	Local SgaID		VOBCIT struct_num	
Observers	**K.Underwood, B.O'Shea**	Assessment Date	**00/10/2009**	Project Name	**Black River**
Town	**Plymouth**	Latitude	**43.47449**	Longitude	**-72.71455**
Location	**40 ft Northeast of Jct w/ Dublin Road**			Reach VTID	**M40T5.02**
Road Name	**DUBLIN RD**	Road Type	**Gravel**	Stream Name	**Patch Brook**
High Flow Stage	**No**	Channel Width			**28**

Bridge Information

Bridge Width	**16**	Material	**Concrete**
Bridge Clearance	**6.1**	Number of bridge piers/arches	
Bridge/Arch Span	**12.8**		
		Skewed to roadway?	**No**

Geomorphic Information

General

Floodplain filled by roadway approaches	**Entirely**	Structure is located at significant break in valley slope	**No**

Upstream

Obstructions at the opening of the structure	**Sediment**	Estimated distance avulsion would follow road	
Steep riffle present immediately upstream of structure	**Yes**	Angle of stream flow approaching structure	**Mild Bend**
If channel avulses, stream will	**Cross Road**		

Downstream

Pool present immediately downstream of structure	**Yes**
Downstream bank heights are substantially higher than upstream bank heights	**Yes**
Pool Depth at point of streamflow entry	**Yes**

	Upstream	Downstream	In Structure
Dominant Bed Material	**Cobble**	**Cobble**	**Cobble**
Bedrock Present	**No**	**No**	**No**
Type of Sediment Deposits	**None**	**None**	**None**
Elevation of sediment deposits >= 1/2 bankfull	**No**	**No**	**No**
Bank Erosion	**None**	**None**	
Hard Bank Armoring	**Intact**	**Intact**	
Stream bed scour causing undermining around or under structure	**Wing walls**	**None**	
Beaver Dam near Structure	**No**	**No**	
Beaver Dam distance (ft.)			

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	**Deciduous Forest**	**Herbaceous/Grass**	
Dominant Vegetation Type - Right	**Shrub/Sapling**	**Herbaceous/Grass**	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

Vegitation Band - Left	**No**	**No**	
Vegitation Band -Right	**No**	**No**	

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	**None**	**None**	**None**

Other Information

Spatial location data collected with GPS?	**Yes**	Photos taken?	**Yes**

Comments **Recorded span is between stepped footers within the bankfull elevation. Above the stepped footers, the span between abutments is 19 feet. Max pool depth = 1.2 feet.**

Bridge Summary Report

Black River

General Information

SgaID	400015000014121	Local SgaID		VOBCIT struct_num	
Observers	KLU, BOS- SMRC	Assessment Date	00/10/2009	Project Name	Black River
Town	Plymouth	Latitude	43.46571	Longitude	-72.70573
Location	570 ft west of Jct w/ VT Route 100			Reach VTID	M40T5.01
Road Name	DUBLIN RD	Road Type	Paved	Stream Name	Patch Brook
High Flow Stage	No		Channel Width		33.3

Bridge Information

Bridge Width	29	Material	Concrete
Bridge Clearance	7	Number of bridge piers/arches	
Bridge/Arch Span	19		
		Skewed to roadway?	Yes

Geomorphic Information

General

Floodplain filled by roadway approaches	Entirely	Structure is located at significant break in valley slope	Yes

Upstream

Obstructions at the opening of the structure	Wood debris	Estimated distance avulsion would follow road	2000
Steep riffle present immediately upstream of structure	Yes	Angle of stream flow approaching structure	Sharp Bend
If channel avulses, stream will	Follow Road		

Downstream

Pool present immediately downstream of structure	No
Downstream bank heights are substantially higher than upstream bank heights	No
Pool Depth at point of streamflow entry	Yes

	Upstream	Downstream	In Structure
Dominant Bed Material	Cobble	Cobble	Cobble
Bedrock Present	No	No	No
Type of Sediment Deposits	None	None	Side
Elevation of sediment deposits >= 1/2 bankfull	No	No	No
Bank Erosion	None	None	
Hard Bank Armoring	Failing	Intact	
Stream bed scour causing undermining around or under structure	None	Footers	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)			

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Deciduous Forest	Shrub/Sapling	
Dominant Vegetation Type - Right	Road Embankment	Shrub/Sapling	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

Vegitation Band - Left	No	No
Vegitation Band -Right	No	No

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	None	None	None

Other Information

Spatial location data collected with GPS?	Yes	Photos taken?	Yes

Comments **Stormwater pipe (4-inch corrugated plastic) drains to channel near bridge outlet (RB, d/s). Bridge is located in Segment B of the indicated reach. Stepped footer (and scour) is along LB. Nearby landowner indicates bridge was washed out in 1973 flood.**

Bridge Summary Report

Black River

General Information

SgaID	400035000014121	Local SgaID		VOBCIT struct_num	
Observers	K.Underwood, B.O'Shea	Assessment Date	00/10/2009	Project Name	Black River
Town	Plymouth	Latitude	43.46483	Longitude	-72.70498
Location	230 ft South of Jct w/ Dublin Rd			Reach VTID	M40T5.01
Road Name	LIBRARY RD	Road Type	Gravel	Stream Name	Patch Brook
High Flow Stage	No		Channel Width		33.3

Bridge Information

Bridge Width	16	Material	Timber
Bridge Clearance	8.6	Number of bridge piers/arches	
Bridge/Arch Span	16		
		Skewed to roadway?	No

Geomorphic Information

General

Floodplain filled by roadway approaches	Entirely	Structure is located at significant break in valley slope	Yes

Upstream

Obstructions at the opening of the structure	None	Estimated distance avulsion would follow road	
Steep riffle present immediately upstream of structure	Yes	Angle of stream flow approaching structure	Channelized Straight
If channel avulses, stream will	Unsure		

Downstream

Pool present immediately downstream of structure	No
Downstream bank heights are substantially higher than upstream bank heights	No
Pool Depth at point of streamflow entry	No

	Upstream	Downstream	In Structure
Dominant Bed Material	Cobble	Cobble	Cobble
Bedrock Present	No	No	No
Type of Sediment Deposits	None	None	None
Elevation of sediment deposits >= 1/2 bankfull	No	No	No
Bank Erosion	None	None	
Hard Bank Armoring	Intact	Intact	
Stream bed scour causing undermining around or under structure	None	None	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)			

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Deciduous Forest	Deciduous Forest	
Dominant Vegetation Type - Right	Mixed Forest	Deciduous Forest	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

	Upstream	Downstream
Vegitation Band - Left	No	No
Vegitation Band -Right	No	No

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	None	None	None

Other Information

Spatial location data collected with GPS?	Yes	Photos taken?	Yes

Comments **Timber deck supported by steel I-beams, on laid-up stone abutments.**

Bridge Summary Report

Black River

General Information

SgaID	200100000214122	Local SgaID		VOBCIT struct_num	
Observers	K.Underwood, B.O'Shea	Assessment Date	00/10/2009	Project Name	Black River
Town	Plymouth	Latitude	43.46428	Longitude	-72.70444
Location	285 ft Southwest of Jct w/ Dublin Rd at Echo Lake Inn			Reach VTID	M40T5.01
Road Name	ROUTE 100	Road Type	Paved	Stream Name	Patch Brook
High Flow Stage	No	Channel Width			25.2

Bridge Information

Bridge Width	34	Material	Concrete
Bridge Clearance	6.8	Number of bridge piers/arches	
Bridge/Arch Span	39		
		Skewed to roadway?	No

Geomorphic Information

General

Floodplain filled by roadway approaches	Entirely	Structure is located at significant break in valley slope	Yes

Upstream

Obstructions at the opening of the structure	None	Estimated distance avulsion would follow road	
Steep riffle present immediately upstream of structure	No	Angle of stream flow approaching structure	Channelized Straight
If channel avulses, stream will	Unsure		

Downstream

Pool present immediately downstream of structure	No
Downstream bank heights are substantially higher than upstream bank heights	No
Pool Depth at point of streamflow entry	No

	Upstream	Downstream	In Structure
Dominant Bed Material	Cobble	Cobble	Cobble
Bedrock Present	No	No	No
Type of Sediment Deposits	None	None	None
Elevation of sediment deposits >= 1/2 bankfull	No	No	No
Bank Erosion	None	None	
Hard Bank Armoring	Intact	Intact	
Stream bed scour causing undermining around or under structure	None	None	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)			

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Deciduous Forest	Deciduous Forest	
Dominant Vegetation Type - Right	Deciduous Forest	Deciduous Forest	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

	Upstream	Downstream
Vegitation Band - Left	No	Yes
Vegitation Band -Right	No	No

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	None	None	None

Other Information

Spatial location data collected with GPS?	Yes	Photos taken?	Yes

Comments

Bridge Summary Report

Black River

General Information

SgaID	100002000014121	Local SgaID		VOBCIT struct_num	
Observers	K.Underwood, B.O'Shea	Assessment Date	00/07/2009	Project Name	Black River
Town	Plymouth	Latitude	43.46511	Longitude	-72.70334
Location	110 ft East of Jct w/ Route 100			Reach VTID	M40
Road Name	KINGDOM RD	Road Type	Paved	Stream Name	Black River
High Flow Stage	No		Channel Width		61.9

Bridge Information

Bridge Width	25	Material	Concrete
Bridge Clearance	7	Number of bridge piers/arches	
Bridge/Arch Span	52		
		Skewed to roadway?	No

Geomorphic Information

General

Floodplain filled by roadway approaches	Entirely	Structure is located at significant break in valley slope	No

Upstream

Obstructions at the opening of the structure	None	Estimated distance avulsion would follow road	
Steep riffle present immediately upstream of structure	No	Angle of stream flow approaching structure	Channelized Straight
If channel avulses, stream will	Unsure		

Downstream

Pool present immediately downstream of structure	Yes
Downstream bank heights are substantially higher than upstream bank heights	No
Pool Depth at point of streamflow entry	No

	Upstream	Downstream	In Structure
Dominant Bed Material	Cobble	Cobble	Cobble
Bedrock Present	No	No	No
Type of Sediment Deposits	None	Point	None
Elevation of sediment deposits >= 1/2 bankfull	No	No	No
Bank Erosion	None	None	
Hard Bank Armoring	Intact	Intact	
Stream bed scour causing undermining around or under structure	None	None	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)			

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Shrub/Sapling	Shrub/Sapling	
Dominant Vegetation Type - Right	Road Embankment	Road Embankment	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

	Upstream	Downstream
Vegitation Band - Left	No	Yes
Vegitation Band -Right	No	No

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	None	None	None

Other Information

Spatial location data collected with GPS?	Yes	Photos taken?	Yes

Comments **Bridge replaced after washed out in 1927 flood. Max pool depth > 4 ft.**

Culvert Summary Report

Black River

General Information

SgaID	990000000014123	Local SgaID		VOBCIT struct_num	
Observers	K.Underwood, B.O'Shea	Assessment Date	00/22/2009	Project Name	Black River
Town	Plymouth	Latitude	43.50409	Longitude	-72.67231
Location	Approx 0.44 mile west of terminus of Reading Pond Road.			Reach VTID	M41T6.06
Road Name		Road Type	Gravel	Stream Name	Buffalo Brook
High Flow Stage	No	Channel Width			8

Culvert Information

Culvert Length	19	Material	Steel Corrugated
Culvert Height	4.1	Number of culverts	1
Culvert Width	3.9	Culvert Overflow Pipe	No
		Skewed to roadway?	Yes

Geomorphic Information

General

Floodplain filled by roadway approaches	Entirely	Structure is located at significant break in valley slope	No
		Culvert slope as compared with channel slope is significantly	Lower

Upstream

Obstructions at the opening of the structure	Sediment	Estimated distance avulsion would follow road	
Steep riffle present immediately upstream of structure	No	Angle of stream flow approaching structure	Sharp Bend
If channel avulses, stream will	Cross Road		

Downstream

Pool present immediately downstream of structure	Yes	Water depth in culvert (at outlet)	0.15
Downstream bank heights are substantially higher than upstream bank heights	No	Culvert outlet invert	Cascade
Stepped Footers	0.4 ft.	Backwater Length (measured from outlet)	0
Maximum pool depth	0.7 ft.	Backwater Length (measured from outlet)	1.7

	Upstream	Downstream	In Structure
Dominant Bed Material	Gravel	Gravel	Gravel
Bedrock Present	No	No	
Type of Sediment Deposits	None	None	None
Material Present throughout			No
Elevation of sediment deposits >= 1/2 bankfull	No	No	No
Bank Erosion	None	Low	
Hard Bank Armoring	Intact	Intact	
Stream bed scour causing undermining around or under structure	None	Culvert	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)			

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Deciduous Forest	Shrub/Sapling	
Dominant Vegetation Type - Right	Deciduous Forest	Deciduous Forest	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

	Upstream	Downstream
Vegitation Band - Left	Yes	Yes
Vegitation Band -Right	Yes	Yes

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	None	None	None

Other Information

Spatial location data collected with GPS?	Yes	Photos taken?	Yes

Comments

VERMONT

Stream Geomorphic Assessment

Agency of Natural Resouces

VT DEC

Vermont.gov

November. 07

Bridge Summary Report

Black River

General Information

SgaID	**400042000014121**	Local SgaID		VOBCIT struct_num	
Observers	**K.Underwood - SMRC**	Assessment Date	**00/18/2009**	Project Name	**Black River**
Town	**Plymouth**	Latitude	**43.47546**	Longitude	**-72.69503**
Location	**420 ft south of Camp Plymouth State Park entrance.**			Reach VTID	**M41T6.01**
Road Name	**SCOUT CAMP RD**	Road Type	**Paved**	Stream Name	**Buffalo Brook**
High Flow Stage	**No**		Channel Width		**32.6**

Bridge Information

Bridge Width	**17.5**	Material	**Concrete**
Bridge Clearance	**6**	Number of bridge piers/arches	
Bridge/Arch Span	**15**		
		Skewed to roadway?	**Yes**

Geomorphic Information

General

Floodplain filled by roadway approaches	**Entirely**	Structure is located at significant break in valley slope	**Yes**

Upstream

Obstructions at the opening of the structure	**Sediment**	Estimated distance avulsion would follow road	
Steep riffle present immediately upstream of structure	**Yes**	Angle of stream flow approaching structure	**Sharp Bend**
If channel avulses, stream will	**Unsure**		

Downstream

Pool present immediately downstream of structure	**Yes**
Downstream bank heights are substantially higher than upstream bank heights	**No**
Pool Depth at point of streamflow entry	**Yes**

	Upstream	Downstream	In Structure
Dominant Bed Material	**Cobble**	**Gravel**	**Gravel**
Bedrock Present	**No**	**No**	**No**
Type of Sediment Deposits	**Side**	**None**	**Side**
Elevation of sediment deposits >= 1/2 bankfull	**No**	**No**	**No**
Bank Erosion	**None**	**None**	
Hard Bank Armoring	**Intact**	**Intact**	
Stream bed scour causing undermining around or under structure	**Culvert**	**Culvert**	
Beaver Dam near Structure	**No**		
Beaver Dam distance (ft.)			

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	**Deciduous Forest**	**Deciduous Forest**	
Dominant Vegetation Type - Right	**Road Embankment**	**Deciduous Forest**	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

Vegitation Band - Left	**No**	**No**	
Vegitation Band -Right	**No**	**No**	

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	**None**	**None**	**None**

Other Information

Spatial location data collected with GPS?	**Yes**	Photos taken?	**Yes**

Comments **"Culvert" choice selected under Step 4, for the question of Streambed scour causing undermining? because choice of "abutments" was not available. Max pool depth = 2.3 feet. Stepped footer along the LB abutment. RB abutment shows cracking, spalling.**

Bridge Summary Report

Black River

General Information

SgaID	700000000114123	Local SgaID		VOBCIT struct_num	
Observers	K.Underwood - SMRC	Assessment Date	00/18/2009	Project Name	Black River
Town	Plymouth	Latitude	43.47507	Longitude	-72.69616
Location	Timber footbridge 370 ft downstream from Scout Camp Road bridge.			Reach VTID	M41T6.01
Road Name		Road Type	Trail	Stream Name	Buffalo Brook
High Flow Stage	No	Channel Width	32.6		

Bridge Information

Bridge Width	4.5	Material	Timber
Bridge Clearance	6.4	Number of bridge piers/arches	
Bridge/Arch Span	39		
		Skewed to roadway?	Yes

Geomorphic Information

General

Floodplain filled by roadway approaches	Entirely	Structure is located at significant break in valley slope	Yes

Upstream

Obstructions at the opening of the structure	None	Estimated distance avulsion would follow road	
Steep riffle present immediately upstream of structure	Yes	Angle of stream flow approaching structure	Channelized Straight
If channel avulses, stream will	Unsure		

Downstream

Pool present immediately downstream of structure	No
Downstream bank heights are substantially higher than upstream bank heights	No
Pool Depth at point of streamflow entry	No

	Upstream	Downstream	In Structure
Dominant Bed Material	Cobble	Cobble	Cobble
Bedrock Present	No	No	No
Type of Sediment Deposits	None	None	None
Elevation of sediment deposits >= 1/2 bankfull	No	No	No
Bank Erosion	Low	Low	
Hard Bank Armoring	Failing	Failing	
Stream bed scour causing undermining around or under structure	None	None	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)			

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Deciduous Forest	Deciduous Forest	
Dominant Vegetation Type - Right	Deciduous Forest	Deciduous Forest	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

	Upstream	Downstream
Vegitation Band - Left	No	Yes
Vegitation Band -Right	No	Yes

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species	None	None	None

Other Information

Spatial location data collected with GPS?	Yes	Photos taken?	Yes

Comments **Bridge on footpath at Camp Plymouth State Park. Structure & path owned by state, but SGA ID # assigned using "private" classification so as not to suggest a vehicle-worthy transportation system and structure.**

Culvert Summary Report

Black River

General Information

SgaID	400027000014121	Local SgaID		VOBCIT struct_num	
Observers	K.Underwood, B.O'Shea	Assessment Date	00/04/2009	Project Name	Black River
Town	Plymouth	Latitude	43.49437	Longitude	-72.65611
Location	1.6 mi north of Jct w/ Kingdom Road			Reach VTID	M41T6.02S1.02
Road Name	READING POND RD	Road Type	Gravel	Stream Name	Reading Pond Brook
High Flow Stage	No		Channel Width		15.5

Culvert Information

Culvert Length	20	Material	Steel Corrugated
Culvert Height	7	Number of culverts	1
Culvert Width	9	Culvert Overflow Pipe	No
		Skewed to roadway?	No

Geomorphic Information

General

Floodplain filled by roadway approaches	Entirely	Structure is located at significant break in valley slope	No
		Culvert slope as compared with channel slope is significantly	Lower

Upstream

Obstructions at the opening of the structure	Sediment	Estimated distance avulsion would follow road	
Steep riffle present immediately upstream of structure	Yes	Angle of stream flow approaching structure	Sharp Bend
If channel avulses, stream will	Cross Road		

Downstream

Pool present immediately downstream of structure	Yes	Water depth in culvert (at outlet)	0.2
Downstream bank heights are substantially higher than upstream bank heights	No	Culvert outlet invert	At Grade
Stepped Footers	0.6 ft.	Backwater Length (measured from outlet)	0
Maximum pool depth	2.5 ft.	Backwater Length (measured from outlet)	0

	Upstream	Downstream	In Structure
Dominant Bed Material	Gravel	Gravel	None
Bedrock Present	No	No	
Type of Sediment Deposits	Side	Side	None
Material Present throughout			No
Elevation of sediment deposits >= 1/2 bankfull	No	No	No
Bank Erosion	None	High	
Hard Bank Armoring	Intact	None	
Stream bed scour causing undermining around or under structure	None	None	
Beaver Dam near Structure	No	No	
Beaver Dam distance (ft.)			

Vegetation

	Upstream	Downstream	In Structure
Dominant Vegetation Type - Left	Mixed Forest	Mixed Forest	
Dominant Vegetation Type - Right	Mixed Forest	Mixed Forest	

Does a band of shrub/forest vegetation 50 ft. wide start within 25 ft. of the structure and extend at least 500 ft. up/downstream?

Vegitation Band - Left	Yes	Yes
Vegitation Band -Right	Yes	Yes

Wildlife

	Roadkill	Outside Structure	Inside Structure
Species			

Other Information

Spatial location data collected with GPS? **Yes** Photos taken? **Yes**

Comments **Minimal fill over the culvert.**

APPENDIX C

QA Documentation

To: Kristen Underwood, South Mountain Research & Consulting
From: Sacha Pealer, VT DEC River Management
Date: 11/03/2010

Black River Phase 2 QA, 2009

Note: This Quality Assurance document covers these ph. 2 segments: **M40-0 (Black River), M40T5.01 to M40T5.04 (Patch Brook), M40T5.03s1.01 (trib to Patch), M41T6.01 to M41T6.06 (Buffalo Brook), and M41T6.02s1.01 to M41T6.02s1.02 (Reading Pond Brook).** The questions raised below are meant to address potential discrepancies within the data, uncover data entry errors, or otherwise clarify and confirm those observations that might not have been expected. While providing notes and comments, try to anticipate the types of questions that may arise due to outliers and exceptions observed within the reach or segment. Please update this document (preferably in a second color) with what steps were (or were not) taken to address each item below.

South Mountain Research & Consulting Services (SMRC) appreciates the opportunity to enhance data accuracy, clarify data limitations, and maximize the utility of the Black River (Patch & Buffalo Bk tribs) Phase 2 (2009) data set. This response to VT River Management Section QA Review Comments has been completed by Kristen L. Underwood, PG, on 11/15/2010. SMRC responses are in blue text following each comment below. Applicable updates have been made to the Phase 1 and Phase 2 data in the VTDEC Data Management System (DMS) and to the summary report which accompanies this data.

S.Pealer, 11/17/2010. Remaining items are highlighted in blue.

K. Underwood, 11/22/2010. Thank you for your comments. Responses are added in yellow.

General Comments:

- Please address automated QC checks in DMS (some segments still "provisional"). See https://anrnode.anr.state.vt.us/SGA/projects/phase2/dataEntry.aspx?pid=118 for list.
- Please label RAF feature in x-section spreadsheets. Have been added, and cross sections uploaded. See M40-0 (for XS-1, see notes), M41T6.02S1.01A, M41T6.02S1.02C
- Step 2.13 largest particles. Why Not Applicable? There are bars noted. Try to get these measurements even where bedform is altered to plane bed. Use N/A on reference plane beds. See M40-0 (NE), M40T5.01A (NE), M40T5.01C (NE), M41T6.02B (bd:450; br:135) , M41T6.04-0 (NE), M41T6.02S1.02-C (bd:180; br:100). OK. I thought in the past that an internal QC check would instruct us to not enter a value here if the bedform was classified as plane bed. Often the bars were not located proximal to the XS (e.g., the relationship of bar to bed particles might not be valid if the channel exhibits a fining downstream sequence)
- Step 4.6. Did you mean to enter "None" for the following reaches? M40-0, M40T5.01A, M40T5.01B, M40T5.01C, M40T5.02A, M40T5.03S1.01-0. These reaches may have had upstream or downstream flow regulations, and in some cases, step 5 comments refer to them. Are you having problems saving step 4.6 in DMS? I'm not sure what happened here. I thought I had entered these in the DMS. The fact that the type of flow regulation is correctly stored there, gives me added confidence that I had. Maybe there was a DMS bug? I just re-entered the appropriate "upstream" or "downstream" values, and they seem to be storing OK.

Comments by reach:

M40-0

- Why is floodprone width (650') entered in step 2 of DMS greater than valley width (440') reported in step 1.5? All three cross sections suggest wider valleys. Please explain in step 5 notes. Valley width entered in step 1.5 represents an average for the segment. Cross section location had a locally higher valley width. Also, valley width is measured perpendicular to the long-valley axis. To be perpendicular to the channel, cross sections XS-3 and XS-2 were oriented at an angle to the long-valley axis. Regardless, all valley widths yielded ER greater than 2.2. Note added to DMS.
- Should step 2.11 riffle spacing be N/A if plane bed due to anthropogenic changes? Riffle pool was chosen as a subdominant, which suggests you might be able to measure riffle spacing, even if riffles are distant. Perhaps you meant to choose Not Evaluated? Added riffle spacing of 610 ft.
- In xs 2, did you consider RAF could be at feature (73.8, 5.1)? Looks lower than field RAF (150, 7.1) and would lower incision ratio. It is possible, and data are insufficient to know with certainty. This would

require more detailed surficial geologic investigations. In absence of that kind of detailed study, I erred on the conservative.

- How much of reach, if any, is affected by lake having "impounded" flows? Please comment in step 5. This is impossible to say with currently available data. The departure analysis of the Phase 2 report includes discussion of the upstream natural impoundment (Echo Lake) and the downstream regulated impoundment (Lake Rescue). Ordinarily, we might expect that upstream impoundment effects could lead to hungry water conditions and incision in M40. However, Patch Brook provides a significant source of sediments to M40. Fluctuations in water levels of the Lake Rescue impoundment over historic times may have alternately induced incision (from a drop in base levels) or aggradation (from a rise in base levels). Today, the net result of historic (and post-glacial) channel adjustments and historic channel modifications is a partially incised and entrenched channel in reach M40.

M40T5.01A

- Why is floodprone width (310') entered in step 2 of DMS greater than valley width (160') reported in step 1.5? XS suggests wider valley. Please check valley width. Valley width entered in step 1.5 represents an average for the segment where valley widths range from 80 to 240 ft. Also, the valley width for Patch Brook merges with the broader Black River main stem valley at this point of confluence. The Patch Brook valley wall shape file is artificially tapered down to close around the downstream reach break in this location. The floodprone width of 310 ft recorded for the cross section includes some area outside of this artificially-narrowed Patch Brook valley width and within the Black River valley.
- What evidence led you to choose channel evolution stage III? Have you considered stage II? It could make sense given the straightening, dredging, eroded steps, berms, incision, reduced channel width, and few depositional features. The fact that channel flows had recently breached the berms and splayed out onto the RB floodplain (sediment and remnant patterns of flood flows observed 8/7/2009). The landowner reportedly works on the RB berm periodically. Also, the "delta" of sediments from Patch Brook at the confluence in Black River main stem suggests a local sediment source (widening to erode the berms). It appears to be a channel in early stage III that is repeatedly managed back to II through berming (and possibly gravel extraction – though extraction not confirmed). The degree of channel incision may have been more pronounced in the past (e.g., following flood recovery efforts after the floods of the 1970s) and the channel has begun to fill in over time, reducing the degree of incision. This is speculation, however.
- Your reach narratives report indicates this segment is a subreach of Cb/riffle-pool (p.15). However, no subreach is entered in step 2.15. Which is correct? It appears you may wish to note a difference in reference bedform. I didn't realize that a difference in only reference bedform (not stream type) was sufficient to justify selecting subreach. I have selected subreach.
- I see you upgraded sensitivity because segment occupies alluvial fan. Protocol for sensitivity ratings does not yet systematically incorporate alluvial fans (other than indirectly, with known D streams), but we appreciate your effort to capture potentially heightened hazard risk. Please comment here further: In your opinion, could this "alluvial fan" reactivate? This segment (and upstream segment B) was classified as an "alluvial fan", in order to capture the marked reduction in valley gradient and confinement, although geologic investigations to confirm the origin and nature of sediments comprising the local landscape as a true alluvial fan, were beyond the scope of this study. If significantly higher sediment loading and/or hydrologic loading in the upstream watershed were to result from a future change in land use and/or hydrologic regime, it would be reasonable to expect that the incidence and rate of lateral migrations/braiding and the potential for avulsions would increase in this segment (and upstream segment B).Could it become a D stream, or is the stream too channelized? Flows have recently breached the RB berms and splayed out onto the floodplain (based on observations of the area on 8/7/2009). Based on this recent activity, it would be possible to see braided flows in this vicinity especially episodically during future flood events, or as a result of a change hydrologic loading or sediment transport from the upstream watershed. Do you think the stream has potential to avulse above Dublin Road bridge onto the north side of the road (ie, outside of the delineated ph.2 valley)? Yes, historic maps suggest that the channel may have once gone there. The Dublin Road bridge was washed out in

the 1973 flood according to the local landowner. Floodwaters and sediment were directed down Dublin Road to the Echo Lake Inn.

M40T5.01B

- Step 3.2. Please check dominant buffer type. FIT shows >58% 0-25 foot buffer on left and >83% on right, yet dominant types are 51-100 and >100. Dominant buffer types changed in the DMS.
  SP: Now, the FIT uploaded to DMS does not include any buffer less than 25' for this segment. Did you mean to remove indexing? If so, perhaps the dominant buffer type should be changed back?
  The latest FIT upload that I made (on 11/15/10), included data only for reach T6.01 (which was the only one for which edits to the FIT were made during the QA review process between 10/15 and 11/15). You, were correct that FIT data uploaded on 10/15/2010, contained 449 ft of LB buffers <25 ft wide for the segment (or >58%), and 639 ft of RB buffers < 25 ft (or >83%). So, the dominant buffer types now stored in the DMS are correct.

M40T5.01C

- Channel dimensions suggest Rosgen stream type B. Due to the very wide bankfull width. Did you mean to enter Cb in step 2.14? Yes. The cross section shows several features around 2x max depth, suggesting that floodprone width may be on the cusp of being smaller, and driving entrenchment more solidly into B territory. Please comment. Do you think there could be an STD from Cb to B? What about a subreach? Valley walls are approximately 85 feet apart here. Compared to a reference bankfull width (28 ft), that would yield an ER of 3+ which would be classified as a C stream (with a subclass slope of b for the estimated 3.8% gradient). Despite a degree of incision (estimated IRraf = 1.4), the channel appears to have access to its floodplain. The FPW elevation is 0.8 feet over the RB terrace. And I suspect that flood flows have access to much of the LB corridor via the LB flood chute and other areas upstream or downstream of local high points like those captured in the cross section (e.g., point -6, -1.5). The reason that the ER is in the range of a B stream type has to do with the wide bankfull width value that includes some area within the LB flood chute (the segment is actively widening and adjusting its planform). The value is on the cusp of a C classification if the +0.2 unit is considered (1.95 + 0.2 = 2.15).

M40T5.01D

- Would you update this sentence in step 5? "This "canal", as it is known locally, returns to the Patch Brook approximately xxx feet downstream in Segment B." 3000 feet; Step 5 in the DMS has been updated.

M40T5.02A

- Why is step 1.5 valley width so much narrower than valley width in cross section? What are you calling ph.2 valley width in xs? It looks like you have the ph.1 valley labeled. Are you choosing the base of a terrace, and if so, how does this support step 1.5? VW shapefile appears to be ~50' wide at xs location. However, xs plot could show 115'? This confusion stems from the uncertainty surrounding degree of incision and which amount of incision occurred historically (say, in the last 250 years) versus post-glacially. Further surficial geologic study would be required to know with greater certainty the composition, origin, and age of the terraces surrounding the Patch Brook in this segment. If we believe that RTER1 at elevation 7.4 represents a historic RAF, and the Patch Brook incised to its present depth below this RAF (IRraf = 2.67) within historic times, then the valley walls for this channel would be positioned at the base of the next terraces (distance -45 ft on the LB, and distance 70 ft on the RB, for a valley width of 115. However, if the RTER1 represents a terrace of post-glacial age and the channel has incised below this terrace over thousands of years, perhaps with incision rates renewed during historic times (as a result of deforestation/reforestation cycles, channelization, historic impoundment & subsequent dam breach, e.g.), then these post-glacial origin terraces may define the valley walls of the current channel – at distance -10 ft on the LB, and distance 43 ft on the RB, for a valley width of 53 ft at the cross section. Originally, I had mapped the ph2 valley wall shape file to depict the wider 115 foot valley width in this specific location – which represented a locally wider valley width as compared to the remainder of the segment (that is why the LVW and RVW are marked the way they are in the cross section spreadsheet). Later, due to the uncertainty regarding degree of historic incision, I changed the ph2 valley wall shape file to reflect the narrower 50-foot valley width near the downstream end of the segment where this cross section is located. This valley width is much more consistent with valley widths measured elsewhere in the reach where the channel is closely confined by terraces at 3 to 4.6 times the Dmx. The uncertainty regarding degree of historic vs postglacial incision is discussed in Appendix E and in Step 5 of the DMS. If I revised the valley wall back to the wider position in this location, it would be consistent with the cross section notes, and it would offer a greater degree of protection in the event that the valley wall was utilized as a basis for development of fluvial erosion hazard corridors and hazard ratings. Please advise.

SP: Suggest going with more conservative valley width in light of FEH (the valley will be reducing the FEH corridor width somewhat in either case). It is okay to have multiple terrace sets within a phase 2 valley. You don't have to limit yourself to RAF and valley wall. Final phase 2 valley wall shape file includes more conservative (wider spacing) of valley walls.

M40T5.02B

- In xs spreadsheet, why is feature at (100, 8.1) labeled as RFPA? Looks well above 2x max depth. I was using the descriptor (RFPA = Right Flood Plane, as noted on the Cross section worksheet) to refer to the generalized floodplain-like feature there. I agree it would not be equivalent to the FPW identified by protocols as 2x Dmx to correspond to the Q10 to Q50 floodplain. This floodplain-like feature would not be active at most flood stages. I have removed the description.
- Please enter RAF to get IR_{RAF} in step 2.5 of DMS. Both incision ratios can be reported. Entered in the DMS.

M40T5.03

- Why is ph. 1 valley width less than ph. 2 valley width for both segments, especially when ph. 2 valley has human-caused change in width? Update phase 1 as needed. I changed the Phase 1 valley width to 40 ft.

M40T5.03A

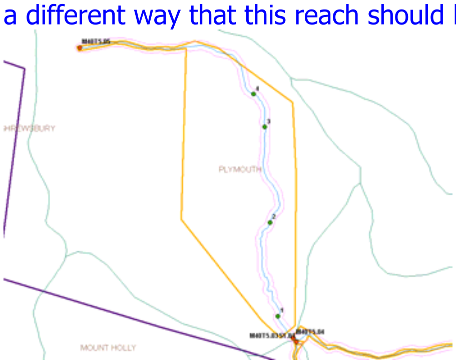
- Why didn't you evaluate step 2.11 step spacing? Although plane bed is dominant due to anthropogenic changes, step pool was chosen as a subdominant, which suggests you might be able to measure some step spacing. Perhaps you meant to choose Not Evaluated in the No Data box? Because the segment was predominantly plane bed. Upon reviewing my notes, there is insufficient data to calculate a step spacing, so I have chosen Not Evaluated.

M40T5.03B

No comments.

M40T5.04

- Do I have the correct valley wall verification data for this reach? It looks unnatural in shape, does not fit reported valley wall dimensions, and crosses the streamline mid-reach. Also, lower end does not even include downstream reach point. See screenshot below where gold line polygon is ph. 2 valley wall. Valley walls were not able to be delineated along most of the reach, because the VHD coverage defining the position of the Patch Brook main stem was considerably different than the actual channel position measured in the field with a GPS (see Figure 1 a on next page). Mapped valley wall positions would have crossed the channel in a number of locations, causing SGAT to generate errors when trying to delineate corridors using these valley walls. Should I delete this reach from the valley wall shape file? Or is there a different way that this reach should be treated?



SP: If possible, it would best to have the actual valley wall location portrayed in the shapefile. SGAT can be amended to account for the correct streamline if the corridor ever needs revision or setback/FEH options are explored. OK. Revised ph2 valley width shape file has been delivered via email attachment to this QA response, as well as stored on the updated Project CD #1. Please be aware that the actual channel position is an estimate only; it is more accurate than the channel position shown by the VHD, but it is not necessarily highly accurate. I would be uncomfortable with this approximate channel position (and the valley wall shape file developed from it) being used to depict fluvial erosion hazards. The GPS I used typically had an accuracy of +/- 17 to 20 ft on the assessment date. The channel width of the Patch Brook measured in this headwater setting ranged from 9 to 14.7 feet wide. Channel position was recorded every 50 or so feet along the traverse at meander cross-over points or prominent meanders (or other FIT features). Valley wall positions (generally high terraces on either side of the channel) were identified at a given distance from each channel waypoint, measured perpendicular to the channel. These segments are located within the Calvin Coolidge State Forest, suggesting that future development surrounding the channel is less likely than on non-state-forest lands. The upstream drainage area of the reach (1 sq mile) is smaller than would typically warrant mapping of FEH boundaries –instead this reach would likely be treated with a buffer of default width.

M40T5.04A

- Notes describe this segment as having "beaver activity". Should there be beaver dams mapped in FIT/step 4.9? None that we noticed in the segment on the assessment date. There is a much larger wetland complex that includes this segment and a tributary channel, extending to the west. There may be channel-spanning or bank beaver dens in that area.

M40T5.04B

- Bars present (mid, diagonal, side) and flood chutes on segment may suggest aggradation and planform adjustment. Step 7 describes "moderate aggradation." Have you considered channel evolution stage III, rather than II? You've indicated incision is historic (and probably limited by grade control), so maybe the channel evolution process has progressed? Depositional bars are present but less than ½ bankfull stage. W/D ratios are low, suggesting minimal active or historic widening. No signs of active widening such as trees leaning into the channel. There was a minor degree of undercut banks in the straightaways. It is possible that minor to moderate aggradation may be leading to a very minimal degree of widening (early stage III). However, lateral adjustments appear to be moderated by the cohesive nature of bank sediments and well forested buffers. Also, the degree of historic incision is relatively small (1.18 and 1.3 locally at XS-1), so bank heights relative to the thalweg are not excessively oversteepened to serve as a driver for widening. It is also possible that the degree of incision was greater in the past, the channel maintained reference widths due to boundary resistance, but has filled in with finer sediments over the years to result in the present minor net degree of incision.
- In both xsections, there is a flat floodplain feature around elevation 3 ft. Do you think this could be bankfull? While it is certainly possible that I underestimated the bankfull elevation, there was a subtle (and in the case of XS1, more pronounced) undercut profile of the left and right banks suggesting incision. And the floodplain feature at elevation 3 ft in each XS was well vegetated and showed no signs of recent, fine-sediment deposition. At both cross sections, the terrace at elevation 3 ft was occupied by mature trees with an organic soil layer. Also, in xs 2, the first terraces on both sides are fairly close to channel; is it possible RTER1 represents RAF, making for incision ratio of ~2 (still historic)? Or are you more comfortable calling them glacial terraces? What you've done fits with upstream segments, but thought to ask when I saw those close terraces. It is possible that RTER1 could represent a historic RAF. Further surficial geologic study, beyond the scope of a Phase 2 SGA, would be required to evaluate the composition, origin and age of these terraces. While the protocols suggest that terraces 3 times the height of Dmx should be considered to be older than historic (glacial or post-glacial), I believe it is possible, particularly in these smaller streams, that terraces less than 3 times the height of Dmx can be glacial or post-glacial in origin.

M40T5.04C

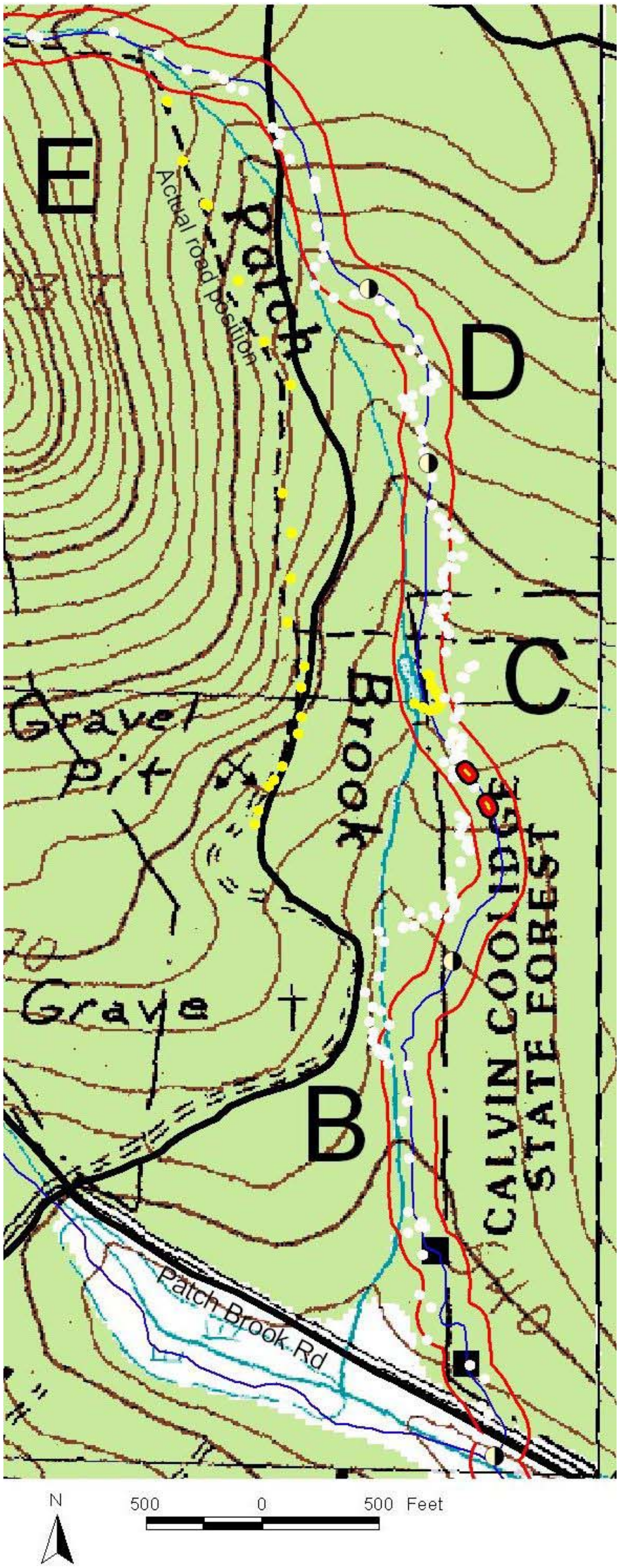
- You note VHD is inaccurate with respect to pond. Would you provide a sketch of current channel location? Can be shapefile or figure in report. (see Figure 1b, next page).
- Again, has segment moved on to stage III? We did not observe signs of active widening such as trees leaning into the channel. W/D ratios are low, suggesting minimal active or historic widening. Bed and bank materials contain large clasts (boulders) reflecting the glacial parent materials; these are likely not mobile except perhaps in extreme flow events. Erosion-resistance of boundary materials has probably limited lateral channel adjustments. Flood chutes are relatively frequent, but not uncommon in such a steep channel (estimated 3.9% gradient).
- If segment is semi-confined with no human-caused change in valley width, then please use Confined form in step 7. Fits slope/bedform better anyway. DMS updated with Confined RGA.

M40T5.04D

- You note VHD is inaccurate. Is actual channel located far enough away to make ph. 1 corridor inaccurate? Yes. Are you able to sketch channel? (see Figure 1a, next page).

M40T5.04E

- No comments.



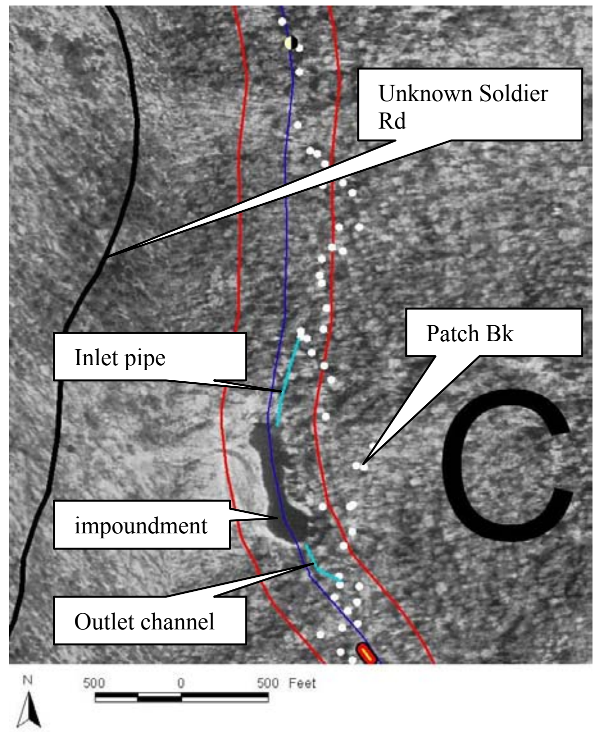


Figure 1b. Actual position of Patch Brook channel (indicated by white dots = waypoints from 2009 assessment) passes 50 to 100 ft east of impoundment.

Figure 1a. Actual position of Patch Brook channel (indicated by white dots = waypoints from 2009 assessment) vs VHD (blue line surrounded by red Phase 1 corridor) vs turquoise line on USGS topographic base map.

M40T5.03S1.01-0

- No additional comments.

M41T6.01A

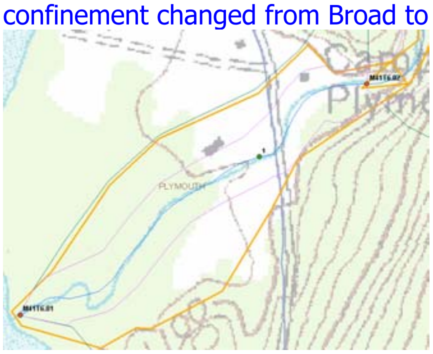
I revised the valley width somewhat (see next segment); still a Very Broad confinement.

- Step 2.13. Are largest particles reversed? Usually bed particle is larger than bar particle.
- I had mistakenly entered a value for a side bar located approx 790 feet upstream of the cross section site. Correct bar particle (170 mm) has been entered.

M41T6.01B

SP: I discovered a duplication in the FIT for buffers <25'. It appears the impact was indexed in phase 1 and again in phase 2, causing data to show an artificially high length of stream effected. Would you mind fixing this and re-uploading? We can fix it in our copy when it arrives by mail, assuming it's just a matter of removing the 2007 entries. Good catch. I have deleted the sections indexed during the Phase 1. FIT data for M41T6.01A and B re-uploaded to the DMS. Full FIT records included in the SGAT files on the revised Project CD #1 which has been sent via US Mail.

- Does valley wall shapefile need to be updated? When I measure segment B in GIS, I get more than 180' (reported in step 1.5). I'm not sure what happened here. I also get a larger value for valley width in Segment B. I took a closer look and revised the valley walls slightly (new valley wall shape file is stored on the Project CD). Average valley width for Segment B is 290. Revised valley width in Ph2 St 1.5; confinement changed from Broad to Very Broad.



- In xs, please label RBF. If there is a berm on right bank, please label it, too. RBF now labeled. Yes, there is a RB berm; I have now labeled it and uploaded revised cross section to DMS.
- Should this segment score good for RGA given change to plane bed, 96% straightening, gravel mining, erosion 11-16%, bank armoring, and severe bridge constriction? Please advise if I am mis-interpretting the protocols. As I understand it, the overall geomorphic rating score describes the degree of active adjustment (which in this case is minor) and the degree of departure from regime. A rating in the "Good" quadrant of the adjustment condition does not mean that the reach is not susceptible to catastrophic adjustment in future high flows. Rather, this susceptibility is captured in the sensitivity rating. The degradation adjustment process (probably enhanced by periodic post-flood windrowing/ channelization) which has resulted in the degree of incision (IRraf = 1.6) is inferred to be historic in nature. The enhanced degree of entrenchment caused by the berms on either side of the channel (IRhef = 1.8) is also inferred to be historic. The degree of channel incision and entrenchment (as well as the straightened planform, and noncohesive nature of bank and bed sediments) does make the channel susceptible to catastrophic adjustments in future high flows. Accordingly, the sensitivity would be noted as "Moderate", following protocols. Due to the location of this reach along the river network at a point of marked reduction in valley gradient and confinement, I have overridden the Sensitivity rating to "Extreme". The segment has been converted from a reference meandering Cb3-riffle pool status to a straightened, armored, partly bermed, undersized-width, transport-dominated, Cb3-plane bed status with moderate incision. Despite the channel being narrow in width, the nearly continuous tree buffer along both banks (along with streambank armoring) has likely moderated the potential for widening and planform adjustment under flow conditions experienced since the last major flood.

  SP: The RGA condition is *not just* a reflection of active adjustment; that is why historic adjustments are incorporated into the RGA questions. Yes, I agree, and I mis-stated the case in the second sentence. The

RGA does include Historic check boxes, and the metrics such as incision ratio and w/d ratio can reflect both active and/or historic processes. Yes, RGA indicates how much the stream has departed from reference condition. The signs I noted above (plane bed, etc.) are usually symptoms of both adjustment (active or historic) and departure. You seem to be okay with "good" because the stream, while altered, is now relatively inactive. I am not necessarily comfortable with an overall RGA score labeled "Good" for this segment. That's, in part, why I overrode the Sensitivity rating to Extreme (also due to the setting at a marked reduction in valley gradient and confinement). This seems to ignore the existing alteration. The existing alteration – historic incision leading to IRraf = 1.4 and berming enhancing the degree of entrenchment to an IRhef = 1.8 – is reflected in the 7.1.2 response and 7.1 score of 8. For example, a reach in stage II with historic incision may not have much active adjustment, but it would not have the same RGA score as a reach in stage I with no incision. I agree. However, it may not have an overall RGA score that drops below the range from 0.65 to 0.84 ("Good" category) if it has a regime w/d ratio with little signs of active widening, and very few signs of aggradation and planform adjustment (as is the case with this segment). In this case, to get an overall RGA score in the range of 0.35 to 0.64 ("Fair" category), I would have to artificially downgrade the scores of 7.2, 7.3 and/or 7.4, which I was not comfortable doing, since it would be a non-standard approach. While a reach "stuck" in stage II may not be actively adjusting, it is in a reduced geomorphic condition if it cannot progress into stage III; in other words, there is little hope for it to regain floodplain access because of its armored, straightened condition, which may even be maintained through gravel mining and further armoring. Unfortunately, these stage II reaches are common in Vermont, especially in areas of encroachment. I am concerned that a reach with an incision ratio of 1.8 (due to berming), plane bedform, and almost complete straightening is being rated "good." I wouldn't characterize it in good condition either, but I would characterize it to be in a minor to moderate present (and/or historic) state of adjustment and/or departure (as a result of historic modifications and encroachments) – which is what I had understood the second-from-the-left quadrant of the RGA labeled "Good" is designed to reflect. Clearly, this segment has departed geomorphically. Yes, the armoring and perhaps the bank trees have reduced the potential for widening; however, this is not necessarily favorable, since we know widening can be a positive step toward achieving equilibrium planform, profile, and channel dimension. That said, there are many stream conditions out there; if you can explain the "good" condition adequately in the DMS notes, perhaps we can come to an agreement about how such an unusual situation should be handled.

As for sensitivity, yes, it refers to likelihood the stream *will* adjust in response to watershed change. Sensitivity is usually assigned in phase 2 by following a specific categorization process as outlined on p.84 of the Phase 2 Handbook (May 2009), where the potential for channel adjustment is based on *both* RGA condition and existing stream type. In this segment, the sensitivity of High would come from Fair or Poor condition on a C3 stream. If you want to override the sensitivity you are getting because it does not seem to reflect the hazards associated with a channelized, bermed stream, then perhaps it is a sign that the RGA score should be lowered Based on feedback from past QA reviews, it seems that it has been more acceptable to override the sensitivity rating than to override the RGA score. Perhaps, I have been in error in the past to do so? As I re-read Step 7 of the protocols, it appears that it would be appropriate to keep the individual adjustment process scores and the overall RGA score as they are (reflecting the measured metrics and observed features) – however, override the RGA classification from "Good" to "Fair" despite the score of 0.68. I have added a note describing this to Step 5 of the DMS – let me know if that is not appropriate. Then, as you noted above, the specific categorization process outlined on p.84 of the Phase 2 handbook indicates that a C3b in "Fair" condition has a "High" sensitivity. I would still be inclined to override the sensitivity to an "Extreme" category, due to the notable decrease in valley gradient and confinement at this segment..

Adjusting sensitivity for alluvial fans is not typically done in phase 2. The phase 3 protocol does acknowledge that certain boundary conditions such as alluvial fans increase sensitivity. However, RMP has not fully developed a protocol for alluvial fans with respect to sensitivity, in part because phase 2 only goes as far as identifying the *setting,* or slope and valley conditions where a fan may have formed. For the purposes of this project, we are okay with you adjusting sensitivity in this way; however, please understand this is a part of the protocol RMP would like to review, and we may need to adjust the sensitivity for these or other alluvial fans in the future. While it is good to think about appropriate sensitivities, keep in mind that ph. 2 determination of an appropriate RGA condition is the key first step.

- Due to alluvial fan, you recommended extreme sensitivity but did not update sensitivity. This was an oversight on my part; I meant to change the Sensitivity rating in the DMS, and have now. As in M40T5.01A, do you think this fan is likely to reactivate/braid/avulse? This segment (and downstream segment A) are probably susceptible to catastrophic erosion or avulsion in the event of a future flood, due to their incised and entrenched status. This susceptibility is probably enhanced by their topographic position of notably-reduced valley gradient and confinement. This segment (and downstream segment A) were classified as "alluvial fan"s by protocol, in order to capture this marked reduction in gradient and confinement, although geologic investigations to confirm the origin and nature of sediments comprising the local landscape as a true alluvial fan, were beyond the scope of this study. Kame terrace deposits and lake sands are mapped in vicinity of this reach by Stewart (1955). If significantly higher sediment loading and/or hydrologic loading in the upstream watershed were to result from a future change in land use and/or hydrologic regime, it would be reasonable to expect that the incidence and rate of lateral migrations/braiding and the potential for avulsions would increase in this segment (and downstream segment A). Did you think it less likely than M40T5.01A since you did not update sensitivity? No, just an oversight.

M41T6.02A

- No comments.

M41T6.02B

- If segment is semi-confined with no human-caused change in valley width, then please use Confined form in step 7. Fits slope/reference bedform better anyway. Revised RGA accordingly. No change in score.

M41T6.03-0

- Again, am I looking at correct valley wall file? When I measure segment B in GIS, I get more than 80' (reported in step 1.5). The valley wall varies in width from 55 ft near the upstream end of the reach to 270 feet near the downstream end of the reach at the confluence of Reading Pond Brook. Taking an average of six evenly-spaced valley width measurements in GIS, I get 160 feet. I have replaced the valley width in Phase 1 St 2.9 and Phase 2 St 1.5 with 160 ft. Confinement type revised to Broad. Reference stream type unchanged. Cross section plot appears to show 240'. Yes, at that location along the reach, I would agree. Are you counting path/forest road as change in valley width? No.

- Step 2.10. Why is riffle type N/A? Data indicate change in bedform from step-pool to plane bed. If plane bed is not reference, then choose a riffle type that fits channel evolution processes. Step 2.10 changed to eroded.
- Please explain why you chose stream type Fb for step 2.14. Entrenchment ratio is 1.60, which is generally B. Although Rosgen's variation in entrenchment allows for F, the cross section suggests flood prone could be wider, if access occurs on right of RAF feature. I would agree, at this cross section

location in particular. Have you considered an STD of Cb to B? I did, but conditions in this very short reach are highly variable, and I wanted to err on the conservative. Meaning, the RB terrace is discontinuous along the length of the reach. Other locations upstream & downstream were more incised and entrenched relative to this cross section location. Some locations (near the upstream end of the reach were less incised and entrenched. Possibly, this historically (and post-glacially) incised reach is slowly evolving from a Cb to an Fb to a B channel. The surrounding sediments may represent coarser materials that were deposited in glacial and post-glacial times under a more intense hydrologic and sediment regime. And in mountain streams it can take more severe, less frequent events than a Q1.5 to do the work of shaping the channel (Phillips, Jonathan D., 2002; Faustini & Jone, 2003; Wohl, 2000). For all of these reasons, I classified the channel as an Fb. I believe this location is susceptible to future avulsions or possible catastrophic erosion in flood events, given it's incised and entrenched status, and its topographic position of notably lesser gradient and lesser valley confinement.

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M41T6.04-0

- Step 2.10. Why is riffle type N/A? Reserve N/A for reference plane bed or dune-ripple systems. If not evaluated, then check box for Not Evaluated. When I review the DMS in both data entry and data view modes, as well as generate the report output, all show "complete" under Step 2.10.
- XS. Is road functioning as an active flood chute? If so, then include flood chute area below 2x max depth in flood prone width to calculate entrenchment ratio. This approach results in C entrenchment. If road is not functioning as flood chute, then channel width would be 13.5' (rather than 14.3'), which is still B type entrenchment. In this particular location (which is generally representative of the segment), I don't believe the road is serving as an active flood chute at bankfull stage. I adjusted the cross section spreadsheet and added an explanatory note; reuploaded the XS to the DMS. Revised BFL width = 12.5, mean depth = 0.87ft, ER = 1.9, W/D = 14.4; updated the DMS record for Step 2. Stream type B3-S/P remained unchanged.

M41T6.05A

- Step 3.2. If right buffer has subdominant width of 0-25', shouldn't there be buffers <25' indexed on right side? Yes, I had missed a small (135 ft) section of RB buffer < 25'. Revised FIT file uploaded to the DMS.

M41T6.05B

- No comments.

M41T6.06-0

- No comments.

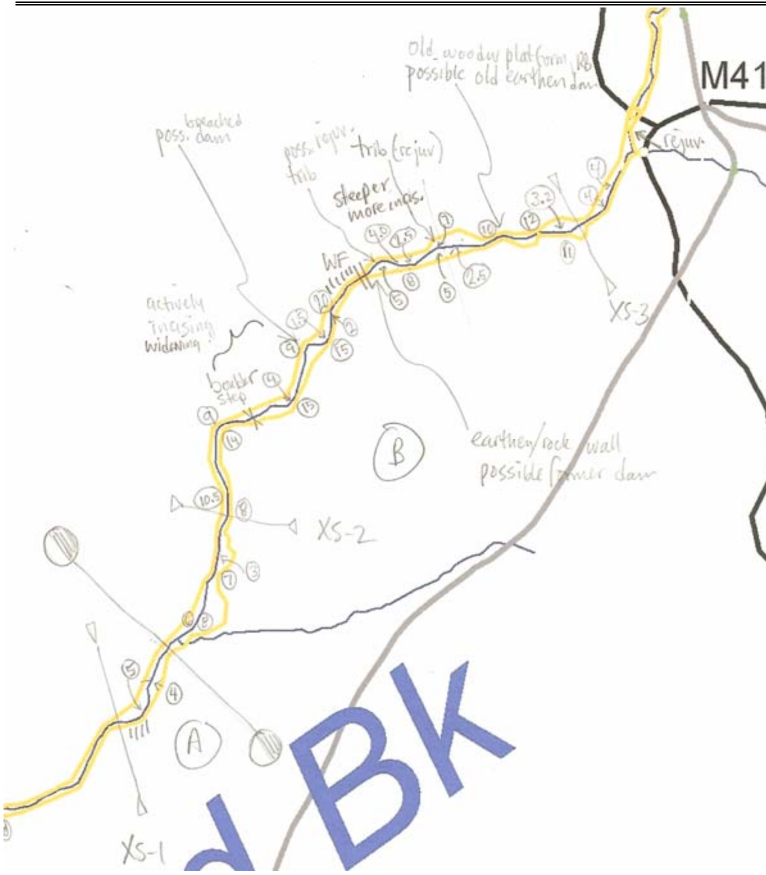
M41T6.02S1.01A

- Step 1.5. Did you mean SC for confinement type? Sorry, I meant Narrowly-confined. (DMS has been updated). Data suggest valley width/channel width=40/21=1.90 or Narrowly Confined. Or should valley width be >40'? Valley width varies between 25 to 60 feet, averaging 40 ft.
- Please label bankfull features, right valley wall, and flood prone in xs. Revised xs spreadsheet uploaded to the DMS.
- Looking at xs, reference stream type appears it could be C, rather than B, according to entrenchment if left floodplain area were accessible. Please consider assigning subreach stream type or explain. I could have picked a better cross section site for the Segment. The valley width at this spot is wider than is typical for the segment. Generally, the valley width is between 1.5 and 2 times the channel width (with just a few exceptions). A reference B stream type is really more representative of the reach as a whole.
- If a headcut is present, then why did you say degradation is historic? I was not certain that the nickpoint observed was in fact a head cut. There appeared to be a little recent incision in the vicinity with erosion evident along both banks in a somewhat straight section of channel. But this location at the head of the segment was not representative of the Segment A as a whole. In hind sight, I might have located the Segment break a little bit further downstream. In contrast to the upstream segment B, no rejuvenating tributaries were noted in Segment A; exposed tree roots along the banks were infrequent and weathered; LWD in the channel was weathered and stripped of small, leafed branches; trees leaning into the channel

were fairly rare. Because the headcut is at the top of the segment? Do you think the headcut is likely to continue working upstream? No.
SP: Would you please add these comments to the DMS, so those reviewing the data in the future will understand how the headcut relates to the overall adjustment noted? Sure, these comments have been added.

M41T6.02S1.01B

- Step 2.11. Did you forget to enter step spacing? If not evaluated, select "Not Evaluated" from no data dropdown menu. When distinct steps were present (rarely), the spacing was approximately 10 feet. (I have entered this value in the DMS). See discussion of cascade classification under next segment. (Because I classified the bedform as dominantly cascade, I had assumed step spacing was N/A).
- 2 xsections are included for this segment, one (XS-3) is Ba with 1.78 incision ratio (which I considered representative) and one (XS-2) is Fa with 1.00 incision ratio (which I considered non-representative, and classified as a B4, considering the +0.2 units for the ER=1.25 allowed by Rosgen). Why do you think such differences occurred? Conditions on this segment are pretty complex with adjustment processes overlapping in time and space. XS-2 is located near the downstream end of a short section of channel, Narrowly-confined by steep till-slopes that formed high terraces at thalweg heights ranging from 9 to 10.5 feet (5.6 to 6.6 times the Dmx) on the RB; and from 8 to 14 feet (5 to 8.8 times the Dmx) on the LB. Signs of recent incision in vicinity of XS-2 were not observed. XS-3 was located near the upstream end of the segment and represented conditions found along a majority of the segment. Valley walls were comprised of till terraces ranging in height from 9 to 30 feet high or more (see Figure 1 on next page). Confinement of the channel between these high terraces varied from Narrowly-confined to Semi-confined and even Narrow in a couple of places. A set of discontinuous lower terraces were present within these valley walls, generally 2 to 4 times the Dmx in height. Flood chutes on these lower terraces were relatively frequent but did not appear to be active at bankfull stage, unless forced at a DJ. Frequently, DJs and/or boulder-rafted LWD had blocked or partially blocked the channel (perhaps during the 2006 flood event) and large sediment slugs had been deposited in the channel behind the obstruction. Then it appeared that recent breaching of the obstruction had lead to localized incision through and beyond the sediment slug. Incision was somewhat localized and head cuts would wash out within a relatively short distance upstream, but might overlap with the next section of incision (see conceptual drawing, Figure 2 on next page). In other locations there might be a short section with little or no incision between sections of more pronounced incision. Tributary rejuvenation was apparent in many of the tributaries to this segment. Banks were undercut exposing fresh tree roots. Trees are actively leaning and collapsing into the channel from both banks. Did the non-incised xs (XS-2) have some localized vertical control? There was an apparent boulder grade control (control height to bed = 4.5 ft; control height to water surface = 3 ft) approximately 450 feet upstream of XS-2, and the transition from Semi-confined to Narrowly-confined occurred at about that point. If active incision in the remainder of the segment upstream from this location was a localized and discontinuous phenomenon related to localized aggradation at debris jams and LWD obstructions, it would make sense that this Narrowly-confined section of channel would have been spared the effects of recent flood-related deposition / local incision (i.e., a transport reach with little room for forced deposition). If the segment were characterized as an F, the sensitivity would be affected. Why did you decide xs #2 was not representative? Because it represented a short piece (less than 500 feet) of the 3,374-foot segment. Also, I classified it as a Ba stream, and felt that it was characterized by more stable conditions than the upstream majority of the segment.


M41
Old wooden platform & possible old earthen dam
breached poss. dam
poss. rejuv. trib
trib (rejuv)
steeper more mass.
rejuv.
WF
actively incising widening
boulder step
earthen/rock wall possible former dam
XS-1
XS-2
XS-3
Bk

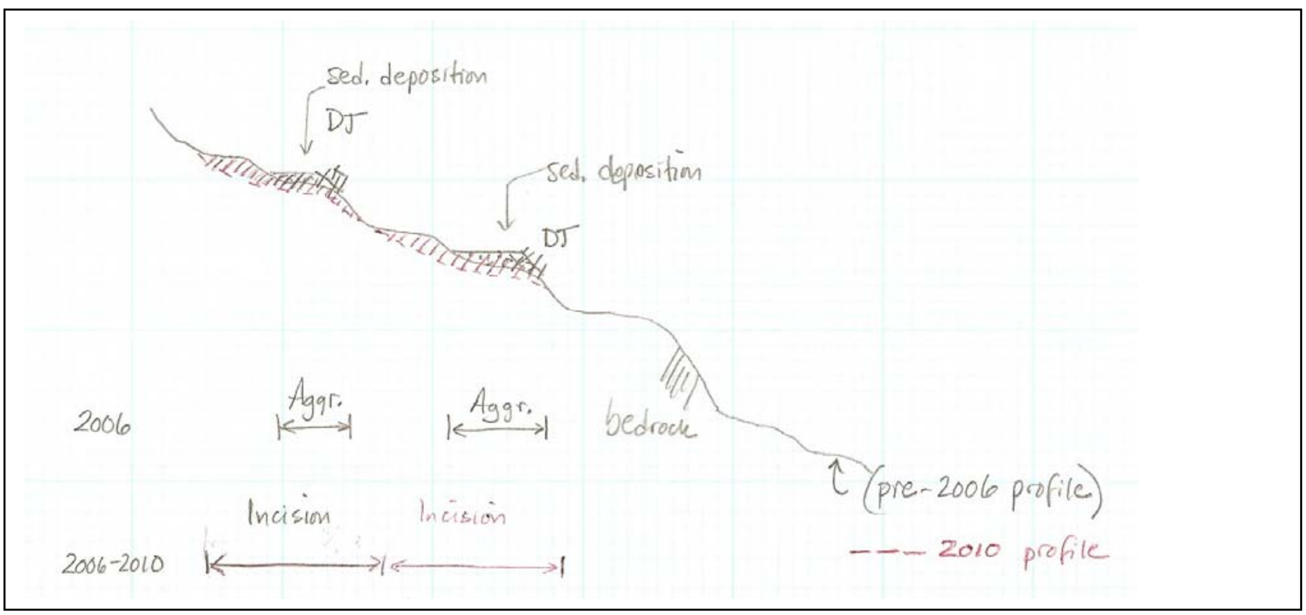

sed. deposition
DJ
sed. deposition
DJ
2006
Aggr.
Aggr.
bedrock
(pre-2006 profile)
Incision
Incision
2006-2010
--- 2010 profile

Figure 2.

M41T6.02S1.02A

- Step 2.10/2.11. Why N/A? Whether cascade or step-pool, "steps" should be measurable. Does not appear to be bedrock dominated. Please explain. When distinct steps were present (rarely), the spacing was approximately 10 feet (I have entered this value in the DMS). And correct, there was no channel-spanning bedrock indexed in the segment. By classifying the segment as cascade, I was following the descriptions for cascade bedform contained in Montgomery-Buffington, 1997 – "longitudinally and laterally disorganized bed material typically consisting of cobbles and boulders". I suspect that flood debris and colluvial processes including mass failures in this semiconfined channel (initiated by the recent flooding) have resulted in a disorganized, jumbled bed, without recognizable discrete steps. Perhaps, in the few years since that flood, the watershed has not been subjected to the magnitude of flows necessary to begin to sort the bed into a more organized step/pool structure that I speculate was the reference bedform.
- Did you mean to choose No for Historic in step 7.1 degradation? Yes, I chose "no" to reflect that I suspect incision is very recent (post-2006 flood) and is probably overprinted on a degree of historic (and/or post-glacial incision). While there were no distinct headcuts noted in the segment, I suspect that mass wasting and colluvial processes from the closely confining valley walls are contributing sediment and debris to the channel that may be blanketing or masking recent incision features. Is this because of recent flooding/ incision or do you think degradation is still ongoing /active?

M41T6.02S1.02B

- Please label bankfull features in xs spreadsheet. I have added the LBF label at point (4, 1.4). I entered a value of 2.0 in the bankfull elevation cell so that the spreadsheet would include the full width of this bankfull bench in the calculation of bankfull width. The right bank was a very steep eroding face, with no discernable bankfull feature at the location of the cross section.
- Did you mean to choose Yes for Historic in step 7.1 degradation? Yes. There is a head cut indexed, implying active incision in at least a portion of the segment, I assume related to recent flooding. I checked the original field notes which indicate two steep riffles, no head cuts. I suspect that I made an error selecting the subimpact during feature indexing. FIT file has been updated, and DMS corrected. Do you think the cut is likely to keep moving upstream? (Not applicable). Given the steep riffle, bars, and flood chutes, which process is more predominant on this segment—degradation or aggradation? Based on qualitative observations and limited metrics from one snap shot in time, I suspect that current adjustment processes are dominated by planform adjustment, driven in part by aggradation, overprinted on historic incision processes. There are only 2 steep riffles, bars are mostly point and side (only 1 MCB); flood chutes are not uncommon in a steep-gradient channel (estimate 2.2%).
  SP: I am still seeing a head cut in DMS for this segment. I don't have the corrected FIT file. Can you check in case there is an error with FIT/DMS transfer? FIT file corrected and uploaded to DMS.

M41T6.02S1.02C

- What is "other" channel constriction? Lower dam or stone mill foundation? Please enter description in step 5 notes. Yes, the lower breached dam near the upper extent of the reach (this is a second dam, not the breached dam that previously controlled the level of Reading Pond). Note entered in DMS.
- Why did you choose N/A for riffle spacing if reference stream type (and subdominant existing type) is riffle-pool? Riffle spacing was on average 220 ft; N/A replaced with this value in the DMS. Is change in bed form related to recent dam failure/flooding, or do you think it could be from historical channel evolution processes in general? It could be both; as I have data from only one snap-shot in time (post June 2006), it is not possible to state with certainty. Historic incision in downstream segment B suggests that historic incision could be present in segment C – overprinted by more recent incision resulting from dam breaching. If there are any riffles, measure the distance between them; if you forgot to evaluate riffle spacing, then enter Not Evaluated in DMS. Add notes to DMS as needed.

References:

Phillips, Jonathan D., 2002, Geomorphic impacts of flash flooding in a forested headwater basin. *Journal of Hydrology* 269: 236-250.

Faustini, John M. and Julia A. Jones, 2003), Influence of large woody debris on channel morphology and dynamics in steep, boulder-rich mountain streams, western Cascades, Oregon. *Geomorphology* 51: 187-205.

APPENDIX D

Reach Segmentation

Table D-1
Segmentation of Patch & Buffalo Brook reaches, 2009 Assessments

Reach	Segment	Feature	Point	Total Reach Length (ft)	Segment Lengths (ft)	Elevation (ft)	Segment Slopes	Reach Slope
M40T5.04		d/s end reach				1740		
	A	segment break	A/B		623	1742	0.3%	
	B	segment break	B/C		2,427	1791	2.0%	
	C	segment break	C/D		2,297	1880	3.9%	
	D	segment break	D/E		851	1919	4.6%	
	E	u/s end reach		10,776	4,578	2362	9.7%	5.8%
M40T5.03		d/s end reach				1265		
	A	segment break	A/B		1,856	1360	5.1%	
	B	u/s end reach		9,479	7,623	1740	5.0%	5.0%
M40T5.02		d/s end reach				1200		
	A	segment break	A/B		1,240	1240	3.2%	
	B	u/s end reach		2,111	871	1265	2.9%	3.1%
M40T5.01		d/s end reach				1060		
	A	segment break	A/B		397	1070	2.5%	
	B	segment break	B/C		764	1095	3.3%	
	C	segment break	C/D		1,449	1150	3.8%	
	D	u/s end reach		3,992	1,382	1200	3.6%	3.5%
M41T6.02S1.02		d/s end reach				1680		
	A	segment break	A/B		505	1700	4.0%	
	B	segment break	B/C		1,360	1730	2.2%	
	C	u/s end reach		2,630	765	1756	3.4%	2.9%
M41T6.02S1.01		d/s end reach				1260		
	A	segment break	A/B		5,564	1500	4.3%	
	B	u/s end reach		8,938	3,374	1680	5.3%	4.7%
M41T6.05		d/s end reach				1350		
	A	segment break	A/B		2,458	1460	4.5%	
	B	u/s end reach		3,964	1,506	1580	8.0%	5.8%
M41T6.02		d/s end reach				1095		
	A	segment break	A/B		1,556	1150	3.5%	
	B	u/s end reach		6,639	5,083	1260	2.2%	2.5%
M41T6.01		d/s end reach				1061		
	A	segment break	A/B		1,361	1080	1.4%	
	B	u/s end reach		2,010	649	1095	2.3%	1.7%

APPENDIX E

Reach Summaries

TABLE OF CONTENTS

E.1 Patch Brook watershed

M40T5.04

M40T5.04 is a 2.0-mile reach of Patch Brook extending through the Calvin Coolidge State Forest from the headwaters near Salt Ash Mountain downstream to the vicinity of Lake Ninevah. The area is generally covered by soils of glacial till origin. A few isolated deposits of glacio-fluvial sediments are also dispersed throughout the subwatershed, and have been historically excavated. Observed gravel pits were elevated above the Patch Brook channel along the valley walls. Hydric soils of alluvial origin are present in a locally wide valley south of Patch Brook Road near the downstream end of the reach. Wetlands are mapped by NWI associated with these alluvial sediments. Bedrock is exposed along the stream bed near the downstream end of the reach above the wetlands. A relatively large tributary drains the southwestern half of the M40T5.04 subwatershed, flows through the wetlands south of Patch Brook Road and joins the Patch Brook approximately 560 feet northwest of the downstream reach break.

Reach M40T5.04 was segmented to capture the natural variation in valley confinement, gradient, and bed substrates with distance downstream that defined distinct subreaches of alternate stream type (see also Figure x).

Segment	Length (ft)	Approx Gradient (%)	Stream Type	Notes
M40T5.04-E	4,578	9.7	B4a-casc	
M40T5.04-D	851	4.6	C4a-R/P	Subreach
M40T5.04-C	2,297	3.9	C4b-S/P	Subreach
M40T5.04-B	2,427	2.0	C4- R/P	Subreach
M40T5.04-A	623	0.3	N/A - Wetland	Not Assessed

Generally the river channel as depicted on the VHD does not match up well with the actual planform (as measured with the GPS on assessment dates 9/3/2009 and 9/11/2009). The channel is actually more sinuous than that depicted by the VHD. In addition, the roads depicted by Trans_RDS and Emergency_RDS shape file coverage obtained from VCGI diverge from the actual path of the gravel forest roads visible on the 1994 orthophotos and as measured with the GPS on the assessment dates.

The channel passes through soils of glacial till origin. There are a few pockets of glacio-fluvial sediments mapped along the west side of the channel, where historic sand and gravel extraction activities are evident. Near the downstream end of the reach the Patch Brook crosses Patch Brook Road to join a broad valley of alluvial sediments. In this location, south of Patch Road, the Patch Brook is dominated by wetland conditions: a multi-thread channel in hydric soils mapped as wetlands (NWI, VSWI).

History of forest clearing, and Class 4 roads cross the watershed draining to reach M40T5.01. The watershed is predominantly forested, with a few remaining gravel roads including the Unknown Soldier Road (TH-48) which crosses the channel mid-segment over a narrow timber bridge on stone abutments. Additional trails (former logging roads) cross the channel above this bridge (indexed as fords)

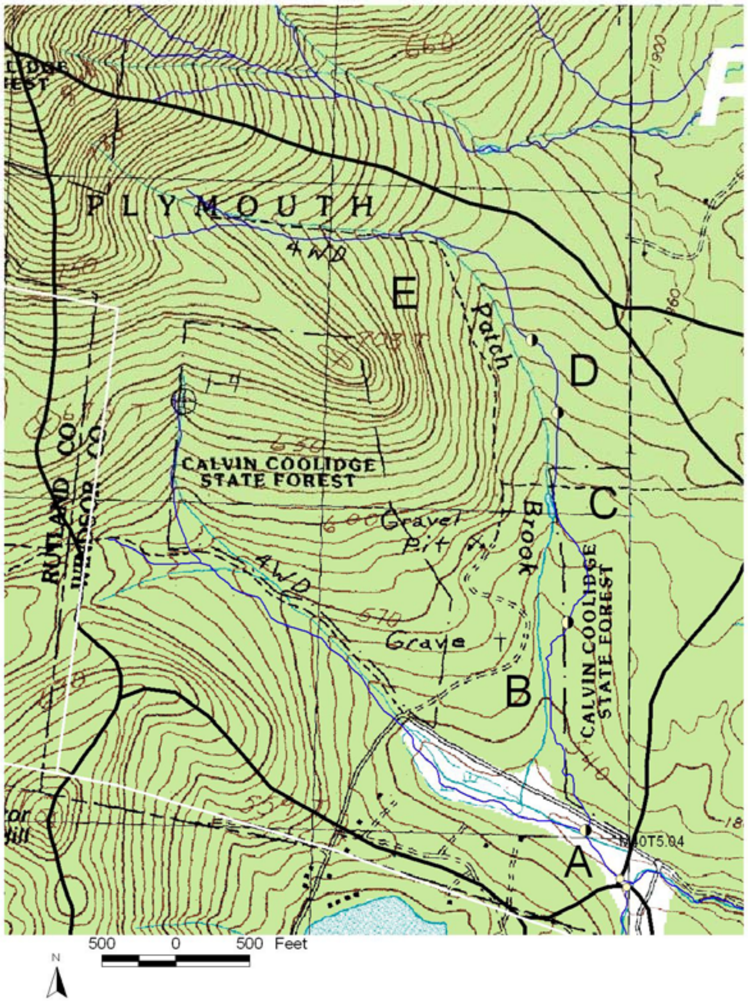


Figure 1. Segmentation of Reach M40T5.04, Patch Brook.

Segment E

Segment E at the upstream end of Patch Brook reach M40T5.04 is a steep-gradient boulder and cobble cascade channel with some sections of step/pool bedform – formed by a combination of colluvial and fluvial processes.

Generally, there are minimal current encroachments. The Unknown Soldier Road (TH-48) crosses the channel mid-segment over a narrow timber bridge on stone abutments. Stormwater inputs were indexed at this bridge location, due to overland runoff of road sediment to the channel. Additional trails (former logging roads) cross the channel above this bridge (indexed as fords)

The segment cross section confirmed the reference stream type of Ba-step/pool. Bed substrates are comprised of well-graded sediments ranging from silt (in the banks) to boulders. It is likely that the largest clasts are not mobile in most flows, and are of glacial rather than fluvial origin. Several glacial erratic boulders were observed along the channel margins. Evidence of recent blowdowns. Active recruitment of large woody debris; frequent debris jams. Occasional mid-channel bars, and flood chutes forced at debris jams. Few bifurcated sections of channel around tree covered islands. – not unusual for a steep, forested channel.

There is good channel connection to a semi-confined floodplain (IR_{RAF} = 1.0). Minor localized widening (mid-channel bars); minor planform adjustment (bifurcations, flood chutes). Lateral and vertical adjustments are probably moderated by the dense, young-growth forest cover, and erosion resistance of glacial till parent material in the bed and banks of the channel.

Figure 2. View upstream, M40T5.04 Segment E, Patch Brook; 3 September 2009.

Segment D

Segment D is a subreach of somewhat lesser gradient in an unconfined setting, with typical valley widths ranging from 100 feet to more than 200 feet. Good floodplain connection. Like the upstream segment E, bed substrates are dominated by very coarse gravels, but Segment D is characterized by fewer boulders and more cobbles. Minor aggradation and planform adjustment (mid-channel bars, point and side bars, one flood chute). A natural reduction in valley confinement and gradient (from approximately 10% in Segment E to 4.4% in Segment D) may be contributing to the minor degree of aggradation and planform adjustment. Lateral and vertical adjustments are probably moderated by the dense, young-growth forest cover, and erosion resistance of glacial till parent material in the bed and banks of the channel. Also, limited degree of sediment from upstream sources. Lots of LWD recruitment and a frequent spacing of channel-spanning debris jams. Woody material contributes to pool formation. Generally closed canopy – offering shading and ample organic material and detritus.

Figure 3. View downstream, M40T5.04 Segment D, Patch Brook; 3 September 2009

Segment C

Segment C is a subreach of slightly lesser gradient than upstream Segment D, but located in a Semi-confined to Narrow confinement setting. Valley walls are comprised of terraces ranging in height from 5 to 7 feet (or approximately 3 to 5 times the thalweg height). The valley defined by these terraces ranges in width from 15 to 80 feet. Low-bank heights along the channel ranged from approximately 1.2 to 1.7 times the thalweg height. Incision appeared historic in nature. The channel bed includes a range of substrate sizes from coarse sand to subangular boulders, but is dominated by very coarse gravels. It is likely that the largest cobbles and boulders are not mobile during bankfull flows, and reflect the glacial till parent material. Where the channel occasionally impinges on the adjacent terrace side slopes, erosion reveals a mix of substrate sizes.

Young-growth forest surrounds the channel. Generally closed canopy. Lots of LWD recruitment and a frequent spacing of channel-spanning debris jams. Large woody debris contributes to pool formation.

Within Segment C is a small flow diversion consisting of a 4-inch black flex hose leading from the channel to a nearby impoundment. The intake in the channel is a PVC pipe connected by a Fernco fitting to a flexible hose. The hose was traced through the woods to a narrow pond impounded by a horse-shoe shaped earthen dam approximately 8 feet high and 270 feet long. A culvert was located at the downstream end of the pond and apparently drains the pond. A concrete pad at the culvert inlet at the top side of the earthen dam is marked with the date "1979". Matted vegetation patterns indicated that the pond had overtopped the dam crest in a few locations east of the culvert outlet, in days prior to the assessment date. The exact outlet location of the culvert could not be located, although seepage was evident at the base of the dam along a majority of its length. A return channel joins the main Patch Brook channel approximately 650 feet downstream of the intake location.

Access to the pond is provided by the Catamount Trail which leads east from the Unknown Soldier Road located approximately 400 feet west of the pond. A small clearing surrounds the pond, which is approximately one-third of an acre in size. While the VHD indicates that Patch Brook flows through this pond, actual conditions on the ground indicate that the Patch Brook flows alongside the pond between 100 and 150 feet to the east (and 5 to 15 feet lower in elevation). This pond is visible on the 1994 orthophotograph of the region and the 1986 Wallingford, VT USGS topographic map, but was not specifically noted on the 1955 or 1893 Wallingford, VT USGS topographic maps.

Figure 4. Impoundment west of Patch Brook reach M40T5.04 Segment C, Patch Brook; 3 September 2009. (a) view upstream (north) from dam; (b) view south to culvert outlet.

Figure 5. View upstream, M40T5.04 Segment C, Patch Brook; 11 September 2009

Segment B

Segment B is a subreach of still lesser gradient (< 2%) than upstream Segment C, located in an unconfined, generally Narrow to Broad valley setting. Valley walls are comprised of terraces ranging in height from 4 to 10 feet (or approximately 2.5 to 6 times the thalweg height). The valley defined by these terraces ranges in width from 45 to more than 250 feet. Low-bank heights along the channel were generally less than in upstream Segment C, ranging from approximately 1.2 to 1.6 times the thalweg height. Incision appeared historic in nature. In contrast to upstream segments, the channel bed was dominated by fine to medium gravels, with the occasional cobble or boulder.

Near the downstream end of the segment was a short section of moderately-steep, narrowly-confined bedrock gorge. This section of B2-step/pool channel underlain by bedrock was indexed as a vertical grade control, but was not segmented due to its short overall length (less than 75 feet). A second occurrence of low-profile, channel-spanning bedrock was observed approximately 600 feet downstream from this gorge. Between the bedrock outcroppings was a short, linear section of channel confined between a left-bank terrace with a thalweg height of approximately 7 feet and a right-bank terrace approx 15 feet above the thalweg. The channel had access to a narrow floodplain approximately 20 to 30 feet wide between these two terraces. A cross section measured here (XS-1) indicated an incision ratio of 1.3 and an entrenchment ratio of 1.8. This gravel-dominated Bc-riffle/pool channel was not characteristic of the segment as a whole, but was not segmented due to its very short length. The linear nature of the channel and its unusual setting suggested historic channel modifications - possibly associated with the history of iron ore mining in the region. Proximity to the upstream bedrock gorge suggests possible mill dam operations. A black smith shop and saw mill were noted in the vicinity on the 1869 Beers Atlas of Windsor County (near the Patch Brook Road crossing). Today, a residence is located at the top of the right-bank terrace in vicinity of this short, linear section of channel.

Young-growth forest surrounds the channel in Segment B. Generally closed canopy. Lots of LWD recruitment and a frequent spacing of channel-spanning debris jams. Entrained woody material contributes to pool formation.

Figure 6. View downstream, M40T5.04 Segment B, Patch Brook; 11 September 2009

At the downstream end of the Segment, Patch Brook flows through a culvert under the Patch Brook Road. This instream culvert is a bankfull constrictor (approx. 24% of the measured bankfull width). The 1986 topographic map and 1955 topographic map seem to depict the crossing of Patch Brook Road at a location approximately 750 feet to the west of the current location, which would suggest a possible relocation of the channel.

Segment A

Segment A of Patch Brook reach M40T5.04 is the downstream-most 623 feet of the reach, located south of Patch Brook Road in an unconfined valley setting dominated by wetland conditions. Beaver activity was evident in the segment. There is a slight reduction in valley width due to the encroachment of Patch Brook Road along the left bank corridor. However, valley type (Very Broad) and confinement status (Unconfined) remain unchanged. Consistent with protocols, an RGA and RHA were not completed for this wetland-dominated segment.

M40T5.03s1.01 (Tributary to M40T5.03)

This is a short reach (1,221 feet) of river comprising the outlet from Lake Ninevah, a tributary to Patch Brook which joins reach M40T5.03 near the intersection of Patch Road and Townsend Barn Road in southwestern Plymouth. Lake Ninevah is described as a natural pond with an earthen dam that artificially increases the elevation and aerial extent of the lake (VTDEC, 2005). Historically, this pond was identified as "Patch Pond" on the 1893 Wallingford, VT USGS topographic map, and the Spaffic Iron Company ("S.I. Co") reservoir on the 1869 Beers Atlas of Windsor County (at the southern margins of the town of Plymouth). The current dam was reportedly installed in 1930 (VT Dam Inventory) on the approximate site of the former dam (perhaps breached in the 1927 flood).

This moderately-steep (2.2%) channel is Semi- to Narrowly-confined by moderately-sloping valley walls comprised of glacial till. Several large boulders are evident along the channel and on the forested slopes. The outlet joins Patch Brook a quarter of a mile north of Lake Ninevah dam at the downstream end of reach M40T5.04 which is dominated by wetland conditions. The downstream end (~125 feet) of the Lake Ninevah outlet channel is also characterized by wetland conditions and backwater effects from this wetland.

The Townsend Barn Road (which is named Sawyer Hill Rd south of the Plymouth town line in the town of Mount Holly) parallels the Lake Ninevah outlet channel beyond the RB valley wall. Loop Road, a private gravel road, crosses the channel near its mid-point via a timber frame bridge on laid-up-stone foundation. The span of this bridge is undersized with respect to the reference (42%) and measured (44%) bankfull width.

Cross section indicates a B3-step/pool channel surrounded by young growth forest. Pebble count suggests that a fraction of the bed material (the larger cobbles and boulders) are not mobile at bankfull flows. Typically, one might expect some degree of channel incision downstream of an impoundment due to "hungry water" effects (Kondolf, 1997). However, the channel appears to have access to a narrow floodplain ranging between 1 and 1.5 times the channel width. Since the Lake Ninevah was an existing natural impoundment that has been enhanced by the addition of an earthen dam, it is likely that the upstream elevation of this reach may not have changed much. The channel that developed naturally downstream of this post-glacial impoundment offered boundary resistance to the potential incision that might be imparted by enhanced pond elevations from the earthen dam. Just a marginal increase in scour energies downstream of the human-elevated impoundment.

M40T5.03

M40T5.03 is a 1.8-mile reach of Patch Brook that shares a narrow and steep valley with the Patch Brook Road. This reach extends from just upstream of the Townsend Barn Road bridge crossing to the vicinity of the Dublin Road bridge crossing located a quarter mile downstream of the Patch Brook Road intersection.

The natural valley setting is between 1.5 and 3 times the channel width, a Narrowly-Confined to Semi-confined setting. Underlying sediments are mapped as being derived from glacial till parent material (USDA), except for an area of glacio-fluvial sediments near the downstream end of the reach. A bedrock gorge approximately 200 feet in length with a vertical drop between 15 and 20 feet is located approximately 1900 feet upstream of the downstream reach break. Below this short bedrock gorge, the valley setting at this downstream end opens slightly (to a Narrow confinement; i.e., Unconfined) and the valley gradient decreases somewhat. The reach was segmented to capture the change in reference stream type inferred at this downstream end of the reach. Conditions in this downstream Segment A have also departed from reference due to a history of channel and floodplain modifications in response to past flood events.

Segment	Length (ft)	Approx Gradient (%)	Stream Type	Notes
M40T5.03-B	7,623	5.0	B3a-S/P	
M40T5.03-A	1,856	5.1	F3a-PB	Subreach of Ca-S/P w/ Vertical Stream Type Departure

Segment B

Segment B comprises the upstream 7,623 feet of reach M40T5.03. While the very upstream end of the segment has a somewhat wider valley width and lesser gradient (slightly less than 4%), the segment is generally a reference Ba-S/P channel. Over the years, Patch Brook Road has been maintained to encroach within this valley, and is elevated above the brook (cut into the left valley wall) at heights generally ranging from 6 to 15 feet (or 3 to nearly 8 times the bankfull depth of the channel). In one location mid-segment, where the height of the road is approximately 3.5 times the bankfull depth, presence of a short berm (between the road and the channel) and left-bank armoring suggests that the river may have avulsed in a past flood to wash out a section of the Patch Brook Road and temporarily occupy a small floodplain on the far side of the road. Encroachment by the road has resulted in human-modification of the valley width, such that the floodplain is now generally less than two channel widths (i.e., Narrowly-Confined). The natural valley width, prior to the road, was probably not much wider (between 1.5 to 2.5 times the channel width, or Narrowly-Confined to Semi-Confined valley type). No significant change in the reference stream type (Ba-S/P) is inferred as a result of the road encroachment.

Figure 7. View upstream, M40T5.03 Segment B, Patch Brook; 29 October 2009

The Beers Map (1869) shows that the Patch Brook Road once crossed the Patch Brook in two locations just upstream of the Dublin Road intersection. Specific evidence of former crossings or the previous road alignment was not able to be located in the field.

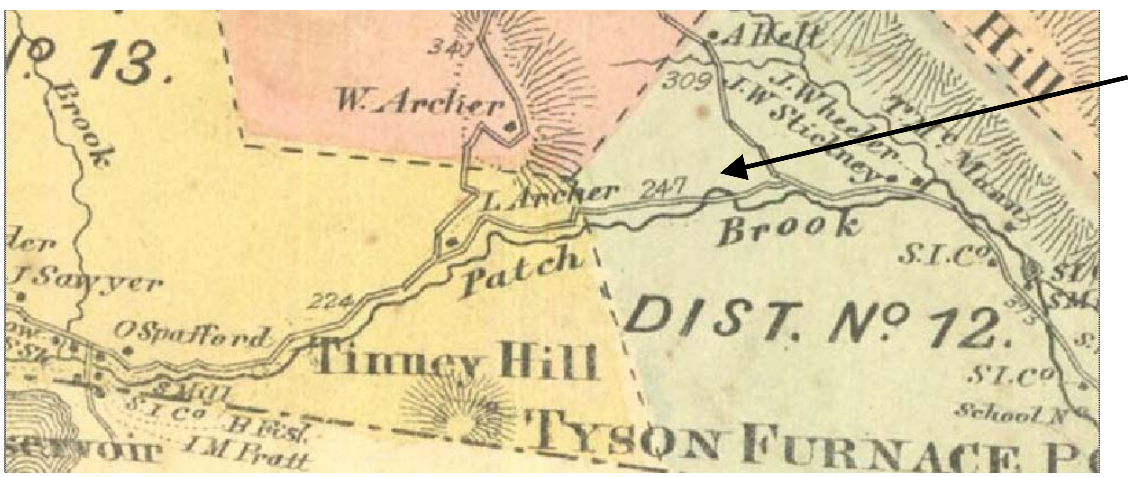


Figure 8. Beers Map (1869) indicates that Patch Brook Road once crossed the Patch Brook in two places.

The present map view of the road is more linear than depicted on this historic map also, suggesting that the road alignment has been somewhat straightened over the years. A few sections of rip-rap armoring were indexed along the reach where the road encroaches on the channel.

Several culverts receive road ditch drainage and small tributary inputs along the uphill (north) side of the road and convey stormwaters under Patch Brook Road directly to the channel. At least 21 cross culverts were indexed, most often 16 or 18 inches in diameter, but a few of 12- to 14-inch diameter and a few 2 feet in diameter. Often fine sand and gravels obstructed culvert inlets and culvert outlets were unstable (no headers). Road sediment was observed directly entering the channel at the outlet of several culverts. A few additional locations of direct sediment runoff by overland flow were indexed along the reach.

Figure 9. Stormwater inputs to Patch Brook, M40T5.03 Segment B, from Patch Brook Road; 29 October 2009. (a) cross culverts without headers are sites of road sediment runoff to the channel; (b) sections of the road are graded to drain directly to the channel.

In the 1980s and early 1990s, there is evidence to suggest that the Patch Brook received increased flows from Lake Ninevah in October of each year, as flashboards were removed at the Lake Ninevah dam to drop lake levels by approximately 3 to 4 feet (for weed management) (VTDEC, 2004). Increased flows would have been sustained in Patch Brook over a one to two-week period. See Section 4.1.1 for further details of the management of the Lake Ninevah dam and lake levels.

Remnants of a possible instream dam were noted near the upstream end of the reach in the vicinity of historic mills depicted on the Beers Atlas (1869). This dam appears to have been breached long ago (perhaps in the 1927 flood or prior events).

Figure 10. Remnants of breached dam at bifurcation in Patch Brook channel. View upstream, M40T5.03 Segment B, Patch Brook; 29 October 2009

Segment A

Segment A of reach M40T5.03 is comprised of the downstream 1,856 feet of the reach from a point just below the short bedrock gorge, along Dublin Road, to just below the Dublin Road bridge crossing. The natural valley width in Segment A is wider than upstream Segment B, suggesting an unconfined reference stream type of Ca-S/P. An alluvial fan was indexed in this segment to capture the marked reduction in natural valley confinement. Sediments of glaciofluvial origin are mapped at this transition point (USDA).

The channel is positioned close to the right valley wall along much of the segment length. Human encroachments along the left bank (Dublin Road and high gravel berms) have reduced the available valley width and led to a stream type departure. Channel straightening with windrowing in the downstream half is inferred due to the linear planform and presence of berms. A residence is located in the RB floodplain at the downstream end of the segment.

A cross section was completed near the mid-point of the segment in vicinity of left-bank berms. This cross section revealed a stream type departure due to encroachment of the berm. The berm was at a height of 8 feet above the thalweg, and constituted a "human-elevated floodplain" yielding an IR_{hef} = 4.2. Due to modifications of the floodplain and berm construction, the location and elevation of the "recently-abandoned floodplain" were not easily discerned. Between the berm and a terrace along Dublin Road there is a low spot at an elevation of 2 feet above the thalweg. It is very possible that this area was excavated in the past to produce gravel and cobble material for construction of the berm. This area may also have been occupied by floodwaters during an avulsion of the channel and may represent a historic flood chute. The terrace to the north of this flood chute along Dublin Road was likely graded at some time during flood recovery efforts and may not represent the natural, abandoned floodplain elevation. Therefore, the IR_{raf} value (of 3.7) may be overstated for this cross section location. Based on quick measurements, low bank heights (RAF) were approximately 2.9 times the measured bankfull depth in locations upstream of the cross section, closer to the short bedrock gorge.

Bed substrates are somewhat finer-grained than upstream Segment B – dominated by small cobbles on the cusp with coarse gravels.

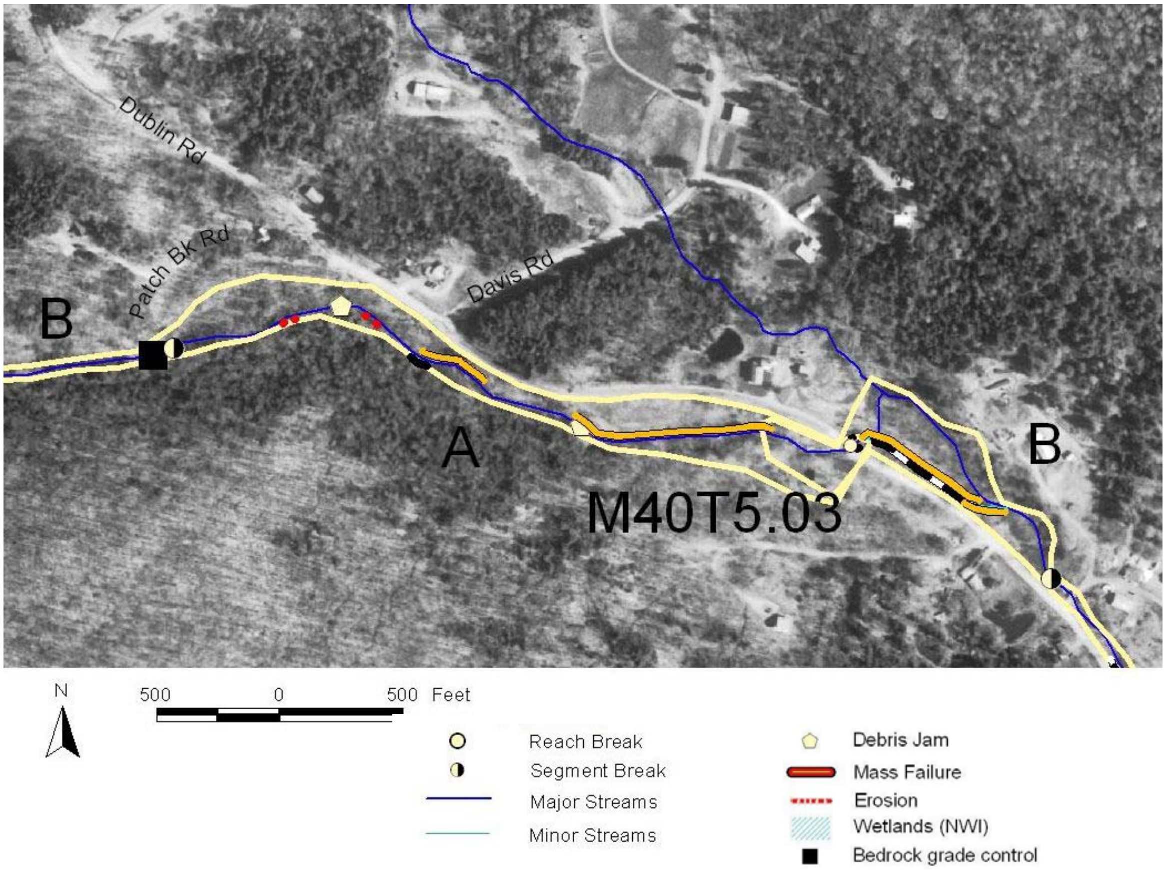


Figure 11. Features encountered along M40T5.03-A and upstream end of M40T5.02 (Segment B), 10 September 2009. (Yellow line indicates human-modified valley wall).

M40T5.02

This reach of Patch Brook extends just over 2,000 feet downstream from the upper Dublin Road bridge crossing, and was segmented to capture a difference in reference stream type in the upper 871 feet above the Tatro Road crossing.

Segment	Length (ft)	Approx Gradient (%)	Stream Type	Notes
M40T5.02-B	871	2.9	F3b-PB	Subreach of reference Cb-S/P that has departed to an Fb-PB
M40T5.02-A	1,240	3.2	B4-S/P	

Segment B

Segment B represents a short subreach of alternate reference stream in an unconfined valley setting. The natural valley width varies from 5 to greater than 10 times the channel width (Narrow to Very

Broad). Historic encroachment of Dublin Road within the RB corridor has reduced the valley width to a degree, to approximately 3 to 7 times the channel width, averaging a Narrow confinement. However, the valley type (Unconfined) has remained unchanged.

Actual channel position does not match VHD (Figure 12). Channel has been straightened along the Dublin Road; windrowing and berming are apparent. A 360-foot long cobble/gravel berm is present along the LB ranging from a thalweg height of 9.7 feet (near the Dublin Road bridge crossing) to 3 feet at its downstream end, where a 4-foot berm is also present along the RB for a short length of 110 feet. This LB berm effectively cuts off the river's access to the floodplain along the LB corridor, resulting in a Cb to F vertical stream type departure. A Human-elevated Floodplain incision ratio (IR_{HEF}) of 4.0 was estimated.

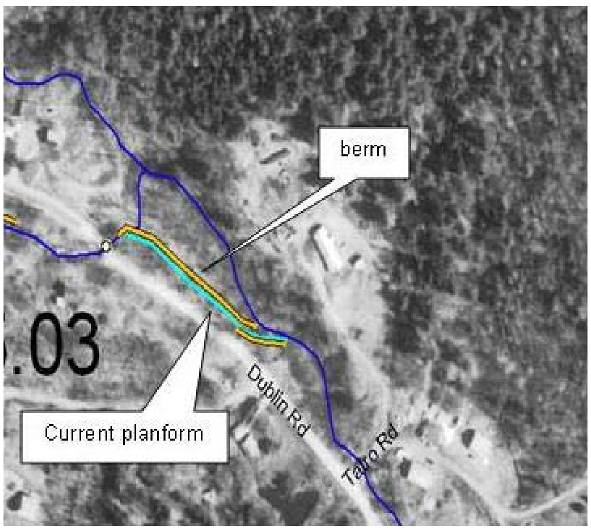


Figure 12. Section of Patch Brook (M40T5.02-B) has been channelized and bermed along Dublin Road.

Segment A

Due to the historic floodplain modifications to accommodate Dublin Road along the RB corridor of reach M40T5.02, the natural valley width of Segment A is somewhat difficult to discern, although it probably averaged between 1.5 and three times the channel width. The channel is confined between moderately-high terraces (mapped as glaciofluvial sediment [USDA]) that range in thalweg height from 7 to 11 feet (or 3 to 4.6 times the bankfull height above the thalweg) along the LB. Along the RB, the Dublin Road comprises the modified (or artificial) valley wall – at a thalweg height ranging between 7.5 and 10.4 feet. Between the road and the channel, there are a few isolated RB terraces, including two narrow terraces at a bankfull elevation near the upstream end of the reach (vegetated side bars), a terrace at a thalweg height of 4 to 5.5 feet at the mid-point of the segment, and a narrow, 6-foot terrace near the downstream end of the segment. These terraces are at approximate heights of 1.2, 2.3, and 2.5 times the bankfull depth, and may represent a more recently-abandoned terrace (resulting from channel incision within the last 250 years) – whereas the higher terraces along LB and RB (at greater than 3 times the bankfull height) likely represent former floodplains abandoned in postglacial times, up to thousands of years before present. Valley widths have been reduced somewhat by the encroachment of the Dublin Road, resulting in a modified valley width that varies between 30 and 75 feet, or 1.1 to 2.7 times the measured bankfull width.

The degree of historic incision versus postglacial incision is uncertain; thus, the reported degree of historic incision may be overstated. At least some degree of historic incision is indicated by the stepped footers on Tatro Road bridge crossing (and upstream Dublin Road crossing), and suggested by the history of straightening and berming. It is also possible that the degree of incision at cross section site for Segment A has been influenced locally by the presence and later breaching of a historic mill dam. In the field, remnants of an apparent stone wall / earthen dam were visible on both sides of the channel near the downstream end of Segment A. The Beers Atlas (1869) shows a small mill pond associated with an "S. I. & Co." saw mill in this approximate position. This former dam was associated with the Tyson Furnace and a diversion channel constructed to support the iron furnace operations and other industries in the hamlet of Tyson Furnace (see descriptions under M40T5.01). On the 1929 USGS topographic map, there is no evidence of a mill pond, suggesting that it was abandoned sometime between 1869 and 1929 (possibly washed out in the 1927 flood).

M40T5.01

Reach M40T5.01 is the downstream-most reach of Patch Brook extending 3,992 feet upstream from the confluence with the Black River. The reach is underlain by sediments of glaciofluvial origin. A decrease in gradient as well as valley confinement is evident near the confluence.

As visible on an 1859 map of the town of Plymouth, the Patch Brook confluence with the Black River was historically located approximately 50 yards south of its current position. The channel was reportedly diverted to its current position in 1929 following the 1927 flood (Jefferies, 2009).

Commercial and residential developments are evident near the downstream end of the reach, including the Echo Lake Inn, Tyson Library, and a church. These buildings are located in the historic hamlet of Tyson Furnace. An iron works was established in this vicinity circa 1837 by Isaac Tyson, Jr. This industrial center flourished for nearly 20 years, and produced a variety of products including farming implements, water pipes, and stoves (VT Historical Society, 2009; Thompson, 1842). The iron works were closed in 1855, but later re-opened during the Civil War and produced "iron for the building of the Monitor class gunboats" (Duffy et al, 2003). Following the war until 1872, the iron works were operated by Spathic Iron Company (Hartford, CT) for the production of steel cutlery (Duffy et al, 2003).

Evidence of a historic flow diversion site along Patch Brook was revealed from a review of the 1859 Map of the Town of Plymouth (Scott, Stickney, & Pollard, publishers), supported by field observations. Near the upper end of the reach (just downstream of the former mill dam in segment M40T5.02-A), a small bypass channel has been constructed historically to convey a portion of the flow from Patch Brook to a culvert under Dublin Road and into a constructed channel that flows somewhat parallel to Patch Brook, but on the far side of residential homes to the west of Dublin Road. This "canal", as it is known locally, returns to the Patch Brook approximately 3,000 feet downstream, below the Dublin Road bridge. This diversion channel was constructed historically to support operations at Tyson Furnace (Scott, Stickney, & Pollard, 1859). On the Beers Map (1869), this diversion channel originates at the downstream end of the small mill pond operated by the Spaffic Iron Company.

Near the downstream end of the reach, Patch Brook is crossed by Library Road and VT Route 100. Based on historic topographic maps, sometime between 1932 and 1983, the alignment of Route 100 was straightened, resulting in a shift in the bridge crossing site over Patch Brook. The bridge and culvert database maintained by VTrans suggests that this bridge was constructed in 1936.

Reach M40T5.01 was segmented to capture a difference in reference stream type at the lower end of the reach and to identify segments with differing dominant adjustment processes.

Segment	Length (ft)	Approx Gradient (%)	Stream Type	Notes
M40T5.01-D	1,382	3.6	F3b-PB	Vertical stream type departure from reference C3b-S/P
M40T5.01-C	1,449	3.8	C3b-PB	
M40T5.01-B	764	3.3	F3b-PB	Subreach of reference Cb-S/P that has departed to an Fb-PB
M40T5.01-A	397	2.5	C3b-PB	Subreach of reference Cb-R/P

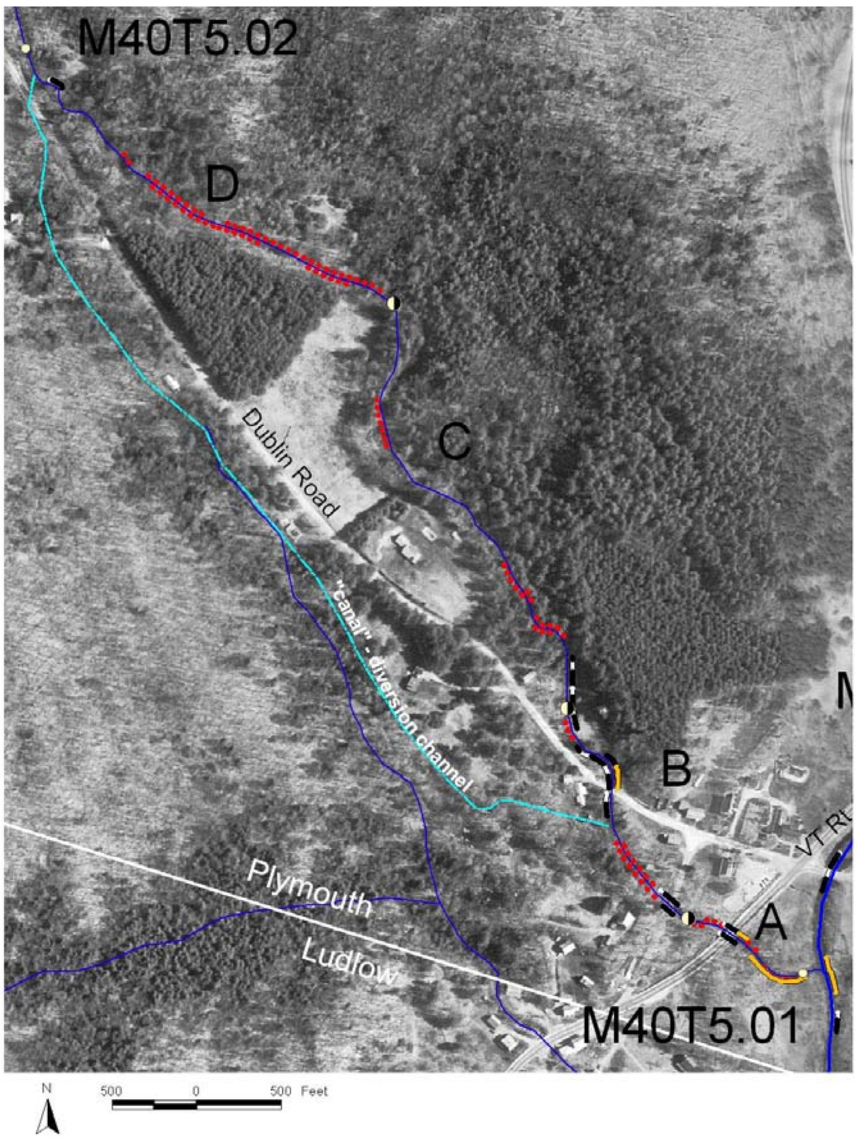


Figure 13. Diversion channel leading from the upstream end of reach M40T5.01 under Dublin Road, to the west of residential homes, and returning to the Patch Brook channel downstream of the DublinRoad bridge crossing.

Segment D

The uppermost 1,382 feet of the reach flows within a Semi-confined valley in a young-growth forested area, east of the Dublin Road. Generally, valley walls are comprised of coarse-grained glaciofluvial terraces between 2 and 4 times the channel width, and ranging in height from a thalweg height of 10 to 12 feet, or 5 to 6 times the thalweg depth of the channel.

Straightening of the channel is apparent from the linear planform with abandoned meanders on either side of the straightened channel. Given the nature of detritus and vegetation that has accumulated in these abandoned channel meanders, it is apparent that channelization is historic in nature. The straightened channel section appears to have undergone some historic incision, exposing tree roots along both banks, which have weathered to some degree.

Near the upper end of the segment, a small bypass channel has been constructed historically to convey a portion of the flow from Patch Brook to a culvert under Dublin Road and into a constructed channel that flows somewhat parallel to Patch Brook, but on the far side of residential homes to the west of Dublin Road. This "canal", as it is known locally, returns to the Patch Brook approximately 3,000 feet downstream in Segment B.

Historic incision and historic planform adjustment (straightening) are inferred. Hhistoric incision may have developed in response to historic channelization and/or channel management in response to the large flood events of 1927 or 1973. Historic incision may also have been associated with the historic mill dam operations, and/or water withdrawals to the canal. The channel is inferred to be persisting in early stage III of channel evolution, with widening moderated by the coarseness of the bed and bank material of glaciofluvial origin and the well-developed, though young-growth, forested buffers. Historic straightening of the channel has enhanced the natural transport function of this semi-confined channel with relatively steep valley gradient. There is little evidence of aggradation.

Figure 14. View upstream, M40T5.01 Segment D, Patch Brook; 10 September 2009

Segment C

Segment C of M40T5.01 is 1,449 feet long. The channel has a more natural planform and slightly more relaxed valley confinement in Segment C, as compared to upstream Segment D. Moderately high terraces (6 to 8 feet thalweg height) and a set of much higher terraces (15 to 25 feet high) along the RB comprised of glaciofluvial sediments define a natural valley width that ranges between 80 and 130 feet wide, or 2.9 to 4.6 times the channel width.

Presence of active flood chutes, and channel bifurcations around tree islands is more prevalent. Despite the steep gradient, a few signs of localized aggradation were noted, including a point bar and side bar. Evidence of breached debris jams and one intact debris jam was also noted, suggesting active recruitment of LWD. The channel has a degree of connection to a narrow floodplain in select locations.

The cross section for Segment C captured a flood chute and reflected the higher width/depth ratio and greater degree of floodplain connection that is characteristic of the segment. Bed and bank sediments are generally somewhat smaller in size than upstream segment D, but cobble is still the dominant grain size. Generally, a plane bed form, with weak step/pool form developing.

Figure 15. View upstream, M40T5.01 Segment C, Patch Brook; 10 September 2009

Segment B

Within the lower end of reach M40T5.01, Patch Brook transitions to a valley setting of more relaxed confinement and slightly lesser gradient on approach to the broader Black River valley and its confluence with the main stem of Black River between Echo Lake (upstream) and Round Pond of Lake Rescue (downstream). This segment was indexed as an "alluvial fan" in accordance with protocols to capture the change in valley setting, although surficial geologic studies to confirm the presence or absence of a true alluvial fan deposit are beyond the scope of this study.

Over the years, with development of the hamlet of Tyson, several encroachments occurred along the river. Dublin Road has been elevated above the floodplain and now forms a berm along the RB of the channel upstream of the crossing and in the LB corridor downstream of the crossing. This Dublin Road crossing reportedly was washed out in the 1973 flood (according to a nearby landowner), and a large cobble / earthen berm is now present along the LB of the channel at a thalweg height of 12.5 feet on the upstream approach to this Dublin Road bridge. Stepped footers of the LB abutment supporting this bridge are being scoured by the channel. The span of this bridge (29 ft) is undersized (87%) with respect to the measured bankfull width (33.3 ft).

Downstream of the Dublin Road crossing, the channel is entrenched and incised below high banks on both sides. The "canal" rejoins the Patch Brook approximately 85 feet downstream of the bridge, and a short distance further downstream, the river joins a high terrace along the RB. The LB corridor has a long history of development including the former Tyson Furnace. Fill material likely encroaches along the LB in vicinity of the present day Tyson Library building. A laid-up stone wall reinforces the LB on approach to Library Road bridge crossing. The 16-foot span between stone wall abutments of this bridge is undersized (48%, 57%, respectively) compared to the measured bankfull width (33.3 feet) and reference bankfull width (28 ft) of this channel.

A cross section was completed approximately 175 feet upstream of the Library Road bridge. If the terrace immediately adjacent to the channel on the LB is considered the Recently Abandoned Floodplain, an incision ratio of 3.7 is calculated. The degree of actual incision may be overstated (although there is a long history of extensive floodplain and channel modifications in this vicinity). It is likely that the current vertical displacement of the channel from the LB floodplain results from a combination of historic incision (associated with channelization, and possibly dredging) and historic encroachments involving fill, regrading of the floodplain, road building and berms. More recently, this area has probably been modified and regraded during flood response activities following the 1973 and 1927 floods, at a minimum.

Figure 16. View downstream to Library Road bridge, M40T5.01 Segment B, Patch Brook; 10 September 2009

Segment A

Segment A comprises the downstream 397 feet of the reach, from just below the Library Road bridge to the confluence with Black River. Like upstream Segment B, this segment of Patch Brook is located at a locally wider valley setting with slightly lesser gradient. It is a natural place for the channel to shift laterally and deposit sediment. Historic encroachments of the Dublin Road to the north have somewhat limited the valley width, and fill material for the VT Route 100 crossing has locally constricted the channel.

Today, although the channel appears moderately incised below the floodplain, the brook occasionally jumps its banks to flow out on the floodplain. The landowner downstream of VT Route 100 has managed the channel and floodplain over the years, placing berms along the RB to prevent the channel from flowing out onto a cleared area. The present channel appears a bit undersized for the given drainage area (narrower than expected width/depth ratio and smaller cross sectional area).

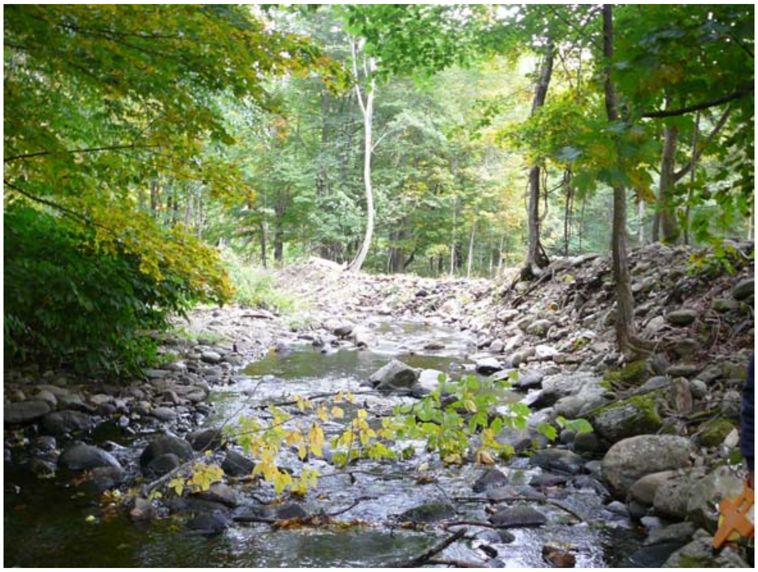


*Figure 17.
View downstream from cross section site to right-bank berms, M40T5.01 Segment A, Patch Brook;
18 September 2009.*

E.2 Black River main stem

M40

Slight reduction in valley width due to Vt Rt 100 along RB, driveway along LB corridor. Valley type (Broad confinement) and status (unconfined) remain unchanged. Reach receives Patch Brook as RB tributary. Position of confluence was reportedly altered over the years (see description under M40T5.01). Kingdom Road crosses the reach via a bankfull-constricting bridge. Former bridge in this position was washed out in the 1927 flood (Ward, 1983). Two discrete sections of berms along LB enhance the degree of channel entrenchment and cut off portions of the floodplain. One short section located near the Patch Brook confluence (Patch Bk itself is bermed just upstream of the confluence; sediment "delta" protrudes from Patch Brook). Second longer, higher berm is located spanning Tiny Brook confluence. Upstream flow regulation = run-of-river dam at Amherst Lake (reach M42, ~1 mile upstream). Downstream flow regulation = run-of-river dam at Lake Rescue (reach M39, ~1.1 mile downstream. Reach M40 flows into Round Pond, a small embayment at the north end of Lake Rescue where a large sediment delta has formed over recent decades. Historic straightening and dredging of M40 is inferred due to linear planform and presence of berms. Also anecdotal evidence indicates channel and floodplain management following flood events of 1973 and 1927.

E.3 Buffalo Brook

M41T6.06

Reach M41T6.06 is 2,415 feet long and represents the upstream–most reach of this tributary to Echo Lake. It drains downslope to the southeast from a gravel forest road beginning at a point approximately 0.44 mile west of the terminus of Reading Pond Road.

The channel is confined between extremely-steep (>25%) bedrock-controlled valley walls. Generally, the valley is between 2 and 4 times the channel width, although occasionally a bit wider, and marked by two main occurrences of steeper-gradient Narrowly-confined bedrock cascade channel. The reach as a whole was classified as a bedrock gorge according to protocols; thus, exempted from the Rapid Geomorphic Assessment. A provisional stream type of B1a-cascade was assigned, although there are short sections of A or Ca stream type, and sections of step/pool rather than cascading bedform with a boulder/cobble veneer over bedrock.

The area surrounding reach M41T6.06 is forested with relatively new-growth deciduous forest. Available historic documents indicate that the area was deforested during the mid-1800s for support of the lumber industry, and possibly to provide charcoal for the nearby Tyson Furnace. There is also a history of gold placer mining in the area.

A forest road (and VAST trail) leads west from the terminus of Reading Pond Road and crosses the reach near the upstream end, approximately 0.4 mile west from the junction. This culvert (3.9 ft wide) is 49% of the reference bankfull width (8 ft) for the channel. The structure invert is perched approximately 2 feet above the channel bed (Figure 18).

Figure 18. View upstream through culvert under forest road at upstream end of reach M41T6.06, Buffalo Brook, 22 October 2009

Three fords were noted in the reach associated with minimally used former logging roads or skidder trails. At one location near the downstream end of the reach, an apparent breached earthen dam was noted – possibly associated with former gold placer mining. Recreational-scale gold mining equipment (bucket, tubing) was noted near a bedrock falls at the upper end of the reach.

M41T6.05

Reach M41T6.05 is a 3,964 feet long. It has been segmented to capture an upstream subreach of steep, narrowly-confined bedrock channel (i..e., "bedrock gorge").

Segment B

The segment has a short section (250 feet long) of C4b-riffle/pool channel at very upstream end in vicinity of tributary confluence, which was too short to segment. Channel quickly transitions from the confluence area to the bedrock gorge.

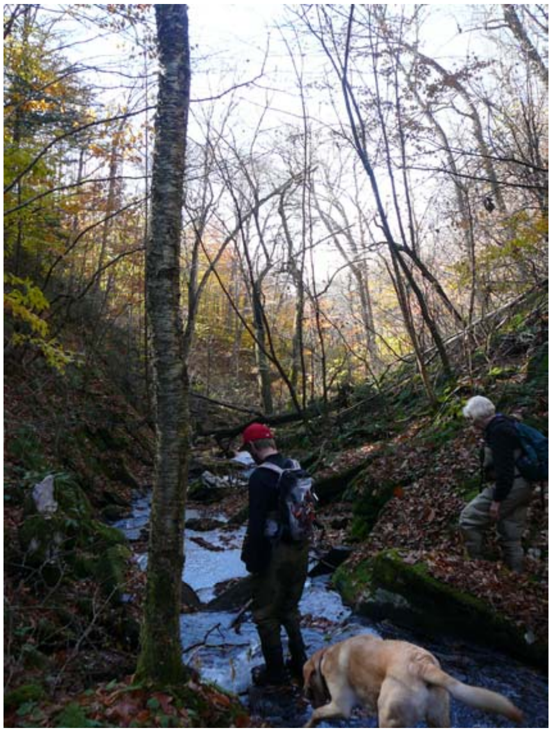


Figure 19. View downstream Segment B, reach M41T6.05, Buffalo Brook, 22 October 2009

Segment A

Slightly lesser gradient and wider valley confinement (2 to 4 times channel width) in Segment A has allowed for an occasional terrace along either side of the channel. Stream bed material is comprised of a wide range of sediment sizes from gravel to boulder, dominated by coarse gravels. Sediments are generally deposited in a shallow veneer over bedrock. Bedrock was observed exposed in the channel in several locations, including three channel-spanning ledges or waterfalls. Bedrock was occasionally exposed along the valley walls. Channel appears partly incised (historically, or post-glacially) below the occasional stream terrace.

In the lower 1300 ft of the segment, an old forest road (gravel) joins the stream valley. The road appears to have been installed at grade on occasional terraces and along the base of the valley wall to either side of the channel. The road height above the channel varies but averages 2.5 feet above the thalweg. No evidence of bridge or culvert crossings was observed, and the road is inferred to have originally crossed the river channel via fords. At least three current ford crossings were located. Over the years, the river appears to have avulsed to flow in the path of the road. In some locations evidence of the road has been eroded away. In other locations the former road grade has been eroded to form a flood chute (Figure 20). Where the road bed is elevated to a position along the right- or left-valley wall, the road segments are intact.

Figure 20. View downstream, river crossing old road bed, which now functions as a flood chute during higher-flow conditions upstream of the crossing, Segment A, reach M41T6.05, Buffalo Brook, 22 October 2009

M41T6.04

Reach M41T6.04 has a slightly lesser gradient (3.4%), but similar valley confinement (predominantly Semi-Confined) to upstream segment M41T6.05-A. As with upstream reach, a gravel road follows the channel in this reach. Often, the road has been cut into the valley wall. In other cases, it follows a discontinuous terrace at grade; occasionally, the road appears to have been excavated below the terrace level (for example, at cross section location). Three road crossings were indexed within the reach. There was evidence of concentrated runoff eroding sections of the road on approach to a crossing. Some sections of the old road serve as flood chutes during high flows. The former road grade serves to concentrate stormwater runoff and convey it to the river channel at locations of flood chute returns or channel crossings.

At the downstream end of the reach, the road segment has been eroded to function as an active part of a bifurcated channel that extends into the next downstream reach. Several tributaries join the channel in this reach. Roads were observed along the banks of two of the larger tributaries. These road networks may be associated with previous logging activity and /or gold placer mining.

In contrast to the upstream segment, reach M41T6.04 appears to have good floodplain connection. A B3-step/pool channel was assigned, consistent with reference stream type.

Figure 21. View downstream, old road bed follows the channel, crossing three times within the reach, with most traces eroded in a bifurcation of the channel near the downstream end of the reach, M41T6.04, Buffalo Brook, 22 October 2009

M41T6.03

This 807-foot reach was separately delineated due to the change in valley setting in the vicinity of the confluence with Reading Pond Brook. At the downstream end of reach T6.03, the Buffalo Brook has a drainage area of 1.9 square miles, and it receives the Reading Pond Brook with an upstream drainage area of 2.9 square miles. It is a short reach exhibiting a significant decrease in valley gradient – transitioning from 5.8% in T6.05 and 3.4% in T6.04 to 2.5% in reach T6.03. A change in valley confinement is also notable within this reach, as the valley transitions from Semi-Confined to Broad in vicinity of the confluence of Reading Pond Brook, whereupon the valley quickly becomes Semi-confined once again in downstream reach M41T6.02. This general location was indexed as an "alluvial fan" following protocols to capture the marked decrease in valley gradient and valley confinement – although geologic investigations to confirm the origin and nature of sediments comprising this feature as a true alluvial fan, were beyond the scope of this study. Soils in the corridor surrounding T6.03 have a glacio-fluvial parent material in contrast to upstream and downstream reaches which pass through soils of glacial till origin (USDA).

The channel follows the right valley wall, where bedrock is occasionally exposed. The channel appears historically (or post-glacially) incised below a discontinuous RB terrace which ranges in height from 1.4 to 2.5 times the maximum depth of the channel. And the channel is entrenched below a higher LB terrace approximately 4 to 5 times the max depth. This LB terrace represents a relatively broad level surface between two steep, bedrock-controlled valley walls. These valley walls range in width from 55 ft near the upstream end to 270 feet near the downstream end, with an average of 160 ft. Forested vegetation is sparse on this surface. Old road networks appear to cross the surface, which may have served as a historic logging landing, or staging area for gold mining operations in the late 1800s.

It is possible that historic incision in this reach has been induced by incision occurring in Reading Pond Brook (upstream of the confluence) and the remainder of Buffalo Brook downstream of reach T6.03. Given the history of gold mining in the area, it is possible that dredging occurred in this reach in the late 1800s, leading to possible incision. Headward migration of incision was likely arrested at the channel-spanning exposure of bedrock located mid-reach and 350 ft upstream in reach M41T6.04. Also, the relatively close confinement of bedrock-controlled valley walls at the upstream end of the reach may have moderated the potential for further upstream migration of incision and widening in the Buffalo Brook due to colluvial processes and the steep gradient.

The degree of historic incision is less pronounced in the upstream third of reach M41T6.03, possibly due to moderating effects of bedrock exposures. This trend may also reflect overprinting of aggradational processes from upstream sediment sources at this local decrease in gradient (and decrease in sediment transport capacity).

M41T6.02

Within reach M41T6.02, the Buffalo Brook drainage area increases by a factor of three with the introduction of flows from Reading Pond Brook. This reach is underlain by sediments of glacial till origin (USDA).

The reach was segmented to capture a subreach of bedrock gorge near the downstream end, which had a somewhat steeper gradient (estimated 3.5%) and closer confinement (Semi-confined) than the remainder of the reach (Segment B).

Segment B

Valley width varies between 50 and 110, but averages 90, or approximately 3.75 times the measured bankfull width (Semi-confined). Bedrock is exposed in a few locations in the banks and bed, with three channel-spanning occurrences of ledge indexed in the segment. A reference C3b-step/pool channel is inferred.

Road follows channel and crosses the channel in at least six locations throughout Segment B. Generally, the road follows the grade of a terrace on either side of the channel, or is occasionally notched into the valley wall. In a few locations where bedrock creates a valley pinch point, the road climbs the valley wall up and over the bedrock control.

In most locations, the historically incised and entrenched channel contains nearly the full volume of a bankfull or low to moderate flood and demonstrates a degree of historic widening (somewhat elevated W/D ratio, leaning curvilinear trees, low-level scour along both banks, including sometimes undercut banks, and exposed tree roots). Overall, widening has been moderated by erosion-resistance of the bed and bank materials and tree buffers. Cross section #1 is representative of this condition. These sections of the channel might be characterized as persisting in channel evolution stage II [F].

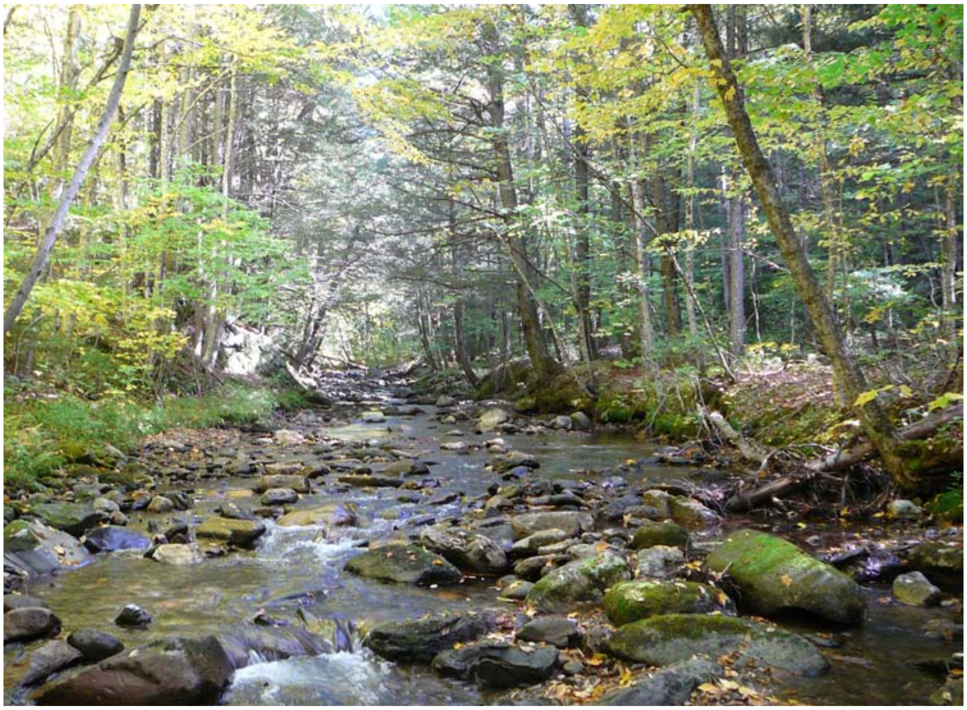


Figure 22. View upstream, forest road is located on LB terrace (picture right) beyond the tree buffer, valley wall is coincident with RB (picture left); plane bed channel form; historically incised, historic widening indicated by curvilinear trees, Segment B, M41T6.02, Buffalo Brook, 24 September 2009

In at least three locations, evidence of the road has been entirely eroded away by avulsions of the channel, occurring in recent years to decades. There are a few locations where the channel has avulsed recently, to occupy the road bed and form a flood chute that is now active at bankfull flows (as evidenced by relative elevation of this flood chute compared to the main channel, imbricated gravels in the bed of the flood chute, and absence of vegetation (Figure 23)).

Elsewhere, the river occasionally occupies flood chutes at a higher-than-bankfull flow stage, which helps to dissipate the flood energy of these higher flows, and minimize the degree of active widening of the incised and entrenched channel. This condition is demonstrated by cross section #2 for the reach. These sections of the channel might be characterized as channel evolution stage II [F] or early III [F]. Incision status may be overstated; there may be a degree of historic incision (related to gold mining, logging history) that is overprinted on a degree of post-glacial incision.

Generally, there were more frequent occurrences of flood chutes and channel avulsions in this segment, as compared to upstream reaches T6.03, T6.04, and T6.05. In part, this is probably related to the somewhat more relaxed valley confinement (Semi-confined to Narrow) and lesser channel gradient (2.5%). The increased incidence of planform adjustment features is likely also related to the recent flooding in upstream reaches of Reading Pond Brook (June 2006, sudden breaching of Reading Pond dam).

Also, there were more frequent occurrences of depositional bars (point bars, mid-channel bars, side bars) in this segment, as compared to upstream reaches T6.03, T6.04, and T6.05 - generally related to locally wider valleys, debris jams, locations of road crossings, and avulsion sites. Still, there is relatively limited floodplain available for deposition of sediments, and this segment is functioning largely as a Transport – dominated channel.

Figure 23. View downstream, recent avulsion along the former path of the forest road in LB corridor, Segment B, M41T6.02, Buffalo Brook, 24 September 2009

Segment A

Bedrock gorge. Tall bedrock walls, Semi-confined.
(As the bedrock walls become steeper and more closely confine the channel in this downstream Segment A, the roads on either side of the channel climb the valley wall and remain somewhat distant from the channel).

Figure 24. View upstream at base of bedrock gorge which comprises Segment A of reach M41T6.02, Buffalo Brook, 18 September 2009

M41T6.01

Underlain by glaciofluvial sediments and alluvial sediments at the downstream end. Identified as an "alluvial fan" following protocols to capture the marked decrease in valley gradient and valley confinement – although geologic investigations to confirm the origin and nature of sediments comprising this feature as a true alluvial fan, were beyond the scope of this study. Kame terrace deposits and lake sands are mapped in vicinity of this reach by Stewart (1955).

Camp Plymouth State Park occupies a majority of the grounds surrounding Buffalo Brook in this reach. This land has been owned by the State of Vermont since 1984. Prior to that time, the Boy Scouts of America operated a camp on these lands from 1927 (VT Division of Historic Preservation sign).

Historic map indicates gold placer mining occurred in the 1800s on this section of the Buffalo Brook (see main report).

Reach segmented to capture an upstream subreach of alternate reference stream type (that has also undergone a stream type departure).

Segment B

Park cabins along the right bank (which have increased in number from two in 1994 to four by 2003). Berms are present along both banks of the channel for a majority of the segment. As the channel pulls away from the right valley wall at the top of the segment, a gravel / cobble / earthen berm is present along the top of the right bank at a thalweg height ranging from 5.5 to 7.5 feet. This berm is reinforced along the toe of the bank by rip-rap armoring. A similar berm is present along the left bank at a height ranging from 4 feet near the upstream end to 2.5 feet near the downstream end of the segment on approach to the Scout Camp Road bridge. Rip-rap reinforces the left bank from a position approximately 40 feet upstream of the bridge. Presence of berms along both banks suggests possible historic windrowing of the channel along with straightening – perhaps in response to the 1973 or 1927 floods, or both.

Figure 25. View downstream, berms along right bank (to protect Camp Plymouth State Park cabins) and left bank, Segment B, M41T6.01, Buffalo Brook, 18 September 2009

The bridge has a span of 15 feet, or approximately 46% of the measured bankfull width (32.6 ft) at a downstream cross section site. Issues: approach angle, sediment upstream, scour pool under the bridge at the downstream end leading to undermining of the abutments (stepped footer on LB abutment). RB abutment has spalling, cracking.

Figure 26. Scout Camp Road bridge, Segment B, M41T6.01, Buffalo Brook, 18 September 2009. (a) View downstream, to sharp approach angle, sediment accumulation at the inlet, armored banks, stepped footers on LB abutment. (b) spalling, cracking and apparent dislodging of right bank abutment.

Some flood scour depressions were observed on the floodplain along the LB corridor beyond the low berm, suggesting that at times in the past, flood waters have been able to breach the berm and overtop the banks to spread out across the floodplain. However, continued channel management following floods has likely been carried out to revert the channel to a more transport-dominated function.

Where this segment / reach might ordinarily serve as a location for sediment attenuation, historic incision (channelization) and construction of berms and armoring of the channel have served to convert the reach to a transport-dominated role. Sediments are conveyed through the reach to downstream areas. However, segment still remains susceptible to catastrophic erosion in future flood events due to partially incised/ entrenched condition. Sensitivity is futher enhanced by its topographic position of notably reduced gradient and lesser valley confinement. For these reasons, sensitivity classification was overridden to "Extreme".

Segment A

General fining downstream sequence of bed material from cobbles and coarse gravels below the Scout Camp Road to medium and fine gravels near the confluence with Echo Lake. Accompanies a gradual decrease in channel gradient. Losing conditions – flow decreases as a component of streamflow recharges the shallow groundwater below the bed of the channel.

Developments of the Camp Plymouth State Park occupy the corridors on either side of the channel in the upstream half of Segment A. Gravel access roads are present at grade along both sides of the channel near the upstream end, providing access to camp pavilions, cabins, and parking areas. A road continues to follow along the RB corridor nearly to the mid-point of the segment. Vegetation then reverts to scrub/shrub and young-growth forest downstream to the confluence of Buffalo Brook with Echo Lake.

Decreased sediment transport capacity due to decreasing gradient on approach to the relatively fixed base level of Echo Lake. Also, losing conditions reduce the flow (and sediment transport capacity) considerably during low-flow to base-flow times of the years. Thus, the lower extent of Segment A has some large accumulations of gravel and sand sediments. In a few cases these have diverted flow to a bifurcated channel, leading to erosion along the banks.

A breached debris jam positioned approx 150 feet upstream of the lake has contributed to local overwidening and forced deposition in a series of side bars and one large mid-channel bar. These features are leading to localized deposition and a series of steep aggradational riffles as the channel incises a path up through these slugs (splays) of sediment.

Figure 27. View downstream, berms along right bank (to protect Camp Plymouth State Park cabins) and left bank, Segment B, M41T6.01, Buffalo Brook, 18 September 2009

A delta of sediment has built out into Echo Lake at the downstream end of Buffalo Brook. Anecdotal accounts (Salerno, 2009; Poirier, 2009) indicate that this delta has grown significantly in area and thickness since the 2006 flooding event that impacted the watershed.

Figure 28. View downstream to delta of fine gravels which extends out into Echo Lake from the mouth of Buffalo Brook, reach M41T6.01, Segment A, 7 August 2009. Kayak paddles mark approximate lateral extent of deposits.

E.4 Reading Pond Brook (Tributary to Buffalo Brook)

M41T6.02S1.02

Mapped as glaciofluvial outwash in a narrow valley between till-mantled bedrock slopes (USDA).

Segmented to capture downstream subreach of alternate stream type below the Reading Pond Road culvert crossing, and to delineate a change in incision status, adjustment processes, and stream type in the remainder of the reach upstream of this crossing.

Segment C

2nd dam 350 feet downstream of main dam. Upper feet of segment appear to have historically been impounded behind a stone / earthen dam which is now breached. Based on field observations, it is likely that this dam was breached prior to the 2006 flood event that breached the upper dam. For example, there was no recently exposed sediments devoid of vegetation in the short channel section between the two dams. Lush vegetation including saplings were present and the channel between the two dams showed a reasonably well-developed fluvial form, rather than an early fluvial form in a recently impounded setting.

Old stone foundation along the left valley wall adjacent to the lower breached dam – possible former mill site.

Segment B

Planform view (199x) – shows pond, two possibly straightened sections that may represent diversions of the channel possibly in support of historic gold mining activities and/or logging operations. Recently, possibly during the 2006 flood event, the channel avulsed to abandon its former (in one case, straightened) path to occupy a new channel.

The Reading Pond Road crossing is a corrugated steel culvert that is a bankfull constrictor. Its span measures 9 feet, or 58% of the measured bankfull width. Sediment has accumulated upstream of the culvert, and a large scour pool has developed downstream of the culvert.

Figure 29. View upstream, to bankfull constricting culvert crossing under Reading Pond Road, Segment B, M41T6.02S1.02, Reading Pond Brook, 4 September 2009.

Segment A

Comprised of the lower 505 feet of the reach downstream of the Reading Pond Road culvert. This is a subreach of alternate reference stream type (B3-S/P), which has undergone recent incision (IRraf = 2.0) resulting in a vertical stream type departure to F3b-S/P.

M41T6.02S1.01

Segmented

Segment B

Valley walls are defined by high terraces ranging from 7 to 20 feet high (or 3.5 to 10 times bankfull depth). Set of discontinuous lower terraces from 1.5 to 4 feet high (or 1 to 2 times bankfull depth - may represent RAF. One waterfall grade control indexed mid-reach. Couple other exposures of lateral bedrock grade controls. Several mass failures in glacial till are exposed where channel impinges upon the higher terraces. Reference B3a-S/P which is undergoing considerable vertical and lateral adjustments, presumably as a response to the 2006 flood event and sudden breaching of the Reading Pond. Frequent MFs, and eroding bank sections that have led to bedform departure from step/pool to cascade flows around LWD and boulders and large cobbles. Frequent side and point bars forced at debris jams, LWD and detritus; frequent flood chutes and bifurcated channel sections around these obstacles. Width / depth ratio (26) is quite large for a semi-confined, steep-gradient channel, suggesting active widening. This observation is supported by the presence of numerous trees leaning into the channel from both banks. Often trees have fallen across the narrow stream valley to perch above the bankfull elevation.

These LWD were not counted in the talley of LWD. Nevertheless, they will continue to be an ongoing source of woody debris to the channel in years to come as they weather and break down to a size that can become entrained within the bankfull channel. Groundwater seeps are evident on the lower terraces.

Conditions on this segment are complex, with adjustment processes overlapping in time and space. XS-2 is located near the downstream end of a short section of channel, Narrowly-confined by steep till-slopes that formed high terraces at thalweg heights ranging from 9 to 10.5 feet (5.6 to 6.6 times the Dmx) on the RB; and from 8 to 14 feet (5 to 8.8 times the Dmx) on the LB. Signs of recent incision in vicinity of XS-2 were not observed. XS-3 was located near the upstream end of the segment and represented conditions found along a majority of the segment. Valley walls were comprised of till terraces ranging in height from 9 to 30 feet high or more. Confinement of the channel between these high terraces varied from Narrowly-confined to Semi-confined and even Narrow in a couple of places. A set of discontinuous lower terraces were present within these valley walls, generally 2 to 4 times the Dmx in height. Flood chutes on these lower terraces were relatively frequent but did not appear to be active at bankfull stage, unless forced at a DJ. Frequently, DJs and/or boulder-rafted LWD had blocked or partially blocked the channel (perhaps during the 2006 flood event) and large sediment slugs had been deposited in the channel behind the obstruction. Then it appeared that recent breaching of the obstruction had lead to localized incision through and beyond the sediment slug. Incision was somewhat localized and head cuts would wash out within a relatively short distance upstream, but might overlap with the next section of incision. In other locations there might be a short section with little or no incision between sections of more pronounced incision. Tributary rejuvenation was apparent in many of the tributaries to this segment. Banks were undercut exposing fresh tree roots. Trees are actively leaning and collapsing into the channel from both banks.

Segment A

Valley width somewhat narrower in this segment as compared to upstream Segment B. Channel confined by higher terraces ranging in thalweg height from 8 to 18 feet and higher. Fewer discontinuous lower terraces than Segment B - at thalweg heights of 4 to 5 feet, or 2 to 2.5 times the bankfull height. Fewer occurrences of mass failures and bank erosion generally. Four occurrences of bedrock grade controls (waterfalls); few exposures of bedrock along the valley walls. Often fine to medium gravels have accumulated upstream of large boulder steps or entrained LWD in forced bars. A few leaning trees or saplings, suggesting ongoing planform adjustments or localized widening. But overall less actively adjusting than upstream Segment B. Abandoned forest road joins the stream valley from the LB corridor near the downstream end of the segment and crosses at one location to the RB.

APPENDIX F

Stressor Tables, Reach-Scale

Abbreviations used in the following tables:

BFL	Bankfull
FPW	Flood Prone Width
RB	Right Bank
LB	Left Bank
I	Increase (of Stream Power or Boundary Resistance)
D	Decrease (of Stream Power or Boundary Resistance)

Text in blue denotes a natural stressor or modifier.
Text in black indicates a human-caused modification.

Table F-1. Stressor Tables, Reach-Scale – Patch Brook and Black River main stem

	Reach-Scale Stressors					
Reach / Segment			**Stream Power**			**Boundary Resistance**
M40T5.04-E	I	Slope	Historic deforestation	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
	D	Slope	Unknown Soldier Rd bridge is bankfull constrictor with negligible upstream aggradation.			
M40T5.04-D	I	Slope	Historic deforestation, more recent logging.	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
	D	Slope	Boulder grade control (likely) and valley pinch point near the downstream segment break.			
M40T5.04-C	I	Slope	Historic deforestation; more recent logging.	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
	D	Slope	Diversion of water to nearby impoundment in upstream end of segment, may have led to decreased stream power in 650 feet of channel.			
	D	Slope	Catamount Trail bridge is bankfull constrictor with some upstream aggradation.			
M40T5.04-B	I	Slope	Historic deforestation; more recent logging.	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
	D	Slope	Natural reduction in sediment transport capacity on approach to wetland segment (T5.04-A).	I	Bed, Banks	Localized bedrock exposures in bed and banks.
	D	Slope	Patch Brook Road culvert is bankfull constrictor (minor upstream aggradation).	I	Bed, Banks	Cohesive sediments
M40T5.03S1.01	I	Depth	Historic localized reduction in sediment supply below dam at upstream end of reach (Lake Ninevah - natural impoundment enhanced by earthern dam).	I	Bank	Armoring (some, RB)
	I	Depth	Recent marginal increase in sustained flows during Fall months as Lake Ninevah was drained prior to Winter - (mid-1980s to late 1990s).			
	I	Slope	Local flow increase downstream of Loop Rd bridge which is a bankfull constrictor (minor to negligible scour).	I	Bank	Maintenance of tree buffers, limited encroachments.
	D	Slope	Loop Rd bridge is bankfull constrictor with minor upstream aggradation (localized).			
M40T5.03-B	I	Depth	Recent marginal increase in sustained flows during Fall months as Lake Ninevah was drained prior to Winter - (mid-1980s to late 1990s).	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
	I	Slope	Localized channelization (historic) along Patch Brook Rd.	I	Bed, Banks	Localized bedrock exposures in bed and banks.
	I	Depth	Stormwater: localized flow increases from stormwater outfalls (overland flow and road ditch outfalls)	I	Bank	Armoring (short lengths, both banks)
M40T5.03-A	I	Slope	Historic channelization w/ windrowing	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
	D	Slope	Natural reduction in sediment transport capacity as valley transitions from Semi-confined to Narrow / Broad confinement.	D	Bank	Localized removal of woody vegetation related to residential use and road encroachments (RB).
	I	Depth	Recent marginal increase in sustained flows during Fall months as Lake Ninevah was drained prior to Winter - (mid-1980s to late 1990s).	I	Bank	Armoring (short length, RB)
	I	Slope	Encroachment: Dublin Rd			
	I	Slope	Encroachment: berms, LB			
	D	Slope	Dublin Rd bridge is bankfull constrictor with significant upstream aggradation (localized).			

Table F-1. Stressor Tables, Reach-Scale – Patch Brook and Black River main stem (CONTINUED)

	Reach-Scale Stressors					
Reach / Segment	**Stream Power**			**Boundary Resistance**		
M40T5.02-B	I	Slope	Historic channelization w/ possible windrowing	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
	I	Slope	Encroachment: Dublin Rd	I	Bank	Armoring (short lengths, both banks)
	I	Slope	Encroachment: berms, LB, RB			
	D	Slope	Natural reduction in sediment transport capacity at reduced valley gradient and confinement.			
M40T5.02-B	I	Slope	Historic channelization w/ possible windrowing	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
	I	Slope	Encroachment: Dublin Rd	I	Bank	Armoring (short lengths, both banks)
	I	Slope	Encroachment: berms, LB, RB	D	Bed	Reported historic dredging
	D	Slope	Natural reduction in sediment transport capacity at reduced valley gradient and confinement.			
M40T5.02-A	I	Slope	Historic channelization possible	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
	I	Slope	Encroachment: Dublin Rd, private road	I	Bank	Armoring (short lengths, both banks)
	I	Slope	Encroachment: berms, LB	D	Bed	Reported historic dredging
	D	Slope	Tatro Rd bridge is bankfull constrictor with upstream aggradation (localized).			
	I	Slope	Local flow increase downstream of Tatro Rd bridge which is a bankfull constrictor (moderate scour).			
	I	Slope	Possible incision due to breaching of historic mill dam at downstream end of segment.			
M40T5.01-D	I	Slope	Historic channelization	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
	I	Slope	Possible incision due to "hungry water" effects during historic operation of mill dam at upstream end of segment.	I	Bank	Armoring (short lengths, LB)
	D	Depth	Possible historic aggradation due to partial diversion of flows to "canal" on west side of Dublin Road.	D	Bed	Reported historic dredging
M40T5.01-C	D	Depth	Diversion of water to "canal" on west side Dublin Rd, may have led to decreased stream power within the segment.	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
	I	Slope	Historic channelization	I	Bank	Armoring (short length, LB)
M40T5.01-B	I	Slope	Historic channelization			
	I	Slope	Encroachment: Dublin Rd	I	Bank	Armoring (short lengths, both banks)
	I	Slope	Encroachment: berm, LB			
	D	Depth	Diversion of water to "canal" on west side Dublin Rd, may have led to decreased stream power within the segment.	D	Bank	Localized removal of woody vegetation related to residential use and road encroachments (RB).
	D	Slope	Dublin Rd bridge is bankfull constrictor with upstream aggradation (localized).			
	I	Slope	Local flow increase downstream of Dublin Rd bridge which is a bankfull constrictor (moderate scour).			
	D	Slope	Library Rd bridge is bankfull constrictor with upstream aggradation (localized).			
	D	Slope	Natural reduction in sediment transport capacity at reduced valley gradient and confinement.			
M40T5.01-A	I	Slope	Historic channelization			
	I	Slope	Encroachment: berms, LB, RB	I	Bank	Armoring (short lengths, both banks)
	D	Slope	Dublin Rd bridge is bankfull constrictor - negligible aggradation	D	Bed	Reported historic dredging
	D	Slope	Natural reduction in sediment transport capacity at reduced valley gradient and confinement.	D	Bank	Localized removal of woody vegetation related to residential use and road encroachments (RB).
M40	I	Slope	Historic channelization			
	I	Slope	Encroachment: berms, LB	I	Bank	Armoring (short lengths, both banks)
	I	Slope	Encroachment: VT Route 100, RB	D	Bed	Reported historic dredging
	D	Slope	Natural reduction in sediment transport capacity at reduced valley gradient on approach to Round Pond at the downstream end of the reach.			

Table F-2. Stressor Tables, Reach-Scale – Buffalo Brook tributary reaches

	Reach-Scale Stressors					
Reach / Segment	**Stream Power**			**Boundary Resistance**		
M41T6.06	I	Slope	Historic deforestation	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
	D	Slope	Forest road culvert is bankfull constrictor with minor upstream aggradation.	I	Bed, Banks	Frequent bedrock exposures in bed and banks.
				D	Bed, Banks	Reported historic gravel mining associated with gold placer mining; probably moderated by shallow bedrock controls.
M41T6.05-B	I	Slope	Historic deforestation	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
				I	Bed, Banks	Frequent bedrock exposures in bed and banks.
M41T6.05-A	I	Slope	Historic deforestation	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
	I	Depth	Stormwater: localized flow increases from concentrated flow along forest road network.	I	Bed, Banks	Frequent bedrock exposures in bed and banks.
				D	Bed, Banks	Removal of trees to construct close forest road with frequent fords, provides opportunity for localized avulsion, channel widening, and sediment erosion.
M41T6.04	I	Slope	Historic deforestation	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
	I	Depth	Stormwater: localized flow increases from concentrated flow along forest road network.	I	Bed, Banks	Occasional bedrock exposures in bed and banks.
				D	Bed, Banks	Removal of trees to construct close forest road with frequent fords, provides opportunity for localized avulsion, channel widening, and sediment erosion.
M41T6.03	I	Slope	Historic deforestation	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
	I	Depth	Stormwater: localized flow increases from concentrated flow along forest road network.	I	Bed, Banks	Occasional bedrock exposures in bed and banks.
				D	Bed, Banks	Reported historic gravel mining associated with gold placer mining;
				D	Bed, Banks	Removal of trees to construct close forest road with frequent fords, provides opportunity for localized avulsion, channel widening, and sediment erosion.
M41T6.02-B	I	Slope	Historic deforestation	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
	I	Depth	Stormwater: localized flow increases from concentrated flow along forest road network.	I	Bed, Banks	Occasional bedrock exposures in bed and banks.
	D	Slope	Moderate constriction at downstream end of segment as channel transitions to steeper-gradient bedrock gorge.	D	Bed, Banks	Reported historic gravel mining associated with gold placer mining;
				D	Bed, Banks	Removal of trees to construct close forest road with frequent fords, provides opportunity for localized avulsion, channel widening, and sediment erosion.
M41T6.02-A	I	Slope	Historic deforestation	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
				I	Bed, Banks	Frequent bedrock exposures in bed and banks.

Table F-2. Stressor Tables, Reach-Scale – Buffalo Brook tributary reaches (CONTINUED)

Reach / Segment	Reach-Scale Stressors					
	Stream Power			Boundary Resistance		
M41T6.01-B	I	Slope	Historic deforestation	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
	I	Slope	Encroachment: berm, each bank	I	Bank	Armoring (some, both banks)
	I	Slope	Apparent channelization (historic)	D	Bed, Banks	Reported historic gravel mining associated with gold placer mining;
	D	Slope	Natural reduction in sediment transport capacity downstream of bedrock gorge due to reduction in valley confinement and gradient - appears moderated by channel modification to transport-dominated condition.			
	D	Slope	Scout Camp Road bridge is bankfull constrictor with upstream aggradation at sharp approach angle.			
	I	Slope	Local flow increase downstream of Scout Camp Rd bridge which is a bankfull constrictor.			
M41T6.01-A	I	Slope	Historic deforestation	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
	I	Slope	Apparent channelization (historic)	I	Bank	Armoring (some, RB)
	D	Slope	Natural reduction in sediment transport capacity downstream of bedrock gorge due to reduction in valley confinement and gradient	D	Bed, Banks	Reported historic gravel mining associated with gold placer mining;
	D	Slope	Natural reduction in sediment transport capacity on approach to relatively stable base level of Echo Lake.			

Table F-3. Stressor Tables, Reach-Scale – Reading Pond Brook tributary reaches

Reach / Segment	Reach-Scale Stressors: Stream Power			Boundary Resistance		
M41T6.02S1.02-C	I	Slope	Historic deforestation	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
	I	Depth	Episodically, by sudden breaching of Reading Pond Brook dam in June 2006	D	Bed, Banks	Reported historic gravel mining associated with gold placer mining
M41T6.02S1.02-B	I	Slope	Historic deforestation	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
	I	Slope	Apparent channelization and possible flow diversion in limited sections (historic)	D	Bed, Banks	Reported historic gravel mining associated with gold placer mining
	D	Slope	Reading Pond Road culvert is bankfull constrictor with upstream aggradation.			
	I	Slope	Local flow increase downstream of Reading Pond Rd culvert which is a bankfull constrictor.			
	I	Depth	Episodically, by sudden breaching of Reading Pond Brook dam in June 2006			
M41T6.02S1.02-A	I	Slope	Historic deforestation	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
	I	Depth	Episodically, by sudden breaching of Reading Pond Brook dam in June 2006	D	Bed, Banks	Reported historic gravel mining associated with gold placer mining
M41T6.02S1.01-B	I	Slope	Historic deforestation	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
	I	Depth	Episodically, by sudden breaching of Reading Pond Brook dam in June 2006	D	Bed, Banks	Reported historic gravel mining associated with gold placer mining
				I	Bed, Banks	Occasional bedrock exposures in bed and banks.
M41T6.02S1.01-A	I	Slope	Historic deforestation	I	Bank	Regeneration of tree buffers and forest cover in the surrounding watershed in recent decades, limited encroachments.
				D	Bed, Banks	Reported historic gravel mining associated with gold placer mining
				D	Bed, Banks	Removal of trees to construct close forest road with frequent fords, provides opportunity for localized avulsion, channel widening, and sediment erosion.
				I	Bed, Banks	Frequent bedrock exposures in bed and banks.

APPENDIX G

Departure Analysis Tables

Abbreviations used in the following tables:

BFL	Bankfull
FPW	Flood Prone Width
RB	Right Bank
LB	Left Bank
H	Human-constructed Constraint
N	Natural Constraint
X	Significant
(X)	Somewhat Significant

Table G-1. Departure Analysis Tables, Patch Brook and Black River main stem reach M40

	Constraints		Transport		Attenuation (storage)			
Reach / Segment	Vertical	Lateral	Natural	Converted	Natural	Decreased	Increased	Asset
M40T5.04-E			**X**					
M40T5.04-D			(X)		(x) due to localized reduction in valley confinement & gradient			
M40T5.04-C				(x)		(x) Somewhat, due to historic incision (moderate degree)		
M40T5.04-B	channel-spanning bedrock (2 locations)				(x) due to localized reduction in valley gradient above wetlands	(x) Somewhat, due to historic incision (minor to moderate degree)		**X**
M40T5.03S1.01 **(Lake Ninevah outlet)**	Earthen impound-ment on bedrock in immediate upstream reach (Lake Ninevah)	H: Loop Road bridge (	**X**					
M40T5.03-B		H: Patch Brook Rd (gravel) H: Townsend Barn Rd bridge (BFL)	**X**					
M40T5.03-A		H: Dublin Road (LB) H: Dublin Road bridge (BFL) H: residence (RB)			(x) due to localized reduction in valley confinement	**X** due to historic incision (moderate degree) and entrenchment by berms, resulting in STD		(x)

Table G-1. Departure Analysis Tables, Patch Brook and Black River main stem reach M40 (CONTINUED)

	Constraints		Transport		Attenuation (storage)			
Reach / Segment	Vertical	Lateral	Natural	Converted	Natural	Decreased	Increased	Asset
M40T5.02-B		H: Dublin Road (RB)			(x) due to localized reduction in valley gradient and confinement	**X** due to historic incision (moderate degree) and entrenchment by berms, resulting in STD		(x)
M40T5.02-A		H: Dublin Road (RB) H: Tatro Road bridge (BFL) H: Old abutments (breached dam, FPW)	(x)			**X** due to historic incision resulting in STD		
M40T5.01-D			(x)			**X** due to historic incision resulting in STD		
M40T5.01-C			(x)			(x) Somewhat, due to historic incision (moderate degree)		
M40T5.01-B		H: Dublin Road (RB) H: Dublin Road bridge (BFL) H: Library Road bridge (BFL) H: residential, commercial buildings			**X** due to localized reduction in valley gradient and confinement	**X** due to historic incision and floodplain encroachments, resulting in STD		
M40T5.01-A		H: VT Route 100 bridge (FPW)			**X** due to localized reduction in valley gradient and confinement	**X** due to historic incision and berms		**X**
M40		H: Kingdom Road bridge (FPW) H: residential, commercial buildings H: VT Route 100 (upstream end, RB)			**(x)** At downstream end, due to localized reduction in gradient at Round Pond	**X** due to historic incision and berms		

Table G-2. Departure Analysis Tables, Buffalo Brook

	Constraints		Transport		Attenuation (storage)			
Reach / Segment	Vertical	Lateral	Natural	Converted	Natural	Decreased	Increased	Asset
M41T6.06	Channel-spanning bedrock	N: Extensive lateral bedrock controls H: Culvert - forest road (BFL)	**X**					
M41T6.05-B	Channel-spanning bedrock	N: Extensive lateral bedrock controls	**X**					
M41T6.05-A	Channel-spanning bedrock	N: some lateral bedrock controls	**X**					
M41T6.04	Channel-spanning bedrock	N: some lateral bedrock controls	**X**					
M41T6.03	Channel-spanning bedrock	N: some lateral bedrock controls		(x)	(x) due to localized reduction in valley gradient and confinement	(x) Somewhat, due to historic (or post-glacial) incision leading to stream type departure		
M41T6.02-B	Channel-spanning bedrock	N: some lateral bedrock controls		(x)	(x) due to localized reduction in valley gradient and confinement	(x) Somewhat, due to historic (or post-glacial) incision leading to stream type departure		
M41T6.02-A	Channel-spanning bedrock	N: Extensive lateral bedrock controls	**X**					
M41T6.01-B		H: berms, both banks H: camp buildings, RB H: Scout Camp Road bridge (BFL)		**X**	(x) due to localized reduction in valley gradient	(x) Somewhat, due to historic incision (minor to moderate degree) and entrenchment by berms		(X)
M41T6.01-A				**X**	(x) due to localized reduction in valley gradient above Echo Lake	X Somewhat, due to historic (or post-glacial) incision leading to stream type departure		**X**

Table G-3. Departure Analysis Tables, Reading Pond Brook

	Constraints		Transport		Attenuation (storage)			
Reach / Segment	Vertical	Lateral	Natural	Converted	Natural	Decreased	Increased	Asset
M41T6.02S1.02-C		H: abutments of breached dam		**X**		X due to recent and historic incision leading to stream type departure		
M41T6.02S1.02-B		H: Reading Pond Road culvert (BFL)		**X**	(x) due to localized reduction in valley gradient and confinement upstream of valley pinch point	(x) Somewhat, due to historic and recent incision		**X**
M41T6.02S1.02-A			**X**			(x) Somewhat, due to historic and recent incision	(x) Somewhat, due to debris jams and LWD	
M41T6.02S1.01-B	Channel-spanning bedrock	N: some lateral bedrock controls	**X**			(x) Somewhat, due to historic and recent incision	(x) Somewhat, due to debris jams and LWD	
M41T6.02S1.01-A		N: some lateral bedrock controls	**X**			(x) Somewhat, due to historic (& post-glacial) incision	(x) Somewhat, due to debris jams and LWD	

APPENDIX H

Valley Wall Updates

South Mountain Research & Consulting (SMRC) has created a Phase 2 valley wall shape file for the purposes of: (1) defining reference (Phase 1) and existing (Phase 2) stream types after Rosgen (1996) and Montgomery & Buffington (1997); and (2) to define locations where human infrastructure has encroached within the natural valley wall to constrain hydraulics of the channel and floodplain and/or change the confinement of the channel as captured under Phase 2 Step 1.5. This valley wall delineation relied on remote sensing resources (USGS topographic maps, published soils data, published surficial geologic data) and limited visual observations. No detailed assessments (such as subsurface geologic investigations, geotechnical evaluations, licensed land surveys, hydrologic or hydraulic assessments) were conducted to estimate the degree that human encroachments will laterally constrain the channel or the degree that human encroachments will change hydraulics of channel and floodplain flow during a flood event.

While SMRC was not contracted to evaluate fluvial erosion hazard boundaries in the Patch Brook or Buffalo Brook watersheds, SMRC is aware that this updated Phase 2 valley wall shape file may be utilized by others in the process of defining what are termed Fluvial Erosion Hazard (FEH) corridors or areas, following procedures prescribed by VT Agency of Natural Resources. The updated Phase 2 valley wall shapefile prepared by SMRC does not necessarily represent lateral extents of fluvial erosion hazard along these Black River tributary channels.

It is possible that a future migration or avulsion of the channel could occur beyond the valley wall. Often the valley wall has been delineated along high terraces inferred to be of pre-colonial (glacial or post-glacial) age and origin. In these cases, the terrace is inferred to define a valley side slope (and valley width) of the reference (and often existing) channel for purposes of assigning stream types under the current hydrologic and sediment regimes. However, sediments comprising these terraces generally are unconsolidated gravels, cobbles, and/or boulders, and would possibly be subject to fluvial erosion hazards and/or landslide hazards where scour velocities exceed the threshold for erosion and/or where bank heights or slopes exceed stable conditions.

While encroachments may be significant enough to theoretically constrain channel or floodplain hydraulics and/or cause a change in confinement that affects stream type designations - thus warranting delineation as the modified Phase 2 valley wall - this human infrastructure (e.g., roads, railroads, engineered levees) may still be susceptible to erosion hazards.

Deliverables:
"ph2vw.shp" - a documentation of human-caused change in valley width as per Phase 2 protocols (2007), Step 1.5 (dated 5/19/2009). Generally, these include roads or railroads that encroach within the phase 1 valley width and are oriented subparallel to the channel and which are elevated to a degree above the floodplain (generally greater than two times the bankfull depth), such that a portion of the natural valley floodplain has been cut off by this artificial valley wall and/or channel and floodplain hydraulics are inferred to have been constrained. This encroachment delineation is offered without a classification of "major" or "minor" and without regard for whether or not the feature will ultimately be identified by the community as an "Encroachment" worthy of FEH-area modification as prescribed on page 13 of the November 12, 2008 *Technical Appendix to the Vermont River Corridor Protection Guide* published by the VT Agency of Natural Resources.

Notes:
Patch Brook reach M40T5.04:
Valley wall positions along this reach should be considered very approximate. The VHD coverage defining the position of the Patch Brook main stem was considerably different than the actual channel position measured in the field with a GPS. Further details and limitations of the valley wall delineation in this reach are contained in the QA Documentation in Appendix C.