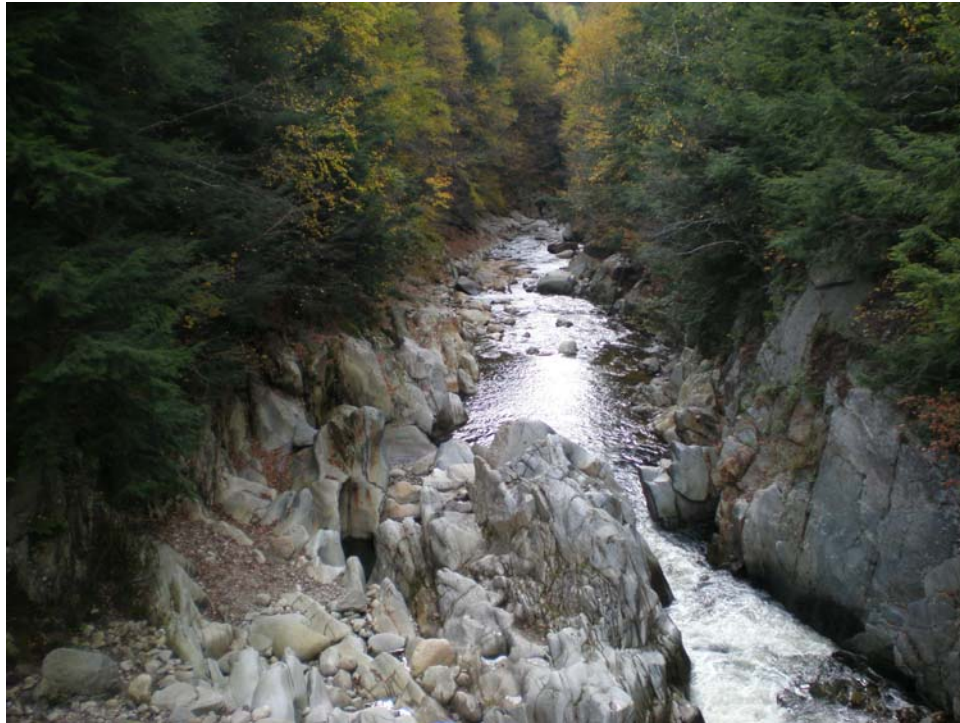


# Mill River

## Phase 2 Stream Geomorphic Assessment

### Rutland County, Vermont



December 31, 2007

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Prepared by:



**Round River Design**  
Michael Blazewicz  
Watershed Scientist  
[www.RoundRiverDesign.com](http://www.RoundRiverDesign.com)

Prepared for:

**Rutland Regional Planning Commission**  
67 Merchants Row  
P.O. Box 965  
Rutland, VT 05702

# Mill River

## Phase 2 Stream Geomorphic Assessment

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## **Round River Design, LLC.**

36 Crombie St., Burlington, Vermont 05401 802.279.0478 [www.RoundRiverDesign.com](http://www.RoundRiverDesign.com)

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# **Mill River Phase 2 Stream Geomorphic Assessment Rutland County, Vermont**

## **Executive Summary**

- The Rutland Regional Planning Commission retained Round River Design to perform a Phase 2 Stream Geomorphic Assessment of the main stem of the Mill River Watershed in the Towns of Clarendon, Shrewsbury, Wallingford, and Mount Holly during the autumn of 2007. This assessment is meant to provide information about the physical condition of the Mill River watershed and the factors that are influencing the stability of this system in order to predict future channel adjustments and inform restoration and management decisions.
- The studies followed the assessment protocol (version 2007) developed by the Vermont River Management Program, Department of Environmental Conservation.
- The main stem of the Mill River varies between highly stable bedrock controlled channels and highly sensitive gravel and cobble dominated channels that are highly influenced by the presence and condition of the riparian vegetation as well as their ability to access a floodplain during high water events.
- The upper section of the Mill River in Mount Holly and East Wallingford has seen high amounts of historic channel straightening, floodplain encroachment, berming, and removal of riparian vegetation. There has been a collective loss of floodplain access for water and sediment storage due to berming, incision of the streambed, and floodplain encroachment. The result has been an increase in river power during high water events which has led to further instability and the exacerbation of fluvial erosion hazards in these reaches. From the Upper Clarendon Gorge to the Lower Clarendon Gorge the Mill River regains a sense of general stability aided by bedrock grade controls. From the Lower Clarendon Gorge to the confluence with the Otter Creek the Mill River is a highly dynamic stream in an alluvial fan area that has a history of channel management in response to natural movements.
- The Mill River is working toward a more stable equilibrium through streambank erosion, widening, and lateral migration. The Clarendon, Shrewsbury, Wallingford, and Mount Holly communities have the opportunity to provide long-term protection to the river corridor and encourage the reestablishment of functioning floodplain and healthy in-stream habitat through river corridor management and protection



# **Mill River Phase 2 Stream Geomorphic Assessment Rutland County, Vermont**

## **1.0 PROJECT OVERVIEW**

Stream geomorphic assessments provide information about the physical condition of streams and the factors that influence their stability. The Vermont Agency of Natural Resources (VTANR) River Management Program has developed a series of protocols (Phase 1, Phase 2, and Phase 3) for the statewide assessment of rivers and streams. A Phase 1 Stream Geomorphic Assessment looks at broad scale landscape data, historical data, and limited field reconnaissance to begin to understand watershed characteristics and potential stressors. A Phase 1 Geomorphic Assessment of the Mill River was completed in 2007 by the Rutland Regional Planning Commission (RRPC). The Phase 1 project report summarized the results of this work (Rutland County Planning Commission, 2007). A Phase 2 Geomorphic Assessment of select reaches of the Mill River was recommended by the RRPC to gather more detailed information about the stream channel and riparian corridor in order to inform current and future planning and restoration efforts. The RRPC retained Round River Design to perform a Phase 2 Stream Geomorphic Assessments of the main stem of the Mill River and a short segment of a tributary in the Towns of Clarendon, Shrewsbury, Wallingford, and Mount Holly during the autumn of 2007.

The Mill River has a watershed area of 71 square miles just above the confluence of the Otter Creek in the Town of Clarendon, Vermont (Figure 1). The Phase 2 study focused on stream reaches on the main stem of the Mill River within the Towns of Clarendon, Shrewsbury, Wallingford, and Mount Holly (Figure 2). The combined length of the stream reaches assessed was approximately 15 miles.

## **2.0 BACKGROUND WATERSHED INFORMATION**

### **2.1 Geographic Setting**

Located in Rutland County (with a very small portion in Windsor County), Vermont, the Mill River watershed area is 71.26 square miles. The Mill River flows to the west and north and joins the Otter Creek which drains north into Lake Champlain. The Mill River drains from its forested headwaters in the Green Mountains southeast of Rutland predominately in the towns of Clarendon, Shrewsbury, Wallingford, and Mount Holly with very minor portions in Mendon, Killington, Mount Tabor, and Weston. It joins the Otter Creek at approximately 550 feet above sea level in the town of Clarendon.



## Mill River Watershed Phase 2 Geomorphic Assessment Study Location Map

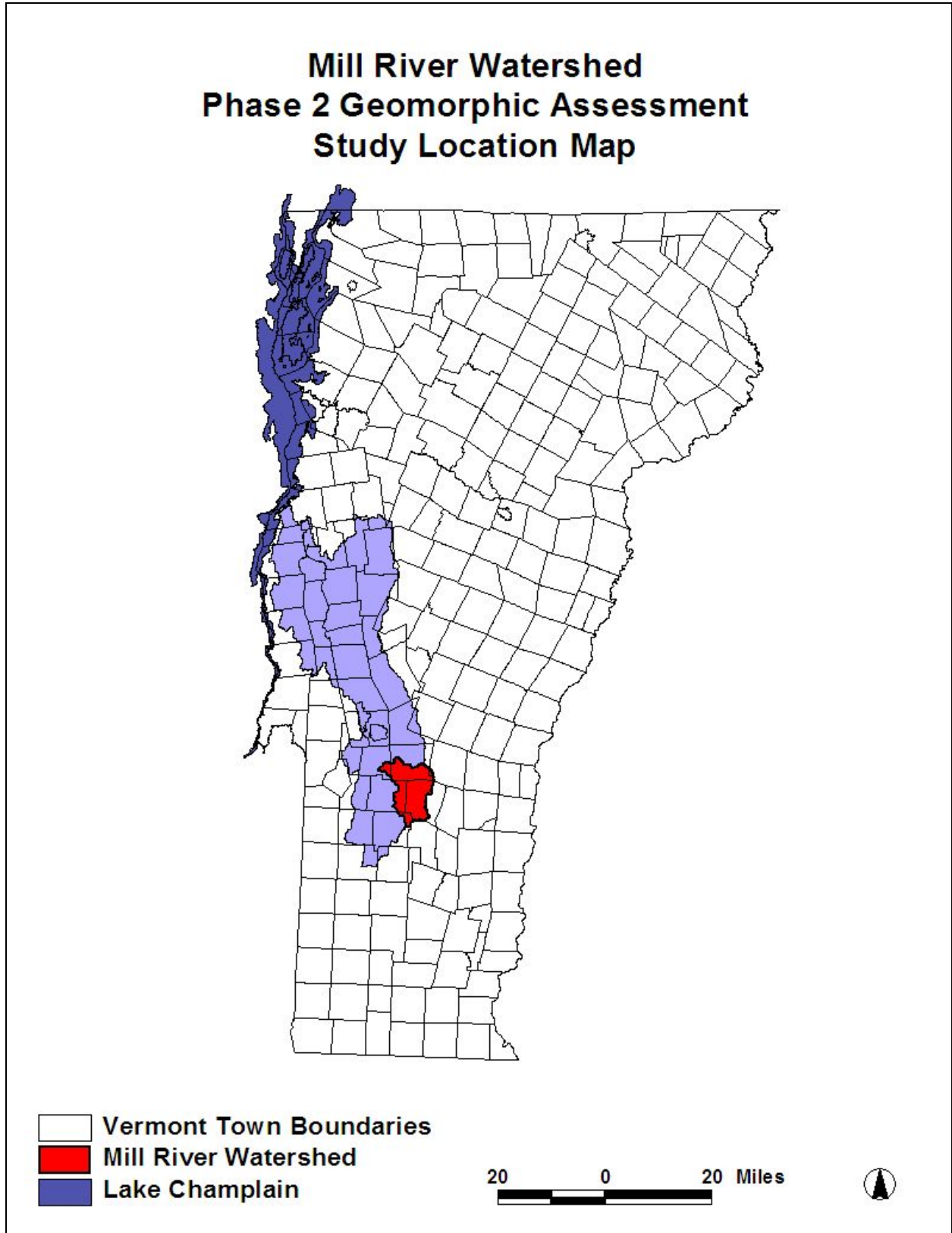


Figure 1: Project Location Map



## Mill River Watershed Phase 2 Geomorphic Assessment Study Reaches

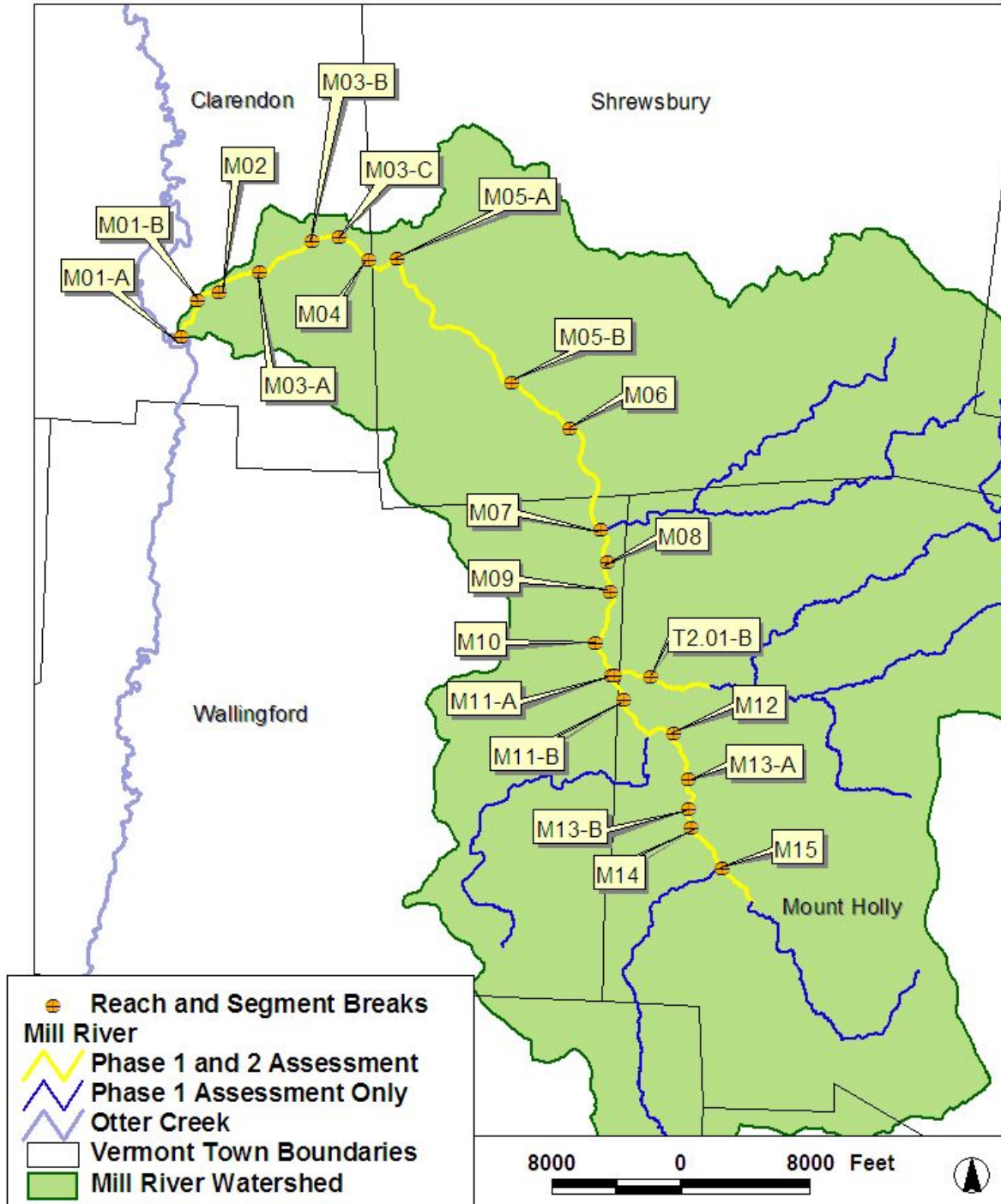


Figure 2: Reach location map for the Mill River Phase 2 Stream Geomorphic Assessment



## 2.2 Geologic Setting

Streams are transport systems that carry not only water but also sediment from highlands to lowlands. The geology of a watershed determines the source material that a river will carry, the way the material is carried, and the rate of channel adjustments. In a broad geological context the Mill River spans two larger physioregions, the “Vermont Valley” – a continuation of the Champlain Valley that lies to the west of the Green Mountains and north of the Taconic Mountains where hills thrust up from bedrock dominate the topography. The upper reaches of the Mill River are considered part of the “Green Mountain” physioregion a huge anticlinorium comprised of three anticlines that have been compressed and uplifted and trend in a north-south direction (Stewart 1972).

### 2.2.1 Bedrock Geology

The headwaters and upper reaches of the Mill River flow over bedrock of the Green Mountain Physioregion. According to Stewart (1972), Precambrian basement rock (Mount Holly Complex) forms the core of the Green Mountains and the bedrock geology of the upper Mill River watershed. The Mount Holly Complex is the most highly metamorphosed rock of the whole region having been subjected to two or more mountain building periods. The rock is a complex mixture of schists and gneisses with large areas of quartzite and small concentrations of calcite and dolomite marble.

As the Mill River descends out of the Green Mountains it enters the Vermont Valley physioregion; a series of mostly Cambrian carbonate rock composed both of dolomitic and limestone marbles with occasional quartzite members. As indicated on a map titled, “Areal Geology of the Rutland Area” (Vermont Geological Survey 1952), the Mendon Formation (a Lower Cambrian quartzite formation is found near reach M04). The Danby Quartzite formation (Upper Cambrian) forms the beginning of the lower Clarendon Gorge with Winooski Dolomite and Monkton Quartzite forming the lower gorge. From here the Mill River spills out to the valley floor of the Otter Creek and into an area dominated by glacial drift and surficial deposits.

The underlying bedrock of the watershed influences the topography and energy gradients of the streams while the rock characteristics can influence the erodibility (and therefore stability of the channel) as well as the chemical water quality properties of a stream and subsequently influence its biology. Frequent bedrock exposures in the Mill River corridor influence the channel position and longitudinal profile of the river locking the channel in place with areas highly resistant to erosion. Bedrock exposed along the valley walls may control the lateral position of the river channel. Channel spanning bedrock (Found in reaches M11-B, M06, M04, M03-C, M03-B and M02) creates a vertical grade control that prevents possible downcutting of the river channel (at least in the near geologic time of which this study is concerned).

### 2.2.2 Surficial Geology

The surficial materials in the Mill River region are composed of sediments transported by glaciers or by melt water from streams or in small lakes associated with glaciation. The exception is the recent alluvium from floodwaters that forms a thin veneer on the floor of most broad river valleys. Till, unsorted glacial debris deposited directly from melting ice, contains a wide variety of particles sizes. According to Stewart (1972), till covers the



uplands of the Rutland region as a thin veneer generally less than 10 feet thick and much thicker in the valleys. At the base of the Green Mountains near the Vermont Valley kame terraces, kames, and valley train deposits (outwash from glacial streams) can be found.

The Phase 1 Stream Geomorphic Assessment (Rutland Regional Planning Commission 2007) used NRCS soil maps to determine that ice-contact, glacial till, and alluvial deposits are the dominant surficial geologic materials in the Mill River watershed (based on soils maps of the watershed). Alluvium soils are frequently flooded and have high erodibility potential. Ice contact soils are infrequently flooded, however have high to severe erodibility. Glacial till deposits are infrequently flooded and have high erodibility.

### 2.3 Geomorphic Setting

The Phase 1 Assessment of the Mill River Watershed (Rutland Regional Planning Commission, 2007) delineated geomorphic reaches using remote sensing and windshield surveys. Reaches were defined according to VTANR Phase 1 protocol based on variations in valley confinement, slope, sinuosity, and soils.

Based on the channel and watershed stressors identified during the Phase 1 Assessment, fifteen mainstem reaches and one tributary reach of the Mill River were prioritized for Phase 2 Stream Geomorphic Assessments in 2007 (Table 1). These targeted reaches were expected to demonstrate higher degrees of channel adjustment and sensitivity.

<b>Table 1: Location of Reaches Selected for Phase 2 Assessment</b>			
Reach Number	Length (feet)	Phase 1 Impact Score* (0 = low, 32 = high)	Location
M01	4853	23	Clarendon
M02	3158	5	Clarendon
M03	8261	15	Clarendon
M04	2220	2	Clarendon/Shrewsbury
M05	16699	22	Shrewsbury
M06	7612	23	Shrewsbury/Wallingford
M07	2380	21	Wallingford
M08	1900	14	Wallingford
M09	3609	20	Wallingford
M10	2369	22	Wallingford
M11	6218	24	Wallingford/Mount Holly
M12	3166	12	Mount Holly
M13	3399	8	Mount Holly
M14	3405	16	Mount Holly
M15	3094	15	Mount Holly
T2.01	6515	22	Wallingford/Mount Holly
*Original Phase 1 Impact score as reported prior to Phase 2 revisions.			



## 2.4 Flood History

According to the Vermont Agency of Natural Resources document “Municipal Guide to Fluvial Erosion Hazard Mitigation” (2006), “Of all the natural hazards experienced in Vermont, flooding is the most frequent, damaging, and costly.” The guide documents that over the last 50 years, flood recovery has cost the state an average of \$14 Million a year and that during the period of 1995-1998 alone, flood losses in Vermont totaled almost \$57 Million. Of particular concern for towns and properties near streams, it notes that, “While some flood losses are caused by inundation (i.e. waters rise, fill, and damage low-lying structures), most flood losses in Vermont are caused by “fluvial erosion”. Fluvial erosion is caused by rivers and streams, and can range from gradual bank erosion to catastrophic changes in river channel location and dimension during flood events (Figure 3).”



**Figure 3:** These image shows damage from the 1927 flood. Left image is looking towards the intersection of Route 104 and Route 155 (Reach M10) in East Wallingford. Right image is of route 103 washout in Cuttingsville near reach M06/M07.

The Municipal Guide further documents that, “Closer study of our rivers and streams reveals that Vermont’s erosion hazard problems are largely due to pervasive, human-caused alteration during the past 150 to 200 years of our waterways and landscapes they drain. By end of the 19th century, forests had been cleared from many watersheds, resulting in major changes in watershed hydrology and sediment production. Towns and villages, the centers of commerce, grew on the banks of rivers, whose role in power generation and transportation at first outweighed flood risks. In addition, many watersheds were changed by development, agriculture, log drives, roads and railways.” The legacy of this landscape manipulation is rivers and streams, such as the Mill River, which are unstable and prone to sudden and significant fluvial erosion (Vermont Agency of Natural Resources 2006).

To further complicate and concern riparian landowners, precipitation trend analysis suggests that intense, localized storms, which can cause flash flooding, are occurring with greater frequency (Vermont Department of Public Safety, 2006). In order to better understand the flood history of the Mill River, long term data from the U.S. Department of the Interior, U.S. Geological Survey (USGS) gauge on the Otter Creek in Rutland, VT (Figure 4) and data from a smaller stream, the Ottauquechee River near West Bridgewater, VT (Figure 5), were obtained (United States Geological Survey 2007). Seventy-eight years of record are available for the Otter Creek gauge at Rutland, VT which provides a continuous record of flow from 1929 through the present. Only the last twenty-two (1985-2007) years of record are available on the Ottauquechee River.



The long term record at the Otter Creek gauge shows major events near 10,000 cfs occurred in the years 1947, 1949, 1973 and 1987. In 1938, during the New England Hurricane, the Otter Creek reached a peak of 13,700 cfs. In the near term record of the Ottauquechee River gauge (from 1985 to 2006) major events occurred in 1996, 1998, 2000, and 2002.

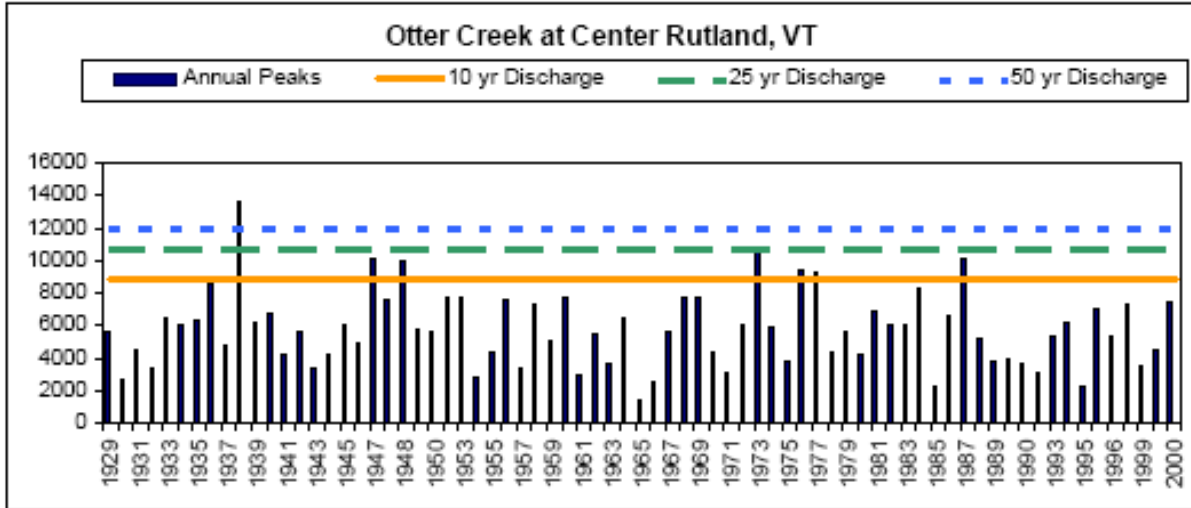


Figure 4: Flood frequency analysis for Otter Creek, Rutland, VT.

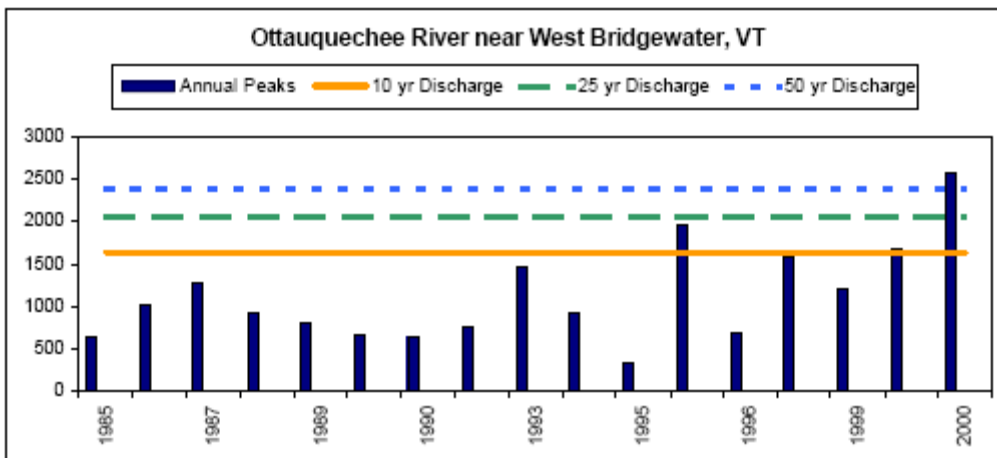


Figure 5: Flood frequency analysis for Ottauquechee River at West Bridgewater, VT.

## 2.5 Land Use and Hydrology

As reported in the Phase 1 Assessment Report (Rutland Regional Planning Commission 2007) most of the Mill River watershed is still forested. Some subwatersheds were reported to have as much as 9% in urban land use and 6% in cropland/pasture based on an analysis of data obtained from the Vermont Center for Geographic Information. Within the stream corridor urban land use percentage rose to as much as 60% of the corridor of one reach.

These numbers are important for many reasons because development in the watershed, both current and historic, may play a large impact on fluvial erosion, water quality and habitat



quality. For instance, according to a study conducted at the University of Maryland, (Barnes et al, 2007) declines in biological integrity and habitat quality are observable in watersheds with impervious cover ranging between 10 percent to 20 percent. The alteration of first-order, and in some cases, second-order channels (the small feeder streams that join to become the major tributaries to the Mill River) is problematic since runoff and sediments formerly distributed among many small channels are now delivered to fewer channels. The outcomes of this are more rapid flow velocities and flood peaks downstream.

Channel and bank instability, which leads to the physical degradation of streams, stems from the increased flooding that follows development. The signs of instability, however, may not become evident for several years following urbanization. Signs of instability include channel widening by bank erosion or a deepening of the channel through down cutting. With the former, channel beds may become covered in sediment; with the latter, beds are subject to frequent scours.

The study continues to describe that, “When development occurs on floodplains not previously developed, natural flooding will inevitably threaten the people and property inhabiting those floodplains, which can lead to environmental harm. What’s more, areas that did not commonly flood before urbanization may suffer more frequent inundations due to the greater volumes of runoff and increased flood heights associated with imperviousness. Properties and structures may be threatened by bank erosion from streams’ whose channels have been destabilized by upstream development (Barnes et al, 2001).”

In addition to current and historic development and land clearing the aptly named Mill River is also affected by another historic land use. At least a dozen mills dotted the Mill River during the 18th & 19th century. The mills used water from the river and its tributaries to power saws, grists, and fulling and carding machines for preparing wool. The exact location of many of these old mills is difficult to discern in the field as many years have passed. Several known mill locations include the Kingsley’s Grist Mill, which served some of Vermont’s grain production needs from 1882 until 1935 which was located at reach M03-B near the Shrewsbury and Clarendon town line. Also on the Mill River near the same town line was Smith’s Sawmill which operated well into the 1820’s. In Cuttingsville, several mills were in harnessing energy from the river from 1820 until 1927 when the great flood washed out the low (~5 foot high) dam spanning the river (at the bedrock grade control on reach M06 upstream from the Route 103 bridge).

### **3.0 METHODOLOGY**

The Phase 2 assessment followed procedures specified in the Vermont Stream Geomorphic Assessment Phase 2 Handbook (Vermont Agency of Natural Resources 2007b). All assessment data were recorded on the Agency of Natural Resources Phase 2 data sheets, and were entered in to the VTANR Stream Geomorphic Assessment data management system (DMS). The Phase 1 database was updated when necessary based on the field data collected during the Phase 2 assessment.



### **3.1 Field Protocols**

The VTANR Phase 2 stream geomorphic assessment protocol outlines a scientific methodology for gathering information about the stream channel and habitat conditions of a stream. The information can be used in watershed planning and detailed evaluations of aquatic habitat and erosion hazards. The Phase 2 Assessment is composed of field observations and measurements that help verify Phase 1 stream geomorphic data and provide more specific information about stream reaches of interest. Phase 2 assessments can be used to compare stream reaches within the same watershed to each other and/or to regional reference conditions.

The VTANR Phase 2 stream geomorphic assessment protocol includes seven categories of investigation. These categories are as follows:

1. Valley and River Corridor
2. Stream Channel
3. Riparian Banks, Buffers and Corridor
4. Flow Modifiers
5. Channel, Bed and Planform Changes
6. Rapid Habitat Assessment (RHA)
7. Rapid Geomorphic Assessment (RGA)

The parameters and protocols used for undertaking each of the above steps are outlined in the Phase 2 Handbook (Vermont Agency of Natural Resources, 2007b). The entire length of each Phase 2 reach was walked during the low flow months of August, September, and October 2007. Where necessary, reaches were further reduced to segments in order to capture important variations in the river channel and/or corridor that may impact assessment calculations and future management decisions.

Bank erosion, grade control structures, bank revetments, debris jams, depositional features, stormwater inputs, flood chutes and other important features were mapped and photographed in the field. In accordance with protocols, specific features were then digitized in ArcView 3.x shapefiles, referenced to the Vermont Hydrography Dataset (VHD), using the Feature Indexing Tool (FIT), a component of the Stream Geomorphic Assessment Tool (SGAT). All assessment data were recorded on the Agency of Natural Resources Phase 2 data sheets, and were entered in to the VTANR Stream Geomorphic Assessment data management system (DMS). The Phase 1 database was updated using the field data from the Phase 2 assessment.

### **3.2 Bridge and Culvert Assessment**

Fifteen bridge and culvert assessments were conducted on the Mill River mainstem following protocols listed in Appendix G of the Phase 2 Assessment Handbook (Vermont Agency of Natural Resources, 2007b).

### **3.3 Quality Assurance (QA) Review**

Assessments were carried out in compliance with the VTANR Programmatic QAPP (VTANR, 2003). Round River Design performed a thorough in-house QA review of the Phase 2 data in November of 2007. The DMS and the ArcView Shapefiles for the Mill River Phase 2 study



were submitted to Shannon Pytlik of the ANR for a QA review in November of 2007. Shannon Pytlik completed the QA review during the first week of December, 2007.

The following considerations and limitations apply to the Phase 2 data for the Mill River watershed:

- All Phase 2 features (including grade controls, bank erosion, stormwater inputs, bank armoring, berms, and more) were geo-located using the Feature Indexing Tool (FIT). These features are indexed to the centerline of the Vermont Hydrography Dataset (VHD) for the Mill River watershed (source date of 1995). In some instances, particularly where the stream has undergone recent planform adjustment such as near the confluence of the Otter Creek, and in areas of heavy forest, the actual channel position may be different than what was mapped in 1995. Therefore, locations and lengths of features indexed with the FIT should be considered approximate.

#### **4.0 PHASE 2 RESULTS**

Phase 2 Reach Summary Reports from the DMS are included on pages 1 through 46 of Appendix A. The Stream Geometry Data Report is found on page 47 of Appendix A, while page 48 of Appendix A provides the Rapid Geomorphic Summary Report. The results of the Phase 2 study are discussed below by reach number. In addition, four overview maps (Figures 6, 16, 22, and 26) have been included to provide a reference for location as well as to display channel modifications such as straightening and berming, both of which have greatly affected the condition of the Mill River.

The most common adjustment processes observed in the Mill River are widening and planform migration as a result of historic degradation within the channel. Degradation is the term used to describe the process whereby the stream bed lowers in elevation through erosion, or scour, of bed material. Aggradation is a term used to describe the raising of the bed elevation through an accumulation of sediment. The planform is the channel shape as seen from the air. Planform change can be the result of a straightened course imposed on the river through different channel management activities, or a channel response to other adjustment processes such as aggradation and widening. Channel widening occurs when stream flows are contained in a channel as a result of degradation or floodplain encroachment or when sediments overwhelm the stream channel and the erosive energy is concentrated into both banks.

#### **RIVER SECTION 1: MOUNT HOLLY TO EAST WALLINGFORD VILLAGE**

*The first section of river (illustrated in Figure 6) begins in Mount Holly and flows northerly towards East Wallingford Village. The valley alternates between very broad and narrow and land use changes from predominately agricultural and forested to commercial and residential in East Wallingford. Major significant impacts in this section include: removal of riparian vegetation, channel straightening, dredging, berming, channel armoring, and floodplain encroachment.*



## Mill River Watershed Phase 2 Geomorphic Assessment Reach Overview and Channel Alterations Map

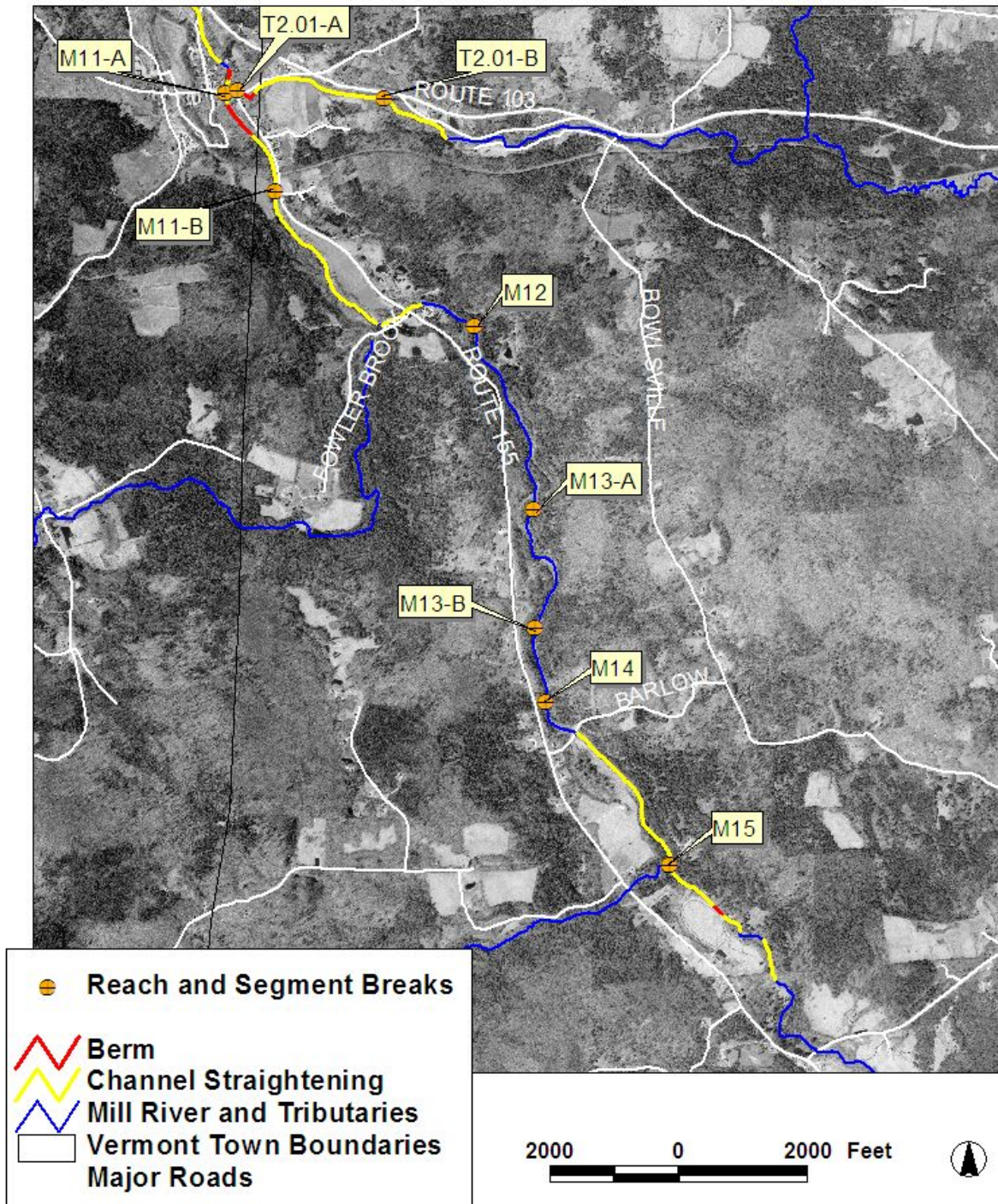


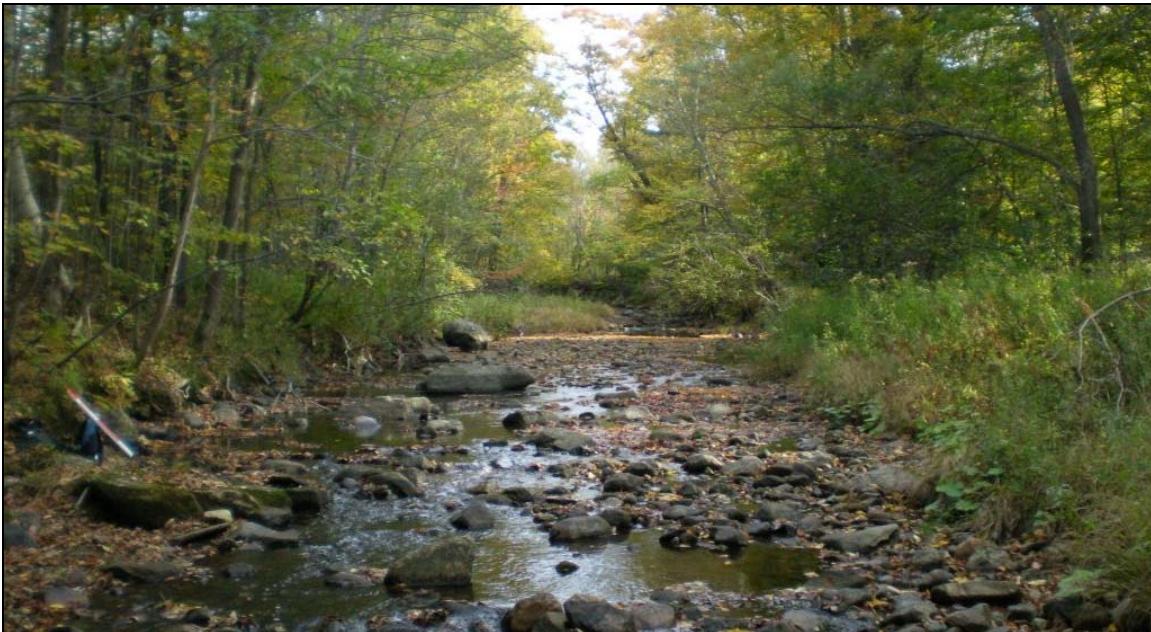
Figure 6: Overview of reaches M11 through M15 (including T2.01), and channel straightening and berming.



#### 4.1 Reach M15

The most upstream reach of this Phase 2 study, M15 of the Mill River is located at approximately 1490 feet above sea level in a very broad valley in the town of Mount Holly. The land on the southwestern border of the stream is pasture land and it appears that the river through this reach has been straightened and pushed up against the right valley wall in order to make more room for agricultural activities. Deep down-cutting into the streambed material has occurred (incision ratio of 2) likely as a result of this straightening. A stream type departure from a reference C riffle-pool channel to a B type plane bed was recorded (Figure 7). This departure has significantly reduced the capacity of this reach to attenuate floodwater and sediment. Currently the reach is exhibiting only minor widening and planform adjustment. This is likely due to the large substrates in the channel. Continued lateral adjustment is expected to occur as the river works to redevelop floodplain in this reach.

Construction of a new bridge was observed. With the exception of this structure, the rest of the reach was undeveloped although as stated the left corridor is currently being used for pasture and hay. By reference this reach should be an area where floodwaters and sediment are able to be stored in the Mill River system. Drainage work in the fields indicates that much of the land may be class III wetland. A riparian buffer restoration project on the left bank may be appropriate as only a very narrow row of trees currently exists.



**Figure 7. Reach M15 has been historically straightened. It is an incised channel with a planebed form that is currently undergoing minor channel widening and planform adjustment.**

#### 4.2 Reach M14

Reach M14 begins where Meadow Brook enters the Mill River in the town of Mount Holly. Similar to M15, this reach borders recently agricultural (some no longer in production) land. The river through this reach appears to have been straightened (Figure 8) and pushed up against the right (northeast) valley wall. An old meander scar is visible on aerial photographs



just upstream from the Barlow Road Bridge indicating a level of historic sinuosity has been lost. Deep incision was observed (measured ratio of 3). A stream type departure has ensued from a C-type channel to a B-type plane bed with a significantly reduced capacity to attenuate water and sediment due to the disconnection with the floodplain. Extensive widening and minor planform adjustments are occurring in the reach as the channel works to recover from the high level of incision.

Also of note in this reach, a large delta exists at the Meadow Brook confluence. The brook appears to be contributing coarse and fine sediment to the system as a result of tributary rejuvenation and possible other adjustments upstream. In regards to land use in the M14 corridor a single residence exists on the left bank. With much of the corridor still void of trees and undeveloped this reach may be suitable for an active geomorphic restoration project and/or buffer restoration efforts on the left bank.



**Figure 8. M14 has been historically straightened and is now has a plane bed form. Widening and planform adjustment are actively occurring.**

### **4.3 Reach M13**

Mill River reach M13 begins below the Barlow Road Bridge in Mount Holly (off of Vermont Route 155) and continues downstream for 3399 feet. The reach was split into two segments by RRD due to a natural change in channel confinement related to the valley width. This change in channel confinement resulted in a change in reference stream type within the reach.

#### **Segment B:**

Reach M13-B is a short segment located where the valley wall of the Mill River narrows thereby creating a semi-confined channel that is a B3 planebed by reference (Figure 9). Some development has occurred along the top of the left valley wall, however, the development is well above the floodplain and is only mentioned as the landowners in this



reach are in close proximity to the stream and may have an impact on its water quality. These houses are also located on top of a steep valley wall and may have some erosion hazard risks. Landowner education in this area to ensure that the forested buffer remains intact and stormwater and garbage is minimized from entering the channel would be beneficial in this segment.

In regards to the observed stream condition, the channel was found to be slightly incised. Some minor widening has occurred. Extreme adjustments are unlikely in this reach due to the stable tendencies of B3 planebed streams.



**Figure 9.** M13-B is a B3 planebed segment by reference.

### **Segment A:**

Mill River segment M13-A is a short segment located in a broad valley. Historic channel incision has led to minor channel widening and major channel planform adjustments. Despite a high degree of incision the stream has remained a C-type channel dominated by gravel substrates (Figure 10). The river is adjusting laterally through several flood chutes and has stored a significant amount of gravel in a large point bar. The well forested buffer in this corridor is an asset for the river as are the floodchutes and wetlands that will store some water and sediment during a large runoff event.



**Figure 10. M13-A is a C type channel that is undergoing planform adjustment and minor widening.**

#### **4.4 Reach M12**

Mill River reach M12 begins upstream from Fowler Brook Road in the town of Mount Holly. This is a C channel that flows through a well forested corridor in a broad valley (Figure 11). Historic incision has led to a great degree of instability in the channel. There were numerous active flood chutes documented as well as new gravel bars indicating both planform adjustment and aggradation as the channel works to redevelop floodplain. Channel widening was also considered a major active adjustment process. This reach may be both a source and sink of sediment and flood waters and will become more of a resource for the watershed as the channel evolution processes continue to improve floodplain access.



**Figure 11. M12 has incised historically. Major planform adjustment, widening, and minor aggradation were observed.**



#### 4.5 Reach M11

Mill River reach M11 begins just upstream from where Fowler Brook enters the mainstem and continues downstream to East Wallingford Village where another tributary (T2.01) enters from the east. M11 was divided into two segments for the Phase 2 assessment due to an observed change in the degree of corridor encroachment, bank armoring, buffer quality, and corridor land use. The segment break was near a railroad bridge crossing from which point downstream the channel is heavily impacted by straightening, streambank armoring, floodplain development, and fill.

##### Segment B:

Mill River segment M11-B captures an area where the valley walls open up and a tributary enters the Mill River from the west. In this segment, soils maps indicate that the parent material is alluvial suggesting the possibility that this area is an alluvial fan. There appears to have been a high degree of historic channel straightening that occurred in this reach, likely in order to increase the amount of agricultural land which dominates the right corridor. In addition active gravel extraction was observed to have recently occurred in the reach.

A high degree of channel incision has caused a departure from a C-type channel to a B plane bed (Figure 12). These channel alterations have caused a significant loss of sediment and floodwater attenuation in an important area upstream of East Wallingford and Cuttingsville Villages.

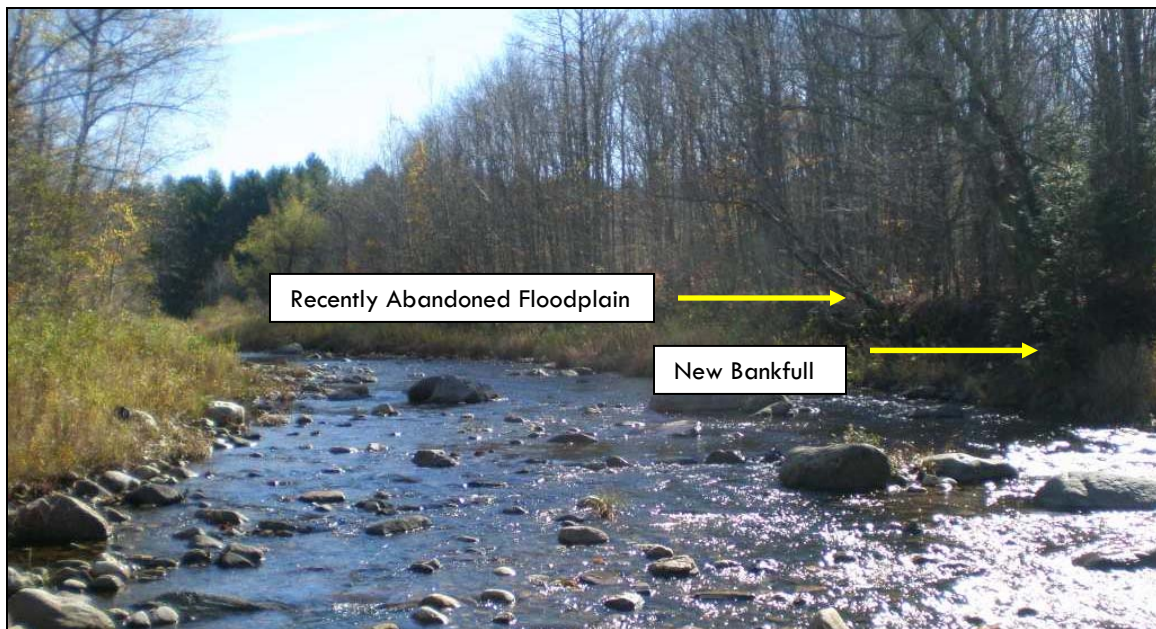


Figure 12. M11-B has been historically straightened. Currently undergoing major planform, widening, and aggradation adjustments.



### Segment A:

Mill River segment M11-A is one of two reaches that run through the Village of East Wallingford. Due to the relative location of the village to the river, extensive channel straightening, armoring, and dredging have altered this channel, likely in response to past flood events. These alterations have transformed riffle-pool system in a broad valley into a F-type stream with a plane bed form lacking in habitat as well as floodwater and sediment storage capabilities. Vermont Route 155 and commercial and residential development have significantly encroached on the channel (Figure 13). The bridge at the downstream end of the reach appears to be a debris/ice jam potential hazard - it already has held enough sediment behind the middle pier for a fully vegetated mid-channel bar to form. In addition a railroad bridge crossing which funnels both a road and the river underneath appears to be limiting sediment transport. The upstream aggradation the bridge is causing may be increasing an erosion issue on pasture land on the left bank of M11-B. Opportunities to increase conveyance of water and sediment underneath these bridges may be appropriate projects to reduce fluvial erosion hazard in East Wallingford Village.



**Figure 13.** M11-A flows through East Wallingford Village and has a high degree of incision due to channel straightening and dredging.

## 4.5 Reach T2.01

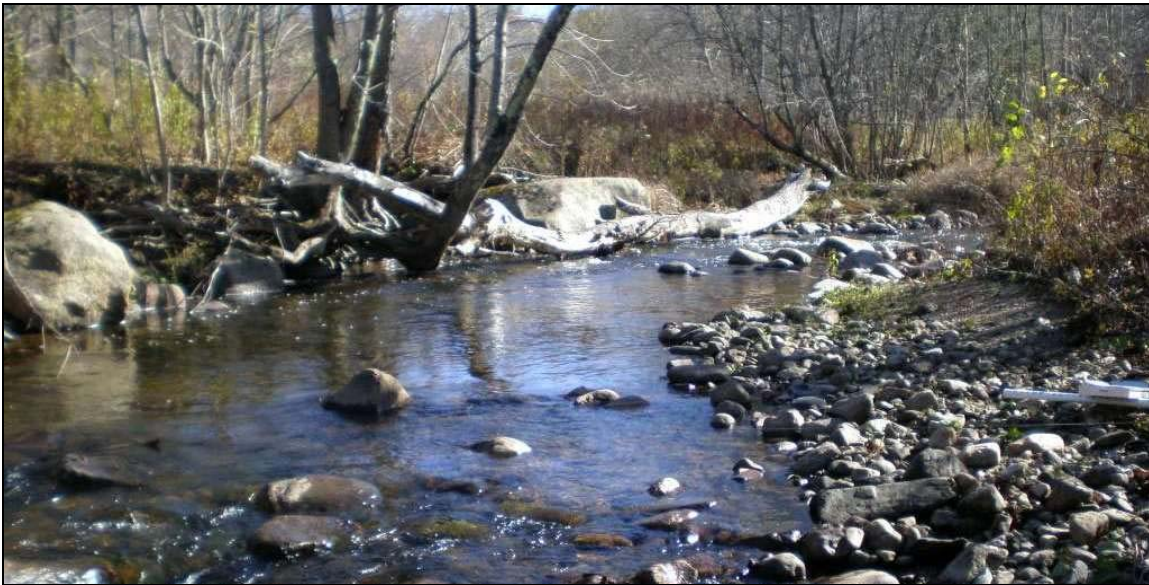
Mill River watershed reach T2.01 is the downstream end of a large tributary to the Mill River. This tributary is unnamed on the 1984 USGS topography map. The reach studied for the Phase 2 Assessment begins at the Bowlsville Road Bridge and continues 6515 feet downstream to the confluence with the Mill River in East Wallingford Village. The reach was divided into two segments by RRD due to an extreme amount of channel straightening and bank armoring that was observed near the lower end of the reach.

### Segment B:

Tributary T2.01-B begins at the Bowlsville Road Bridge and ends downstream near the west entrance to Millbrook Lane. The upper portion of this segment is in fair geomorphic condition.



It has undergone major historic incision, however, is actively working to redevelop floodplain and has a fairly well developed riffle-pool bedform that looks to be providing good habitat with several deep pools. Active planform adjustment has led to the development of small gravel bars and a juvenile floodplain in some areas (Figure 14). Continued planform, widening, and aggradation adjustments are expected. Preventing further development of the floodplain of this reach will be an important step to ensure that floodwaters and sediment storage capacity is retained in this reach.



**Figure 14.** T2.01-B has historically incised, however is undergoing major planform adjustment as a new floodplain bench is developed.

### **Segment A**

Tributary segment T2.01-A has seen extensive historic channel straightening and armoring (Figure 15). There is also evidence of dredging and windrowing just above the Route 140-East Bridge. The right side of the floodplain has been filled almost entirely by Routes 140 and 103 which create the top of the right bank. On the left side of the channel the riparian buffer has been cleared down to a thin strip of vegetation along the top of the bank. Agricultural land use dominates the left corridor while commercial and residential land use dominates the right corridor. Cross section analysis indicates that a stream type departure has occurred from a C-type channel to an F-type stream due to a high grade of incision.



**Figure 15. T2.01-A has been historically straightened and is now has a plane bed system that is disconnected from its floodplain.**

#### **RIVER SECTION 2: EAST WALLINGFORD VILLAGE TO CUTTINGSVILLE**

*The second section of river (illustrated in Figure 16) begins below East Wallingford Village and continues downstream to Cuttingsville. The valley alternates between very broad and narrow and the land use changes from commercial and residential in East Wallingford to agricultural and then back to development in Cuttingsville. Major significant impacts in this section include removal of riparian vegetation, channel straightening and dredging, berming, channel armoring, and floodplain encroachment.*

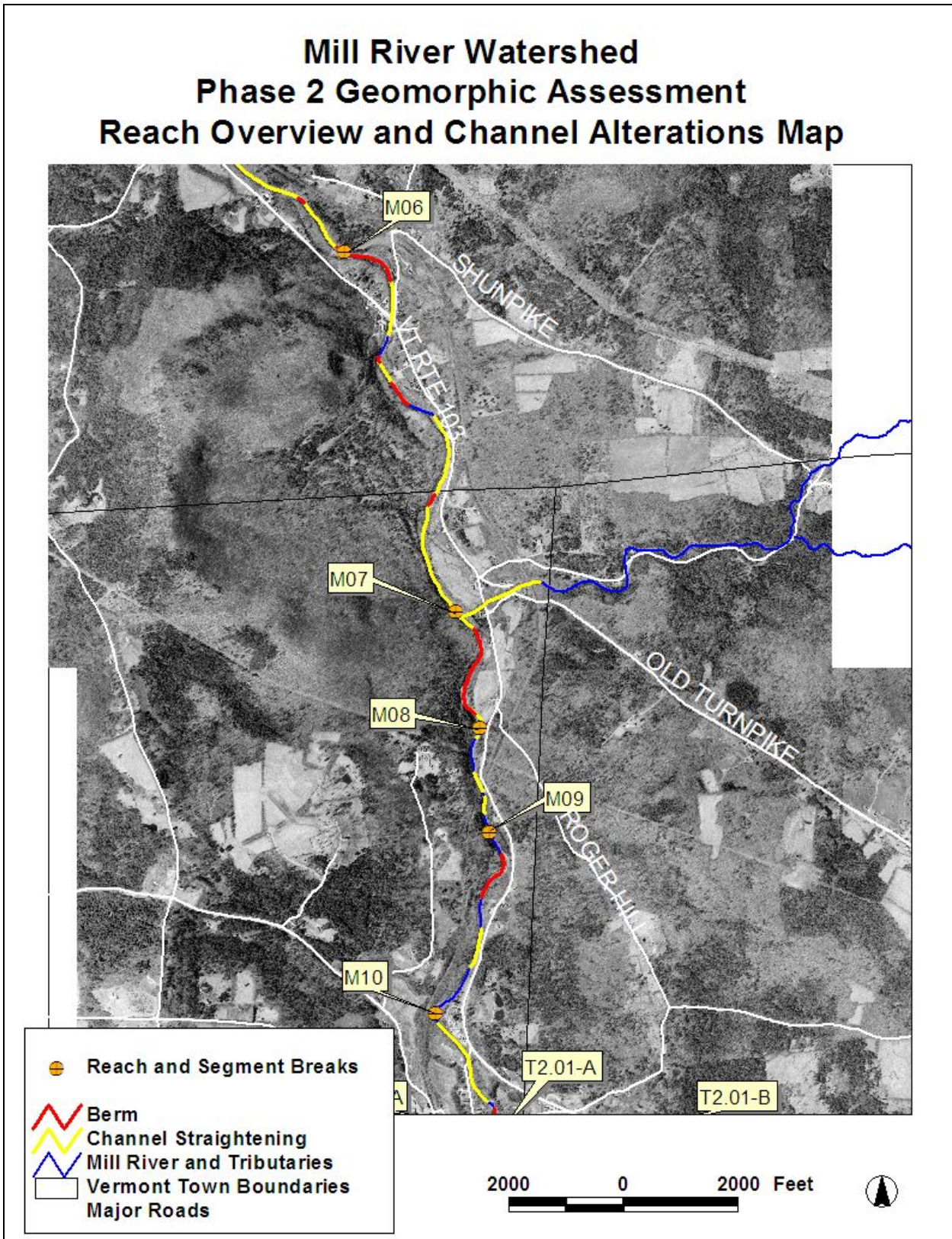


Figure 16: Overview of reaches M06 through M10 and channel straightening and berming.



#### 4.6 Reach M10

Mill River reach M10 flows through East Wallingford Village. The reach begins just below the Route 140 Bridge at the confluence with tributary T2.01 and continues downstream for 2369 feet. This short reach has been highly managed in order to maintain its location and minimize flooding in the Village. RRD observed evidence of channel straightening and armoring (Figure 17). The high incision ratio has caused a stream type departure from a C-type channel which historically flowed through a forested broad valley to a B-type plane bed system that has a high degree of floodplain development. Due to the significant investment in infrastructure within this reach the Mill River is likely to be maintained near its current configuration. Deteriorating bridge conditions on Village Street may provide an opportunity for redesigning access to the Village and or at least allowing better sediment and water transport under the bridge (which is currently holding sediment in its mid-pier and may create debris jam and flooding under the right conditions).



**Figure 17.** M10 has been historically straightened. There is a high degree of bank armoring within the reach.

#### 4.7 Reach M09

Although development pressure is not as significant as in the reach upstream, Mill River reach M09 has been impacted predominately by VT Route 103 which has changed the valley width from broad to narrow. In order to protect the roadway and a few structures located within the river corridor, extensive berming and channel armoring has occurred (Figure 18). Berming and straightening has increased the erosive forces in the channel leading to a high degree of incision (ratio of 1.8) and a stream type departure from a C riffle-pool channel to a B plane bed system. Adjusting to this incision, the stream has undergone extreme channel widening. Extensive channel management (riprap, dredging, straightening) has prevented the channel from developing new floodplain and storing sediment.



**Figure 18.** The valley width of M09 has been decreased due to encroachment from VT Route 103. The channel has undergone extreme widening.

#### 4.8 Reach M08

Mill River reach M08 is a short reach in a semi-confined valley that has been further confined by Vermont Route 103. Despite a high degree of historic channel incision (Figure 19) the stream remains a C-type channel with access to floodplain during only the largest events. Although there is no stream type departure or bedform change (planebed by reference) the stream is nearly an F-type channel due to the high degree of incision. As a result of the incision the current sediment and floodwater storage capability of this reach has been significantly reduced.



**Figure 19.** M08 is a short reach that has limited floodplain access due to streambed degradation.



#### 4.9 Reach M07

Mill River reach M07 is a very short reach that appears to have been straightened up against the left valley wall in order to increase cultivatable land. Significant berming has occurred on the right bank in order to prevent flooding (Figure 20). Incision and channel widening in response to these channel management activities have led to a stream type departure from a C channel to a F-type channel and loss of bedform from riffle-pool to plane bed system.



Figure 20. M07 has seen significant berming on the right bank causing a significant loss of floodplain access.

#### 4.10 Reach M06

Mill River reach M06 runs directly through Cuttingsville Village with a great deal of human alteration, both historic and recent. Channel straightening, berming, dredging, armoring, and windrowing were all observed. Additionally much of the floodplain has been filled by development and roads (Figure 21) increasing stormwater inputs into the system. It appears that the stream may have been straightened and relocated up against the left valley wall through much of the reach. A high degree of incision (1.8 ratio) was observed with major channel widening and planform adjustments currently occurring. Although there was some evidence of juvenile floodplain creation most of the reach still lacks significant floodplain benches. Some opportunities for channel adjustment and floodplain reconnection still exist in this reach.



**Figure 21. M06 flows through Cuttingsville and has been significantly impacted by channel straightening, armoring, berming, and floodplain development.**

### **RIVER SECTION 3: CUTTINGSVILLE TO THE UPPER CLARENDON GORGE**

*The third major section of river (illustrated in Figure 22) begins just downstream of Cuttingsville Village. From here down to the upper Clarendon Gorge, the Mill River flows through a broad valley. Major significant impacts in this section include removal of riparian vegetation, channel straightening and dredging, corridor encroachment and an undersized bridge.*



### Mill River Watershed Phase 2 Geomorphic Assessment Reach Overview and Channel Alterations Map

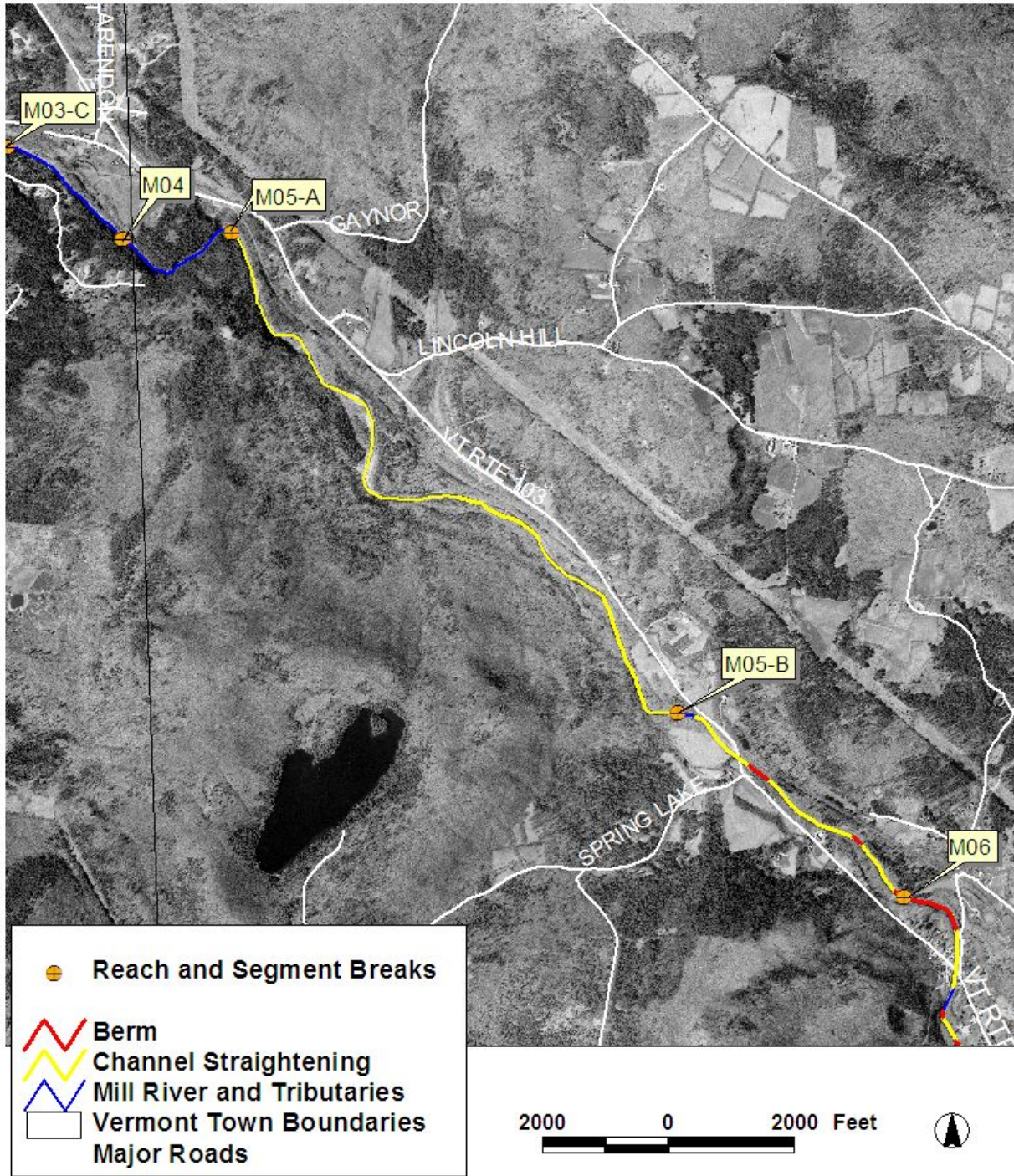


Figure 22: Overview of reaches M03-C through M06 and channel straightening and berming.



#### 4.11 Reach M05

Mill River reach M05 is a long reach (16699 feet) that begins just below Cuttingsville Village and flows downstream to the beginning of the Upper Clarendon Gorge near the Long Trail suspension bridge. RRD divided the reach into two segments based on major shifts in corridor encroachment and channel dimensions as the stream transitions from the residential, commercial, and agricultural development near Cuttingsville and enters a forested corridor.

##### **Segment B:**

M05-B, as with many segments upstream, is heavily influenced by recent and historic channel management activities including berming, armoring, dredging and windrowing. Floodplain encroachment from VT 103 and residences and commercial development along with significant channel straightening have led to an incised stream that has departed from a reference C riffle-pool system (Figure 23). The B-type channel that now exists has less capacity to attenuate floodwaters and sediment and is a plane bed system with low quality habitat. A berm at the upstream end of the reach has prevented access to a major flood chute. Active major widening is occurring in response to channel incision. The planform and widening adjustments are limited by the valley wall, armoring, and dredging. Although there are significant corridor encroachments, some limited floodplain connectivity may be able to be restored in this reach in areas where structures are not currently located.



**Figure 23.** M05-B has been significantly altered through channel straightening, berming, armoring, and floodplain encroachment.

##### **Segment A:**

Mill River segment M05-A flows through a well forested corridor. Limited encroachment by the railroad track has impacted the right corridor. The channel has incised enough to abandon an old floodplain and begin to develop a juvenile floodplain. The degree of channel incision is low enough so that the stream remains unentrenched and able to store flood waters during the largest events. A large mass failure within this reach is a source of fine sediment and gravels to the downstream system (Figure 24). This sediment appears to be



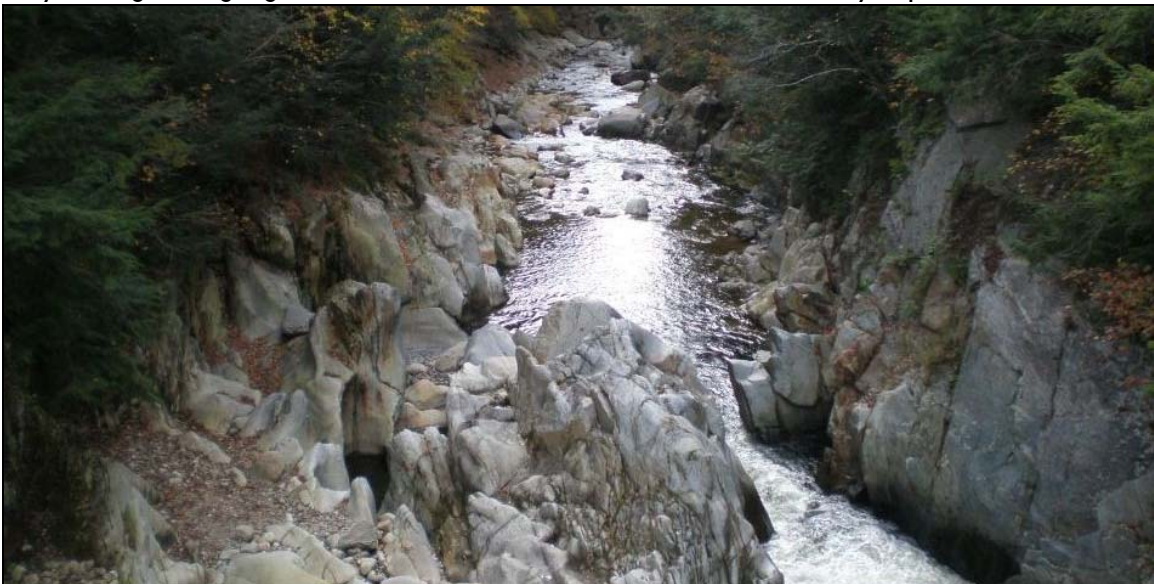
assisting the stream in rebuilding bars and floodplain downstream. Several large flood chutes exist in the stream corridor indicating planform adjustment.



**Figure 24.** A large mass failure on the left bank is providing some sediment recruitment to help rebuild bars in the incised Mill River reach M05-A.

#### 4.12 Reach M04

Mill River reach M04 encompasses the Upper Clarendon Gorge (Figure 25). The gorge begins at a sharp southwestward bend in the river where a Long Trail suspension bridge hangs from the bedrock cliffs on each side. The Mill River cuts through the Dalton Formation (a cambrian dolomite/conglomerate), the Mount Holly Gneiss, and the Cheshire Quartzite on its way through the gorge. Due to the bedrock this reach received only a partial Phase 2.



**Figure 25.** M04 consists of the Upper Clarendon Gorge.



**RIVER SECTION 4: UPPER CLARENDON GORGE TO CONFLUENCE WITH THE OTTER CREEK**

The final section of river (illustrated in Figure 26) begins below the Upper Clarendon Gorge (near the Kingsley Covered Bridge) in the town of Clarendon. From here down to the confluence with the Otter Creek, the Mill River flows through a few bedrock dominated reaches bordered by state and federally owned wooded landscapes before spilling onto the much broader Otter Creek valley bottom. Major significant impacts in this section include removal of riparian vegetation, channel straightening, dredging, and several undersized bridges.

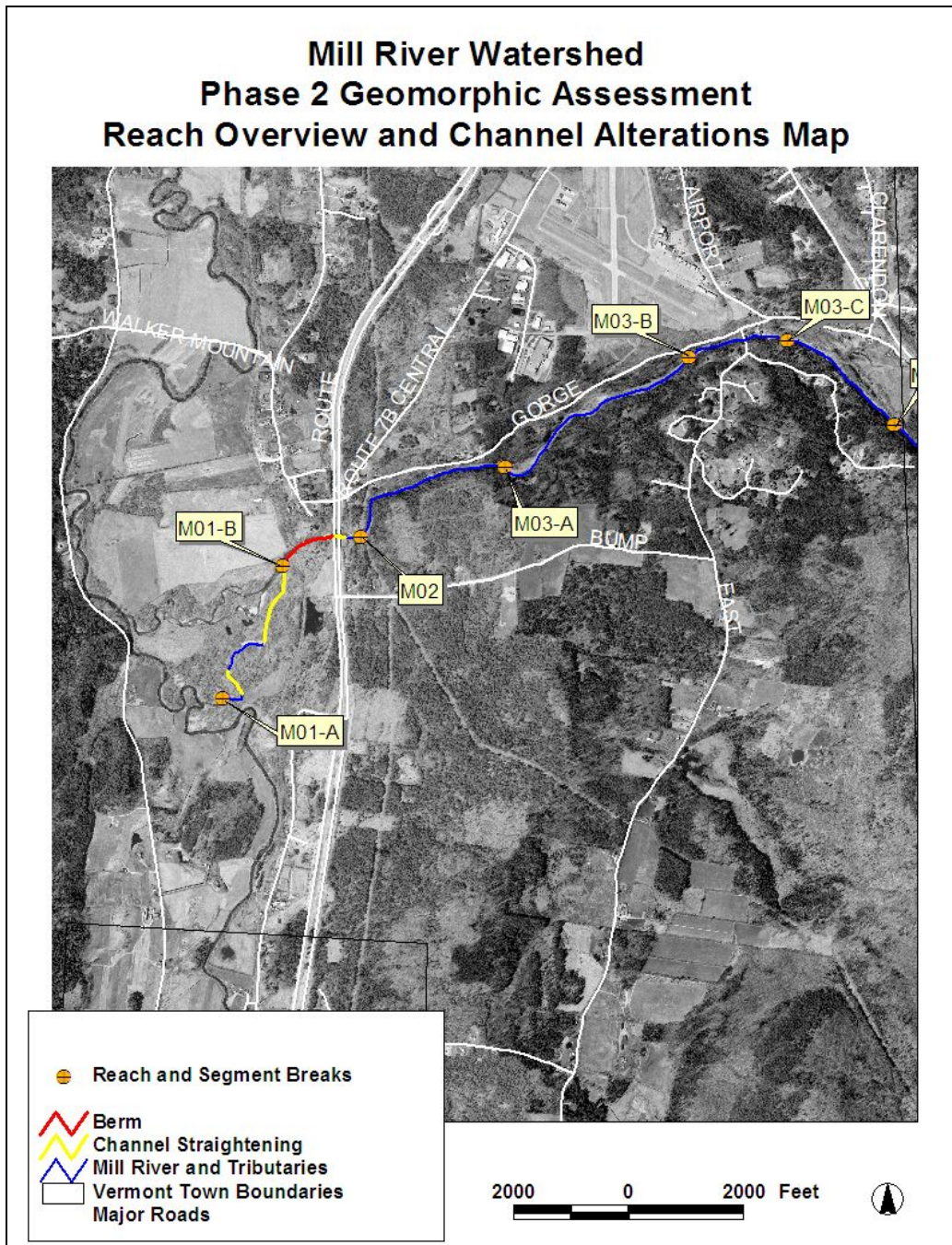


Figure 26: Overview of reaches M01 through M03 and channel straightening and berming.



### 4.13 Reach M03

Mill River reach M03 flows through residential and forested land in the town of Clarendon. The reach begins near the Clarendon/Shrewsbury town line at the end of the Upper Clarendon Gorge. RRD divided this reach into three segments due to significant changes in channel dimensions, entrenchment, and grade controls that occur throughout this reach.

#### Segment C:

This segment is located between the Upper Clarendon Gorge (a bedrock controlled section) and the bedrock controlled segment at the former Kingsley Mill site. Channel incision observed here may be a result of the river working back through sediments that were stored when there was a mill dam, or due to a sediment imbalance upstream. The Mill was in operation from 1882 until 1935. There are residences encroaching on the river corridor on the left bank, and land was cleared for agriculture on the right of the corridor. This reach was observed to be a B-type channel with a planebed form dominated by gravel substrates (Figure 27). This is expected to be the reference stream type despite major channel widening.

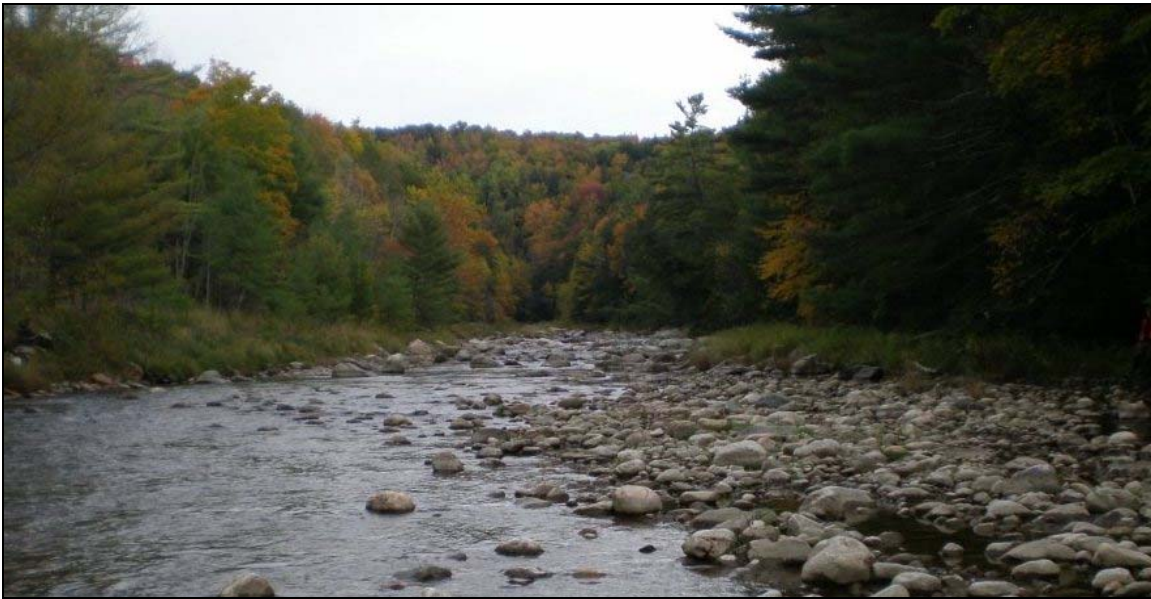


Figure 27. M03-C is a short plane bed segment between two bedrock grade controls.

#### Segment B:

Segment M03-B is a short bedrock controlled segment that includes the former Kingsley Mill dam site (Figure 28). Bedrock grade control and bedrock on most of the banks limited this segment to receiving only a partial Phase 2 assessment. Although some residential development has affected the riparian buffer, in general the bedrock has created a stable geomorphic condition in this segment.



**Figure 28. M03-B is a bedrock controlled segment at the site of the former Kingsley Mill.**

#### **Segment A:**

Mill River segment M03-A is also located between two bedrock grade controlled segments. Although this segment is slightly incised, it seems to be an area of sediment and floodwater attenuation, having large gravel bars, accessible floodplains and a forested buffer greater than 100 feet on both sides (Figure 29). As a result of the incision there is evidence of widening that has occurred in this segment. Minor planform and aggradation were observed as the stream rebuilds floodplain on both the left and right banks. This area will likely continue to be an important area in the lower Mill River watershed for sediment and floodwater attenuation.



**Figure 29. M03-A is bordered by a forested buffer. Large bars of unvegetated sediment indicate recent adjustments in the channel.**



#### 4.14 Reach M02

Mill River reach M02 consists of the Lower Clarendon Gorge (Figure 30). The gorge is carved through the Cambrian Dalton formation and Cheshire Quartzite (Van Diver 1987). The Dalton formation lies on Precambrian rocks of the Green Mountain core at the upstream end of the gorge. Only a partial assessment was conducted for this reach due to the bedrock controlled channel.



Figure 30. M02 is the Lower Clarendon Gorge in Clarendon.

#### 4.15 Reach M01

Reach M01 is a highly dynamic reach located at the foothills of the Green Mountains where the Mill River spills out onto the valley floor of the Otter Creek. Here the bedrock dominated channel of the Lower Clarendon Gorge gives way to the alluvial soils of the Otter Creek Valley. This area is a natural alluvial fan area for the Mill River. Channel migration, sediment deposition, and seasonal flooding were likely frequent occurrences in the predevelopment watershed. RRD divided this reach into two segments due to a significant amount of recent channel alteration that has occurred in the area just downstream from the Clarendon Gorge.

##### **Segment B:**

Mill River segment M01-B is a C-type channel by reference in a very broad valley. Significant channel management in the form of straightening, dredging, berming, and armoring has significantly altered the channel dimensions and entrenchment of this segment. The current incision ratio was observed to be 1.8 indicating that both berming and bed degradation have affected the nature of the channel. A landowner whose family has managed much of the surrounding land recounts the 1973 flood that washed out the railroad bridge. He noted that there was significant dredging of the stream channel after the 1973



flood between the railroad bridge and Route 7. He also noted that in the 1950's the area below the railroad bridge was dredged for gravel to help build Route 103. Field observers from RRD and VTANR recorded that the channel has become a plane bed cobble dominated channel as a result of increased stream power (Figure 31).



**Figure 31. M01-B has been significantly impacted by channel straightening, berming, dredging, and armoring.**

### **Segment A:**

M01-A is the lowest reach of the Mill River. This segment is located at a highly dynamic zone where floodwaters and sediment coming down from the relatively steep Green Mountain hillsides are released in the flat valley bottom of the Otter Creek. Scientists from RRD and VTANR observed a high degree of bank erosion and channel adjustment in this segment (Figure 32). The steambank material are composed of silts and clay near the confluence with the Otter Creek and the bank height increases significantly which is likely due to the influence of the Otter Creek. There is plenty of woody debris recruitment in this reach as the river migrates laterally pulling in trees. Although some areas are in need of a healthier riparian buffer, the habitat in this reach overall looks to provide good depth cover and structure. It is certain that continued investment in channel management will be necessary in order to keep the channel in its relative location, however this area is highly dynamic and should be expected to always be undergoing extreme adjustment, especially during flood events as the river reacts to changes in sediment transport and hydrology in the watershed upstream.



**Figure 32. M01-A is a gravel dominated reach near the confluence with the Otter Creek. Agricultural land use dominates the corridor. The river is undergoing extreme planform adjustment and major widening and aggradation.**

## 5.0 BRIDGE AND CULVERT ASSESSMENT RESULTS

Bridge and culvert assessments were completed for all permanent structures located on Phase 2 reaches. Complete bridge and culvert assessment results can be found in Appendix C of this report. Fifteen structures were assessed according to VTANR protocols for such characteristics as specific height and width, geomorphic and fish passage data, nearby vegetation, and evidence of wildlife.

During the Phase 2 Assessment a number of channel and floodplain constricting bridge and culverts were observed to be considerably narrower than the existing bankfull width, subsequently causing instability in the river (Table 2). In particular need of replacement based on the problems observed and their percent bankfull width are the Route 155 Bridge in East Wallingford and the Barlow Road Bridge in Mount Holly. Also the two structures located on T2.01 were found to be undersized. From a technical measurement the railroad bridge on M11-A does not appear to be a problem, however, the channel width of the river from bridge abutment to the Route 155 embankment was only 39 feet (70% reference channel width) and should also be considered a problem structure (Figure 33).



<b>TABLE 2: MILL RIVER BRIDGES: PROBLEMS AND POTENTIAL FAILURE MODES</b>																	
<b>Reach</b>	<b>Road</b>	<b>Type</b>	<b>F1</b>	<b>F2</b>	<b>F3</b>	<b>F4</b>	<b>F5</b>	<b>F6</b>	<b>P1</b>	<b>P2</b>	<b>P3</b>	<b>P4</b>	<b>P5</b>	<b>P6</b>	<b>P7</b>	<b>Width</b>	
M15	Private road	Bridge	-	-	-	X	-	X	X	X	X	X	-	-	X	111 %	
M14	BARLOW RD	Bridge	-	-	-	-	-	-	-	-	-	-	-	-	X	77 %	
M11-B	ROUTE 155	Bridge	-	X	X	X	X	X	-	X	X	-	-	-	X	54 %	
M11-A	Railroad	Bridge	X	-	-	X	-	X	X	-	-	-	-	-	-	190 %	
M10	ROUTE 140-EAST	Bridge	-	-	-	X	-	X	X	-	X	X	-	-	X	172 %	
M10	VILLAGE ST	Bridge	-	-	X	X	-	X	-	-	X	-	-	-	X	253 %	
M08	Railroad	Bridge	-	-	X	-	-	X	X	X	X	-	-	-	X	163 %	
M06	VT RTE 103	Bridge	-	-	-	-	-	X	-	-	-	-	X	-	X	171 %	
M05	VT RTE 103	Bridge	-	-	-	X	-	X	X	-	X	X	-	-	X	237 %	
M03-B	EAST ST	Bridge	-	-	X	-	-	-	-	X	-	-	-	-	X	85 %	
M01-B	ROUTE 7	Bridge	-	-	-	X	-	X	X	-	-	X	-	-	X	364 %	
M01-B	ROUTE 7	Bridge	-	-	-	X	-	X	X	-	-	X	-	-	X	364 %	
M01-B	Railroad	Bridge	-	-	-	X	-	X	X	-	-	X	-	-	X	154 %	
T2.01-B	BOWLSVILLE RD	Bridge	-	X	X	X	X	-	-	X	X	-	-	-	X	50 %	
T2.01-A	ROUTE 140-EAST	Bridge	-	X	X	X	X	X	X	X	-	X	X	-	X	61 %	
<b>Failure Modes</b>																	
<b>F1</b>	Concern for structure due to fluvial condition or process																
<b>F2</b>	Potential failure due to out-flanking																
<b>F3</b>	Potential failure due to scour																
<b>F4</b>	Potential failure due to ice or debris jam																
<b>F5</b>	Structure related damage due to flooding of adjacent property																
<b>F6</b>	Structure related damage due to erosion of adjacent property																
<b>Existing Problems</b>																	
<b>P1</b>	Upstream sediment deposit																
<b>P2</b>	Upstream Scour and/or erosion present																
<b>P3</b>	Downstream Scour and/or erosion present																
<b>P4</b>	Inlet obstruction present																
<b>P5</b>	Poor location or alignment																
<b>P6</b>	Beaver activity																
<b>P7</b>	Floodplain filled entirely or partially by roadway approaches																
<b>Width</b>	Structure width divided by channel width as a percent (% bankfull width)																



**Figure 33: The railroad bridge span on M11-A is adequate for the Mill River, however, location of Route 155 in relation to the bridge and the river creates a channel constriction between the bridge abutment and the road.**

## 6.0 SUMMARY AND DISCUSSION

Understanding the response to changes in the sediment regime, hydrology, and channel of the Mill River is highly useful for informing restoration and planning efforts.

### 6.1 Watershed, Floodplain, and Channel Stressors

Natural and anthropogenic impacts may alter the equilibrium of sediment and flow in natural stream systems and set in motion a series of morphological responses (aggradation, degradation, and widening and/or planform adjustment) as the channel tries to reestablish a dynamic equilibrium. Small to moderate changes in slope, discharge, and/or sediment supply can alter the size of transported sediment as well as the geometry of the channel; while large changes can transform reach level channel types (Ryan 2001).

Between the 1700's and the 1800's, the building of roads and railroads within Vermont floodplains, deforestation, and straightening and moving streams to accommodate agricultural fields and villages resulted in unstable river channels. Even in recent decades, large-scale channelization practices have been employed to reclaim damaged lands after large flood events. The 1970's and 1980's were also a period of extensive gravel mining in many Vermont streams. Other human-induced practices that have contributed to stream instability within the Mill River watershed include (also see Table 3):

- Forest clearing
- Channelization, berming, dredging, and bank armoring
- Removal of woody riparian vegetation
- Floodplain encroachments
- Undersized bridges
- Loss of wetlands and floodwater storage



These anthropogenic practices have altered the balance between water and sediment transport within the Mill River watershed. Channel morphologic responses to these practices contribute to channel adjustment that may further create unstable channels (Figure 34).

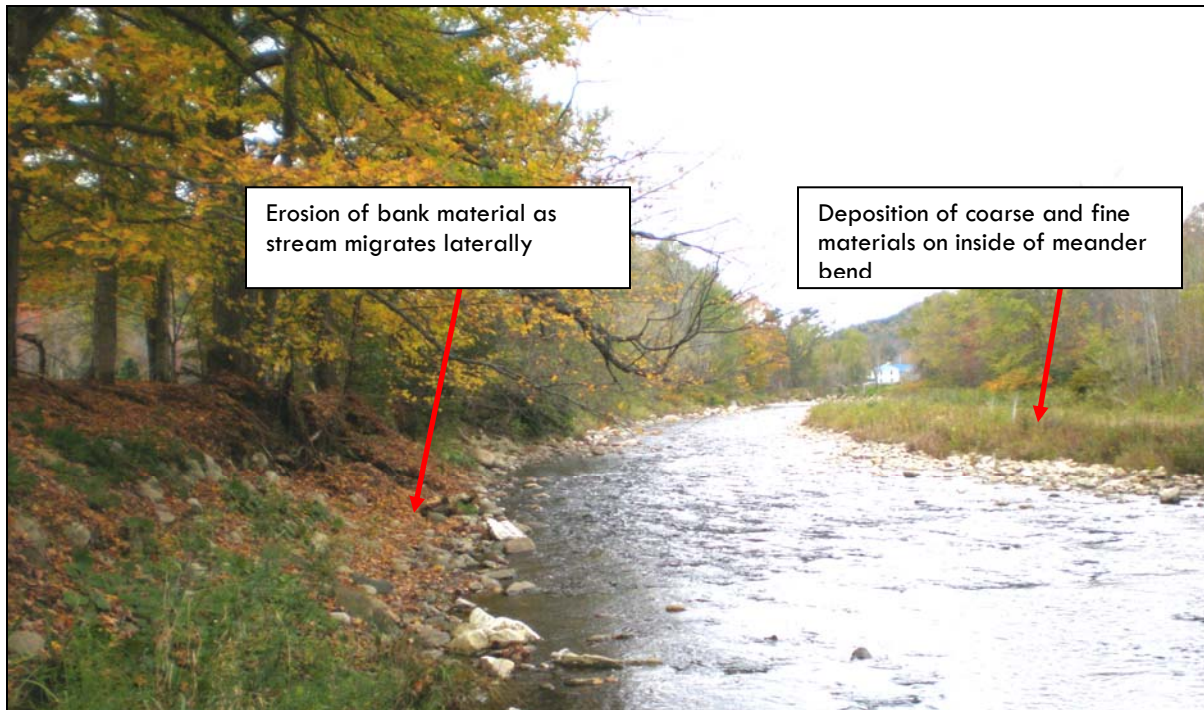


Figure 34: Planform migration associated with floodplain development in the Mill River.

## 6.2 Channel Adjustment and Evolution

The stability of a stream channel is based on maintaining a certain flow of water, shape and slope of the channel, and sediment load. When any of these change significantly, the river channel must change, typically resulting in erosion of the stream bed or banks. A steep channel in a relatively flat valley may initiate a process of bed degradation or incision. Post-flood channel straightening, gravel mining of point bars, and similar watershed and reach stressors have the effect of increasing stream channel gradients. Once a stream begins to incise, it will typically erode its way through an evolution process until it has created a new floodplain at a lower elevation in the landscape. The common stages of channel evolution, as shown below in Figure 35, include:

- A pre-disturbance period
- Incision – Channel degradation and downcutting
- Aggradation and channel widening
- The gradual formation of a stable channel with access to its floodplain at a lower elevation.



**Table 3: Watershed, Floodplain, and Channel Stressors**

Segment Number	Watershed Stressors			Floodplain and Channel Stressors									
	Deforestation in the 1800's	Increased Road Networks (1800-1900's)	Historic Flood Events	Channelization/Straightening	Dredging	Berming	Bank Armoring	Floodplain Development	Loss of Forested Buffers	Impoundment (Historic)	Gravel Extraction	Undersized Bridge/Culvert	Stormwater Inputs
M15				√		√			√				√
M14				√			√		√			√	√
M13-B													√
M13-A													
M12													√
M11-B				√	√		√		√		√		√
M11-A				√	√	√	√	√	√			√	√
M10				√	√	√	√	√	√			√	√
M09				√	√	√	√	√					
M08				√			√	√					√
M07				√	√	√		√	√				
M06				√	√	√	√	√	√	√			√
M05-B				√	√	√	√	√	√				√
M05-A				√	√		√						√
M04													
M03-C									√				
M03-B									√	√			√
M03-A													
M02													
M01-B				√	√	√	√	√	√		√		
M01-A				√	√				√				
T2.01-B							√	√				√	
T2.01-A	↓	↓	↓	√	√	√	√	√	√			√	

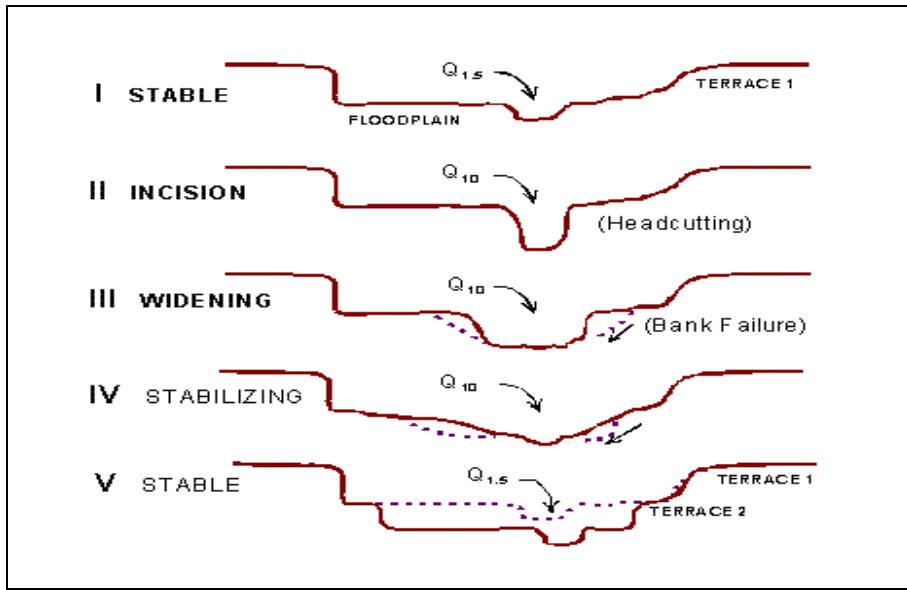


Figure 35. F-stage Channel Evolution Process (from Vermont Agency of Natural Resources, 2006)

The bed erosion that occurs when a meandering river is straightened in its valley is a problem that extends to other sections of the stream. Incision points will travel upstream and into tributaries eroding sediments from otherwise stable streambeds. These bed sediments will move into and clog reaches downstream leading to lateral scour, widening, and erosion of the streambanks. Channel evolution processes may take decades to play out. Even landowners that have maintained wooded areas along their stream and riverbanks may have experienced eroding banks as stream channel slopes adjust.

It is difficult for streams to attain a new equilibrium where the placement of roads and other infrastructure has resulted in little or no valley space for the stream to access or to create a floodplain as is the case with many of the Mill River's reaches. Landowners and government agencies have repeatedly armored and bermed reaches of Vermont's rivers to contain floodwaters in channels. These efforts have proven to be temporary fixes at best, and in some cases have led to disastrous property losses and natural resource degradation. A more effective solution is to limit encroachments within the riparian corridor and maintain a buffer of woody vegetation between the stream and adjacent land uses. Maintaining vegetated riparian corridors and offsetting development limits the conflict between property investments and the natural processes of flooding and channel migration that occurs gradually over time. Given room, a channel can adjust its shape and slope to changes in flow and sediment load. In general, the space provided by an established riparian corridor allows the river or stream system to be more resilient to watershed changes, thereby protecting the fish, wildlife, and humans that depend on Vermont's rivers and streams (Vermont Agency of Natural Resources 2006).

The reach condition ratings of Mill River indicate that several of the reaches are actively, or have historically, undergone a process of minor or major geomorphic adjustment. The most common adjustment processes in the Mill River are widening and planform migration as a result of historic degradation within the channel. Several of the reaches studied in the Mill River watershed are undergoing a channel evolution process in response to large scale



changes in its sediment, slope, and/or discharge associated with the human influences on the watershed. Table 4 below summarizes the channel evolution of each study reach and the primary adjustment processes that are occurring.

<b>Table 4. Stream Type, Active Adjustment Processes*, and Channel Evolution Stage</b>							
<b>Segment Number</b>	<b>Incision Ratio</b>	<b>Entrenchment Ratio</b>	<b>Width to Depth Ratio</b>	<b>Reference Stream Type</b>	<b>Existing Stream Type</b>	<b>Channel Evolution Stage</b>	<b>Active Adjustment Process</b>
M15	2.08	2.18	17.09	C4	B3c	III	None
M14	3.16	2.0	20.51	C3b	B3	III	<b>Widening</b>
M13-B	1.97	1.75	27.83	B3	B3	III	None
M13-A	1.85	5.83	28.17	C4	C4	IV	<b>Planform</b>
M12	1.89	4.88	30.48	C4	C4	IV	<b>Widening Planform</b>
M11-B	2.33	1.54	29.74	C4	B3c	III	<b>Aggradation Widening Planform</b>
M11-A	3.19	1.37	36.00	C4	F3c	II	<b>Widening</b>
M10	1.80	2.14	22.11	C4	B3c	III	None
M09	1.84	1.28	39.55	C4	B3c	III	<b>Widening</b>
M08	1.90	3.47	25.35	C3	C3	III	None
M07	1.65	1.29	45.79	C4	F4	III	<b>Widening</b>
M06	1.84	6.10	32.06	C4	C3	III	<b>Widening Planform</b>
M05-B	1.74	1.79	35.33	C4	B3	III	<b>Widening</b>
M05-A	1.57	4.76	26.84	C4	C4	IV	<b>Planform</b>
M04	Not Assessed: Bedrock Controlled Gorge						
M03-C	1.61	1.74	33.74	B4	B4	III	<b>Widening</b>
M03-B	Not Assessed: Bedrock Controlled Gorge						
M03-A	1.55	5.24	38.89	C3	C3	IV	<b>Widening</b>
M02	Not Assessed: Bedrock Controlled Gorge						
M01-B	1.83	5.00	36.02	C4	C3	III	<b>Widening Planform</b>
M01-A	1.95	10.88	54.44	C4	C4	IV	<b>Aggradation Widening Planform</b>
T2.01-B	1.93	1.93	26.98	C4	B4c	IV	<b>Planform</b>
T2.01-A	2.29	1.3	25.6	C4	F3c	II	<b>Widening</b>
<p><b>Bold Red lettering</b> - denotes extreme adjustment process  <b>Bold Black lettering</b> – denotes major adjustment process</p> <p>*NOTE: All reaches except M01-A, M03-A, M03-C, and M13-B had major or extreme historic degradation</p>							



In terms of the ANR channel evolution model, the Mill River is predominately at stage III of the “F-stage” channel evolution model (Appendix B). In many reaches the channel has undergone historic degradation as evidenced by abandoned terraces, juvenile floodplain benches, and rejuvenating tributaries. Many of the cross sections on study reaches were found to be incised. The incision ratio ranged from 1.5 to 3.1. Along many of the main stem reaches and near the mouths of the tributaries, the system is actively adjusting to this lower bed elevation by moving laterally and widening in order to create a new floodplain at a lower elevation. This widening and planform adjustment is leading to another adjustment process, aggradation. Aggradation in the Mill River study area is likely a combination of endogenous sediment that is created as the stream widens and erodes its banks in response to channel adjustments well as from exogenous sources such as gravel roads and land clearing.

### **6.3 Sediment Transport and Attenuation**

Successful river corridor restoration and protection projects require an understanding of where in the channel evolution process a stream reach is and how rapidly one might expect the channel to evolve back to equilibrium conditions. As channel conditions both upstream and downstream (degradation downstream can progress upstream at a “nickpoint”) may affect a given reach, it is important to keep in mind that this analysis should not be isolated to the project reach. An analysis of departure and sensitivity must be conducted over larger reach and watershed scales. Whether a project works with or against the physical processes at play in a watershed is primarily determined by examining the source, volumes, and attenuation of flood flows and sediment loads from one reach to the next within the stream network. If increasing loads are transported through the network to the sensitive reach, where conflicts with human investments are creating a management expectation, little success can be expected unless the restoration design accommodates the increased load or finds a way to attenuate the loads upstream (Vermont Agency of Natural Resources 2007a).

Within a reach, the principals of stream equilibrium dictate that stream power and sediment will tend to distribute evenly over time. Changes or modifications to watershed inputs and the stream channel may 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 equilibrium is achieved. Figures 36 and 37 have been provided to assist in understanding where sediment transport areas have been increased and attenuation areas have been lost in the Mill River watershed. These maps may be extremely useful in preliminary project identification because specific strategies may be devised to deal with reach and watershed stressors, which have been targeted as contributing to the departure.

Figure 36 indicates that nearly the entire main stem of the Mill River had the capacity to store fine sediments in the floodplain and to transport the normal balance of gravels, cobbles, and the occasional boulder downstream at a rate that was in balance with the inputs coming from the highest sources in the watershed thus leading to long term stability. Analysis of Figure 37, the current sediment regime map, indicates that numerous reaches in the upper Mill River watershed are sources of both fine and course materials. In areas where course deposition is occurring in the upper watershed this deposition may be at occurring at a high rate (leading to numerous mid channel bars and channel migration and conversely the human response



which has been the dredging of this accumulating material) such as in reaches M11-B and M06.

The excessive degree of departure in the upper watershed presents two situations downstream. First, the downstream reaches may be moving towards excessive aggradation of material (such as in reach M05-A) and therefore a high degree of lateral channel adjustment and bar building. Second, the storage capacity of these downstream reaches is a key asset to the watershed and the receiving watershed, the Otter Creek (and eventually Lake Champlain). Finally, analysis of these maps reveals that restoration of attenuation capacity in the upper reaches of the watershed, especially above the village locations of East Wallingford and Cuttingsville, may be helpful to restoring some of the overall equilibrium of the Mill River watershed.

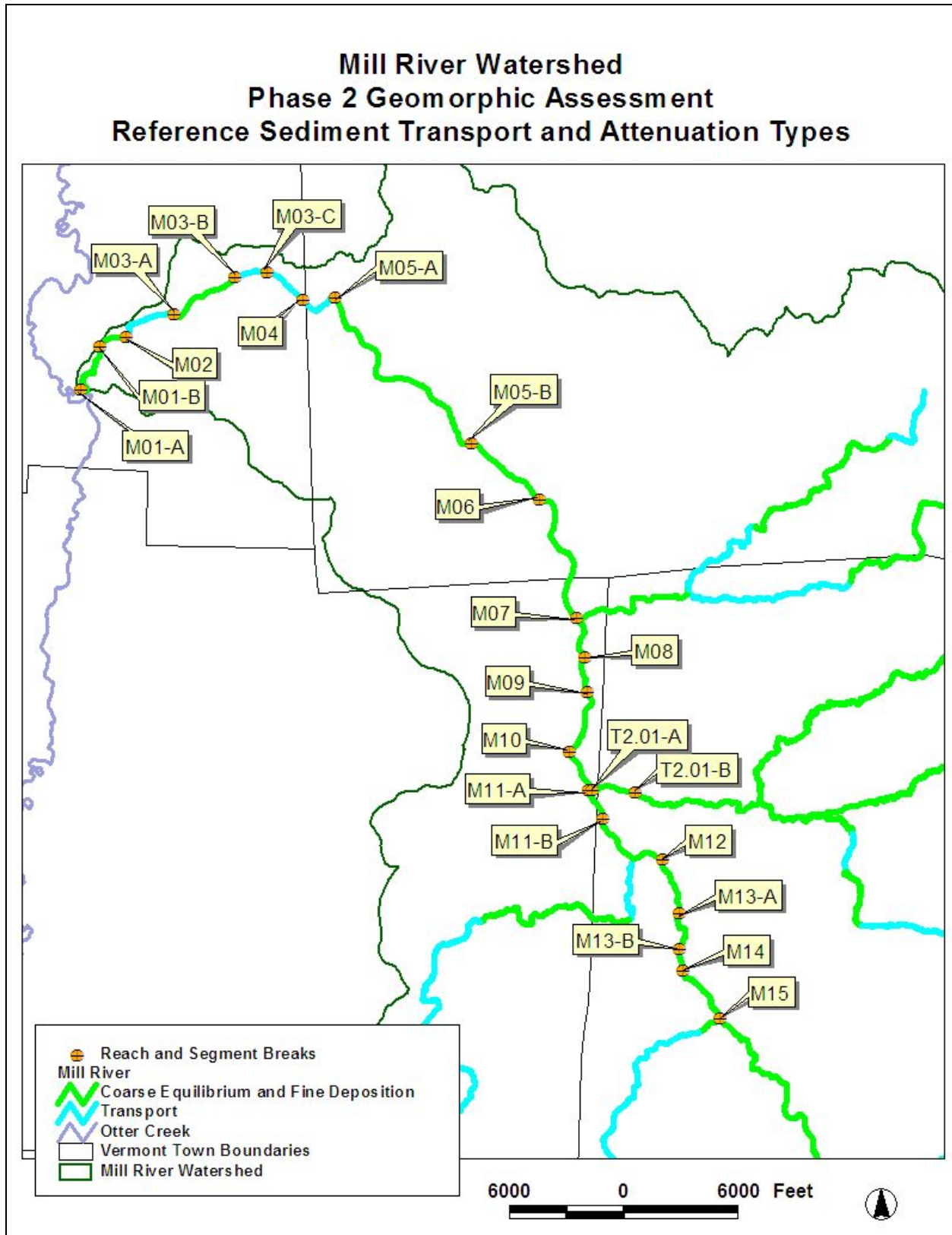


Figure 36. Sediment Transport and Attenuation under reference conditions.



### Mill River Watershed Phase 2 Geomorphic Assessment Sediment Regime Departure Map



Figure 37. Sediment Transport and Attenuation, Existing Cold River conditions.



#### 6.4 Stream Sensitivity

Sensitivity refers to the likelihood that a stream will respond to a watershed level or reach level stress, such as; floodplain encroachment, channel straightening, berming, armoring, changes in sediment or flow inputs, and/or disturbance of riparian vegetation. A stream's inherent sensitivity is based on a host of factors including the relative magnitude of channel adjustments occurring together with the topographic, geologic, and vegetative context that the surrounds the reach. The sensitivity of a given reach may be heightened when human activities alter the setting characteristics that influence a stream's natural adjustment rate including: boundary conditions; sediment and flow regimes; and the degree of confinement within the valley. Streams that are currently in adjustment, especially those undergoing degradation or aggradation, may become acutely sensitive (Vermont Agency of Natural Resources 2007b).

Generally speaking, channels with steeper gradients in confined valleys with coarse sediments (boulders, cobbles) and ample vertical grade controls (e.g., channel spanning bedrock) are considered less likely to undergo large scale vertical and lateral shifts in response to watershed and corridor stressors. In contrast, more sensitive reaches (high, very high, and extreme), are considered susceptible to future adjustment and are typically channels with a low to moderate gradient (less than 2% slope) dominated by gravel and sand substrates lacking in vertical grade controls.

Figure 38 is a map presenting the existing stream types found in the Mill River watershed. Most of the reaches are Rosgen (1996) "C" channels by reference. C channels have wide valleys and moderate to gentle gradients. B channels have moderate to steep slopes and have narrower valleys than C channels. The stream sensitivity of these reaches, categorized according to ANR protocol, is depicted in Table 5 and in Figure 39. For the most part the Phase 2 purposefully studied reaches that would be expected to exhibit a higher sensitivity and be undergoing active adjustments. It is not surprising therefore that all of the study area reaches were defined as having high, very high, or extreme sensitivity. The exception being the bedrock controlled reaches M04, M03-B, and M02 which have a greater resistance to rapid adjustment due to the underlying bedrock and lateral constraints.

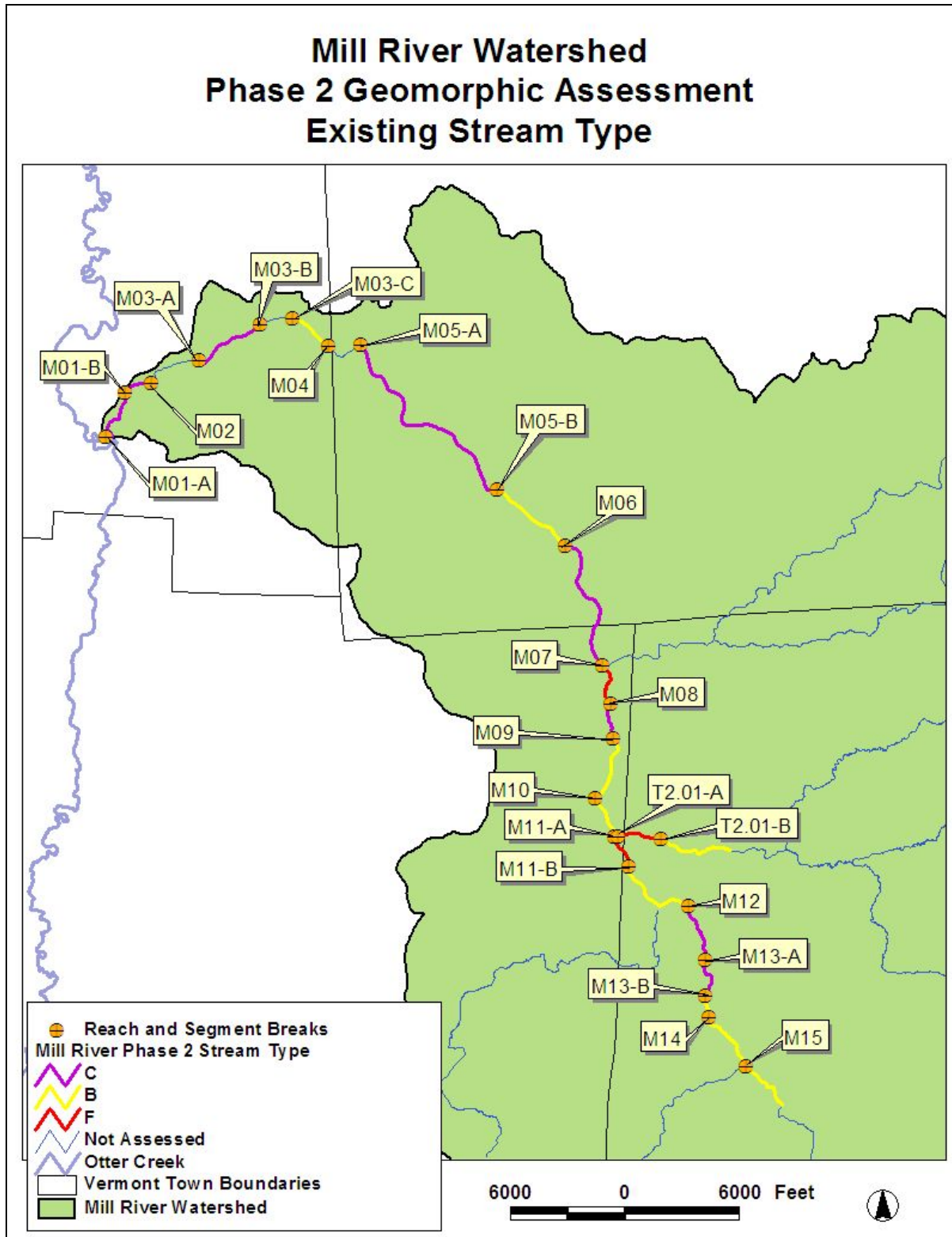


Figure 38. Phase 2 Existing Stream Types



<b>Table 5. Stream Sensitivity for Phase 2 Reaches</b>					
<b>Segment Number</b>	<b>Reference Stream Type</b>	<b>Existing Stream Type</b>	<b>Stream Type Departure</b>	<b>Geomorphic Condition</b>	<b>Sensitivity</b>
M15	C4	B3c	C to B	Fair	High
M14	C3b	B3	C to B	Fair	High
M13-B	B3	B3	None	Good	High
M13-A	C4	C4	None	Fair	<b>Very High</b>
M12	C4	C4	None	Fair	<b>Very High</b>
M11-B	C4	B3c	C to B	Fair	High
M11-A	C4	F3c	C to F	Fair	<b>Extreme</b>
M10	C4	B3c	C to B	Fair	High
M09	C4	B3c	C to B	Fair	High
M08	C3	C3	None	Fair	High
M07	C4	F4	C to F	Fair	<b>Extreme</b>
M06	C4	C3	None	Fair	High
M05-B	C4	B3	C to B	Fair	High
M05-A	C4	C4	None	Fair	<b>Very High</b>
M04*	B1	B1	None	Good	Very Low*
M03-C	B4	B4	None	Fair	High
M03-B*	B1	B1	None	Good	Very Low*
M03-A	C3	C3	None	Fair	High
M02*	B1	B1	None	Good	Very Low*
M01-B	C4	C3	None	Fair	<b>Very High</b>
M01-A	C4	C4	None	Fair	<b>Very High</b>
T2.01-B	C4	B4c	C to B	Fair	<b>Very High</b>
T2.01-A	C4	F3c	C to F	Fair	<b>Extreme</b>

\*Partial Assessment – Administrative judgment made regarding geomorphic condition and sensitivity

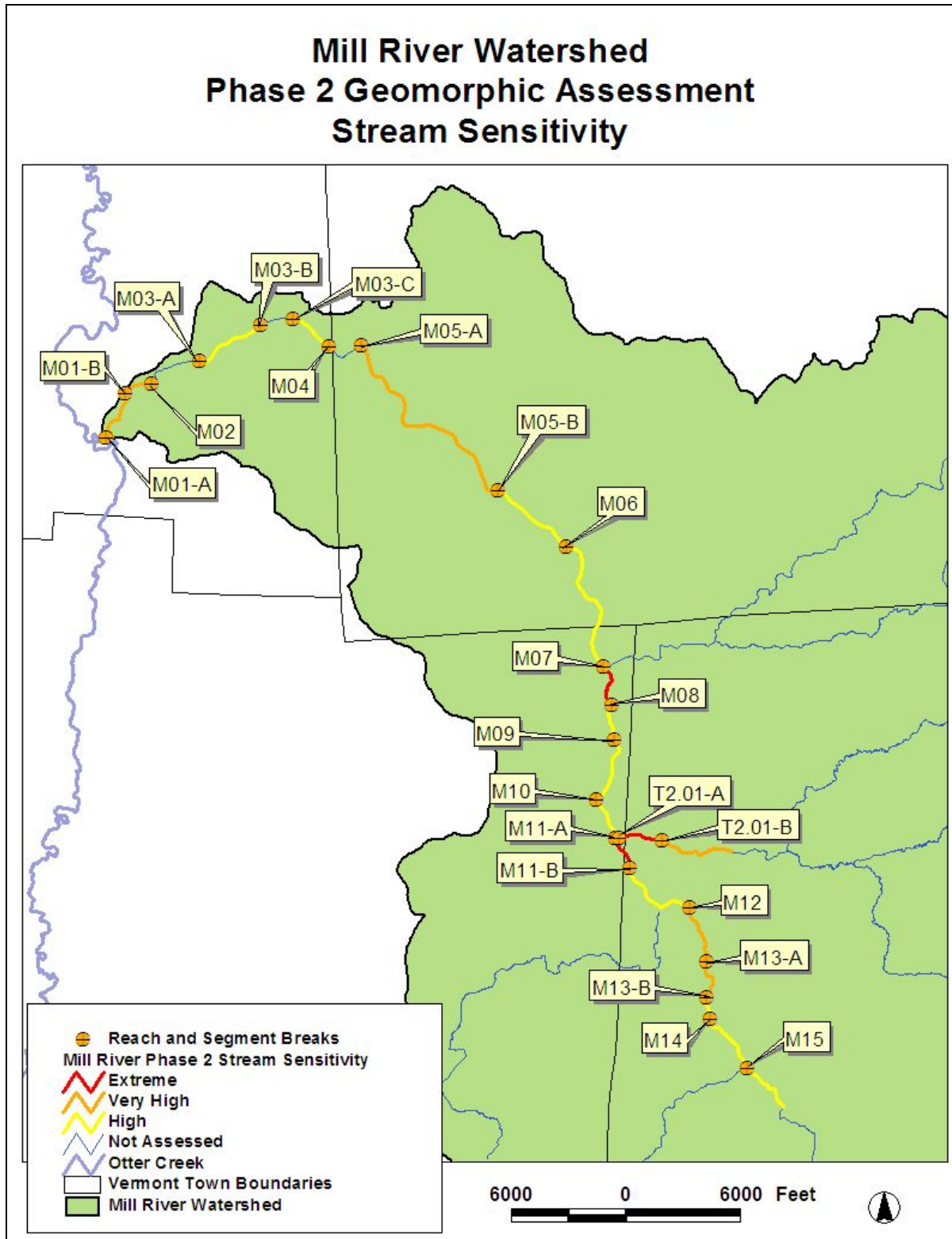


Figure 39: Phase 2 Stream Sensitivity Map



## 7.0 HABITAT EVALUATION

A comparison of the habitat condition based on the RHA and the geomorphic condition based on the RGA can be found in Appendix A (page 49). For fifteen of the twenty assessed segments, both the RHA and the RGA resulted in a fair rating. Four segments had a rating of good for habitat, but a rating of fair for geomorphic condition. Reach M13-B was the only reach with a rating of good for both geomorphic and habitat condition. In-stream cover within many of the upstream reaches consisted only of small pocket pools behind large boulders with shading from the riparian corridor varying between very good to poor. Many of the reaches that had been straightened or had floodplain alterations lacked a strong riffle-pool bedform and the diversity of habitat features that this brings. Many reaches, especially near the villages had major intrusion into their river corridor from roads and many had inadequate riparian buffers due to historic and /or recent land clearing. Overall, the RHA score was similar to the RGA score, implying that the ecological health of the Mill River is closely related to the geomorphic condition of the stream.

## 8.0 PRELIMINARY PROJECT IDENTIFICATION

Future management strategies should take into account geomorphic data for the Mill River. For a given reach or segment, identifying the active channel stressors, adjustment processes, degree of departure from reference stream type, and sensitivity will inform the short-term compatibility and long-term sustainability of various restoration or conservation options and future land use or channel management activities.

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

- Field observations (summarized for each reach in Sections 4.1 through 4.15)
- Field and remotely sensed (Phase 1) observations of channel and floodplain stressors (Section 6.1)
- Analysis of stream type, adjustment processes, departure, and channel evolution sequence (Section 6.2)
- Stream sensitivity data (Section 6.3)

This provisional listing of potential projects in the Mill River watershed follows the outline of management actions identified in the “*River Corridor Planning Guide to Identify and Develop River Corridor Protection and Restoration Projects*”. (Vermont Agency of Natural Resources 2007a). According to the document all projects may be classified under one of three broad management approaches that are meant to best expend community resources based on the current conditions, limitations, and opportunities of a given project area:

**Active Geomorphic:** This approach seeks to restore or manage rivers to a geomorphic state of dynamic equilibrium through an active approach that may include the removal or reduction of human-placed constraints or the construction of meanders, floodplains, and bank stabilization techniques. Active riparian buffer revegetation and long-term protection of a river corridor is essential to this alternative. This approach typically costs the most and has the highest potential for failure.



**Passive Geomorphic:** This approach allows rivers to return to a state of dynamic equilibrium through a passive approach that typically involves the removal of constraints from a river corridor thereby allowing the river, utilizing its own energy and watershed inputs to re-establish its meanders, floodplains, and self-maintaining equilibrium condition over an extended time period. Active riparian buffer revegetation and long-term protection of a river corridor is essential to this alternative. This approach typically costs the least, however may take the longest to see realized results.

**Active-Passive Combination:** This approach uses a sequenced combination of active and passive approaches to accommodate the varying constraints that typically occur along a project reach.

Sections 8.1 through 8.6 of this document are intended to form the basis for future project development and implementation efforts in the context of watershed, community, and corridor planning projects. This information has not included public outreach or technical, financial and social feasibility studies. Nor has this information taken into account the community priorities and landowner commitment for restoration work which may also be an important factor in determining priorities and project identification.

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 (e.g., Phase 3 Geomorphic study) and efforts to conduct alternatives analyses, conduct landowner outreach and negotiations, and identify potential stakeholders and funding sources.

## 8.1 Protecting River Corridors

Protection of river corridors is an essential element to all passive and active geomorphic restoration and conservation projects. An overriding objective of river corridor protection is to reduce the need for maintenance of traditional channel management applications (i.e. berming, straightening, riprapping, etc.) and shift the focus of management projects from short term control to long term equilibrium and stability. River corridor protection is a very worthwhile initiative because it can support multiple objectives for the Mill River community including:

- *Returning the Mill River to a state of "Dynamic Equilibrium"* – Corridor protection would help preserve (or support a return to) reference sinuosity, slope, and channel dimensions. It would also help the community refrain from future detrimental channel management activities, such as channelization, dredging, berming, armoring.
- *Reestablishing Floodplain Access* – Corridor protection would help preserve or restore the river's access to its surrounding floodplain in bankfull and higher flow events in order to improve sediment attenuation (the storage of sediments within the channel margins, floodplain, and channel-contiguous wetlands) and flood water attenuation (detainment of flood flows through overbank flooding, increased channel length (sinuosity), increased channel roughness (e.g., buffers), and inundation of channel-contiguous wetlands).



- *Preventing Future Conflict* – Corridor protection would help the community refrain from placing further developments and infrastructure in the Mill River corridor to minimize future restrictions and fluvial erosion losses.

River corridor protection is generally thought of as a passive geomorphic approach. The river channel is allowed to freely meander within an area determined scientifically through fluvial geomorphology. For a reach that is already close to reference condition or exhibiting only minor adjustments, preserving a river corridor will ensure the river’s ability to continue to meander through the valley unconstrained by human infrastructure. In turn, human investments in the landscape will be protected from future channel adjustments. For a reach that has seen significant channel management in the past, and has lost some floodplain connection and some measure of its sinuosity (as with many of the Mill River’s reaches), the channel is allowed to adjust unimpeded to a more sinuous, meandering planform determined by the nature of the river. Through minor and major adjustments, the river will reestablish greater floodplain access (where access has been lost) and readjust channel dimensions for optimum transport and storage of its water and sediment loads. Where active geomorphic restoration approaches are deemed necessary, river corridor protection will help to prevent future channel management that might unravel constructed features of a recently restored reach.

Although all reaches of the Mill River would benefit from a community initiated river corridor identification process, lower priority reaches for river corridor protection include “wooded corridors experiencing very little threat from encroachment and less sensitive reaches not playing a significant flow or sediment load attenuation role in the watershed (Vermont Agency of Natural Resources 2007a)”. Of the Mill River reaches assessed, this would include the three bedrock gorge reaches (M04, M03-B, and M02) which were assigned a “very low” sensitivity due to the stable nature of their channels.

The highest priority reaches for river corridor protection are “highly sensitive reaches critical for flow and sediment attenuation from upstream sources or sensitive reaches where there is a major departure from equilibrium conditions and threats from encroachment (Vermont Agency of Natural Resources 2007a)”. River corridor protection may be accomplished through informal landowner agreements, limited or long term easements, and/or fluvial erosion hazard zoning which takes into account geomorphic channel adjustments and seeks to assist the community in preventing future conflicts. Table 6 provides direction on where to start for prioritizing river corridor protection projects.

Description	Reach	Town
<b>Protection Upstream of Constrained / Altered Reaches</b> Reduction of streambank erosion, improved floodplain access and enhanced sediment and flow attenuation in these reaches upstream of village areas of East Wallingford and Cuttingsville, will reduce sediment production and delivery in the long-term to downstream segments which are constrained by the topographic setting and floodplain encroachments and are unable to adjust their dimensions, planform, and profile in response to excess sediment and water loads delivered from upstream.	M15	Mount Holly
	M14	Mount Holly
	M11-B	Mount Holly
	M09	E. Wallingford
	M07	E. Wallingford
	M06	Shrewsbury
	T2.01-B	Mount Holly



<p><b>Sediment attenuation areas - preservation and enhancement.</b> At present, land uses contiguous to many of these locations do not appear to be in conflict with channel adjustment processes. These sites are high-priority candidates for outreach and eventual conservation with the willingness of landowners.</p>	<p>M13-A M12 M05-A M03-A</p>	<p>Mount Holly Mount Holly Shrewsbury Clarendon</p>
<p><b>Reduction of Fluvial Erosion Hazards</b> Corridor protection in all reaches enabled by FEH mapping and zoning, can:</p>		
<p>(a) Inform residents of FEH hazards in already densely populated areas</p>	<p>M11-A M10 M06 M05-B T2.01-B</p>	<p>E. Wallingford E. Wallingford Shrewsbury Shrewsbury Mount Holly</p>
<p>(b) reduce future fluvial erosion hazards along highly “sensitive reaches where there is a major departure from equilibrium conditions and threats from encroachment” (VTANR, 2007a)</p>	<p>M11-A M07 T2.01-A</p>	<p>E. Wallingford E. Wallingford Mount Holly</p>
<p>(c) reduce future fluvial erosion hazards along reaches at <b>alluvial fans or points of marked valley slope reduction</b> that contributes to increased sediment aggradation and planform adjustment. Carefully manage land use changes in the upstream watershed to reduce the potential for increases in sediment or flows that may induce channel adjustments in the subject reach/segment.</p>	<p>M01-B M01-A</p>	<p>Clarendon Clarendon</p>

## 8.2 Planting Stream Buffers

The reference stream type for much of the main stem of the Mill River is “C”. These slightly entrenched, meandering channels are highly dependent upon vegetation for stability. For this reason, the establishment and protection of vegetated buffers should be high priority in restoration planning and design work. Riparian buffers provide many benefits. Some of these benefits are protecting and enhancing water quality, providing fish and wildlife habitat, providing streamside shading, and providing root structure to prevent bank erosion. In fact, from a water quality and habitat standpoint it is important to establish a buffer of vegetation on all river borders.

The column heading “Loss of Forested Buffers” in Table 3 (Section 6.1) is a good first pass at identifying the Mill River reaches which would benefit most from buffer plantings. As a stand alone restoration option highest priority should be given to highly sensitivity reaches that are vertically stable (see Table 5). Due to the extreme lateral adjustments that may be occurring in unstable reaches, tree plantings may be quickly washed out if they are only along the top of an eroding bank. For these reaches long-term restoration would be better served by planting trees away from the top of the streambank focusing more on reestablishment of a belt-width forest so that long-term channel adjustment is met by trees that have had at least



several years to establish. Table 7 below provides a good first focus of where to prioritize buffer restoration projects.

Description	Reach	Town
<b>Reestablishment of Riparian Buffers.</b> Restore and maintain dynamic equilibrium of the channel by increasing resistance to boundary shear stresses along the channel margins where wooded buffers have been removed.	M15	Mount Holly
	M14	Mount Holly
	M11-B	Mount Holly
	M11-A	E. Wallingford
	M10	E. Wallingford
	M06	Shrewsbury
	M05-B	Shrewsbury
	M01-B	Clarendon
	M01-A	Clarendon
	T2.01-A	Mount Holly

### 8.3 Stabilizing Stream Banks

Physical efforts to stabilize streambanks may 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 (Vermont Agency of Natural Resources 2007a)”. Also in reaches upstream of sensitive reaches where bank stabilization efforts may allow for the reestablishment of riparian vegetation. As with most techniques, bank stabilization projects 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.

As described in Table 8, at the writing of this report no specific streambank stabilization projects were observed that were immediately threatening structures or infrastructure. Nor were any eroding banks determined to be detrimental to sensitive reaches downstream where excess sediment may destabilize a channel. Public meetings may yield observations/concerns that would identify priority projects.

Description	Reach	Town
No specific streambank stabilization projects were observed that were immediately threatening structures or infrastructure. Nor were any eroding banks determined to be detrimental to sensitive reaches downstream where excess sediment may destabilize a channel. Public meetings may yield observations/concerns from landowners that were not observed in the field for one reason or another.	None	None



### 8.4 Removing Berms / Other Constraints to Flood & Sediment Load Attenuation

Removing berms or other constraints (such as roads) to the lateral migration of streams and floodplain connection of a river channel may accelerate a return to dynamic stability in the channel, and reduce impacts to downstream segments, by creating more opportunities for sediment and flow attenuation. Priority for berm removal, listed below in Table 9, should go to reaches where a significant (>50%) portion of the river (belt width) corridor would become accessible to the stream if the berm were to be removed or where the berm constitutes the predominate reason why the reach is incised.

Description	Reach	Town
<b>Restore Floodplain Access and Remove Constraints for Increased Flow and Sediment Load Attenuation</b>		
Evaluate the feasibility of lowering elevation of near-bank areas where berms/roads constrain the channel and limit floodplain access. These activities should be accompanied by corridor protection (see Section 8.1)	M01-B M06 M07 M09	Clarendon Shrewsbury Wallingford Wallingford

### 8.5 Removing / Replacing Structures

Buildings, road crossings, and dams are examples of structures that may limit the vertical and lateral movement of the channel and/or result in a significant constriction of the floodplain causing localized and systemic instability. Removing such structures may be an important and highly effective way to restore dynamic equilibrium to a reach or section of river. Several problem bridge and culvert crossings were encountered during the Bridge and Culvert Assessment. Their status as either a bankfull or flood-prone-width constrictor is addressed in section 5.0. This information data may be utilized by the town road crews and regional planning commissions when establishing schedules and budgets for crossing rehabilitation and replacement.

In general, the geomorphic context of the streams that are being crossed should be considered when replacing or installing new structures. New or replacement bridges and culverts should ideally have openings which pass at least the bankfull width and better the floodprone-width without constriction. They should be perpendicular to the channel and should take into account the historic and predicted lateral movement of the stream. Efforts to keep a natural channel bottom and minimize hard armoring of streambanks may help to reduce scour downstream and benefit aquatic and terrestrial organism passage.

### 8.6 Restoring Incised Reaches

As noted in previous sections, the majority of the reaches assessed in the Mill River are incised. Further study could evaluate the feasibility of various active geomorphic and engineering techniques to restore some of these incised reaches which could accelerate a return to dynamic



equilibrium of the channel, and reduce impacts to downstream segments, by creating more opportunities for sediment and flow attenuation within floodplain.

For any of the potential project reaches, listed below in Table 10, a more detailed geomorphic assessment (Phase 3) and an alternatives analysis would be required to evaluate the long-term feasibility of controlling the stressors that resulted in the incision. The study would also want to examine the feasibility or restoring full channel equilibrium including slope and profile, removing corridor constraints, and long-term landowner commitment.

Description	Reach	Town
<p><b>Restore Floodplain Access to Improve Flow and Sediment Load Attenuation and take pressure off downstream reaches (with the intention to reduce fluvial erosion hazard and restore dynamic equilibrium).</b></p> <p>Evaluate the feasibility of lowering elevation of near-bank areas that constrain the channel and limit floodplain access. These activities should be accompanied by corridor protection (see Section 8.1)</p>	<p>M15 M14 M11-A</p>	<p>Mount Holly Mount Holly Wallingford</p>

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- Vermont Geologic Survey. 1952. Map: Areal Geology of the Rutland Area. Montpelier, VT.

# APPENDIX A

## STANDARD PHASE 2 DMS REPORTS



**1.6 Grade Controls**      **None**      **Step 7. Rapid Geomorphic Assessment Data**

Confinement Type	Score	STD	Historic
7.1 Channel Degradation	11	None	Yes
7.2 Channel Aggradation	8	None	No
7.3 Widening Channel	7		No
7.4 Change in Planform	5		No

Total Score      **31**

Geomorphic Rating      **0.3875**

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

**4.8 Channel Constrictions**      **None**      **Step 6. Rapid Habitat Assessment Data**

Stream Gradient Type      **High**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?	Score
6.1 Epifaunal Substrate - Available Cover						14
6.2 Embeddedness						8
6.3 Velocity/Depth Patterns						16
6.4 Sediment Deposition						8
6.5 Channel Flow Status						10
6.6 Channel Alteration						18
6.7 Frequency of Riffles/Steps						16
6.8 Bank Stability						Left: 4    Right: 4
6.9 Bank Vegetation Protection						Left: 5    Right: 8
6.10 Riparian Vegetation Zone Width						Left: 4    Right: 8
Total Score						123
Habitat Rating						0.615

Habitat Stream Condition      **Fair**

**Narrative:**

Historic incision likely associated with past channel management and incision in the otter creek. current extreme planform expected in alluvial fan/delta area. major widening and aggradation indicative of the high degree of adjustment occurring.



Project: **Otter Creek - Mill River**      **Phase 2 Reach Summary**      page 2 of 2      December 12, 2007  
 Stream: **Mill River**      Reach # **M01**      Segment: **B**      Completion Date: **October 2, 2007**  
 Organization: **Rutland RPC**      Observers: **Michael Blazewicz, Shannon Pytlík**      Rain: **No**  
 Segment Length (ft): **1,800**      Segment Location: **From the end of the lower Clarendon Gorge to below a railroad bridge.**

**1.6 Grade Controls None**      Step 7. Rapid Geomorphic Assessment Data

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken	Confinement Type	Score	STD	Historic
						<b>Unconfined</b>			
7.1	Channel Degradation						<b>8</b>	<b>None</b>	<b>Yes</b>
7.2	Channel Aggradation						<b>11</b>	<b>None</b>	<b>No</b>
7.3	Widening Channel						<b>9</b>		<b>No</b>
7.4	Change in Planform						<b>9</b>		<b>No</b>

Total Score **37**  
 Geomorphic Rating **0.4625**

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type	High	Score
6.1 Epifaunal Substrate - Available Cover		11
6.2 Embeddedness		13
6.3 Velocity/Depth Patterns		6
6.4 Sediment Deposition		10
6.5 Channel Flow Status		8
6.6 Channel Alteration		5
6.7 Frequency of Riffles/Steps		8
6.8 Bank Stability	Left: 8 Right: 8	
6.9 Bank Vegetation Protection	Left: 5 Right: 5	
6.10 Riparian Vegetation Zone Width	Left: 8 Right: 4	
Total Score		99
Habitat Rating		0.495

Habitat Stream Condition **Fair**

**Narrative:**

Historic incision associated with channel straightening and dredging. Berming and armoring has limited channel widening and planform adjustment and kept it in stage III.

Project: Otter Creek - Mill River  
 Stream: Mill River  
 Organization: Rutland RPC  
 Segment Length (ft): 3,158

Reach # M02  
 Observers: Michael Blazewicz  
 Segment Location: Lower Clarendon Gorge.

December 12, 2007 SGAT Version: 4.56  
 Completion Date: September 13, 2007  
 Why Not assessed: bedrock gorge Rain: No

**QC Status - Staff: Provisional Cons**

**Step 1. Valley and Floodplain**

1.1 Segmentation	None	Both
1.2 Alluvial Fan	None	
1.3 Corridor Encroachments		
Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	1,294	0
height	40	0
Railroads	0	0
height	0	0
Improved Paths	638	0
height	40	0
Development	0	0
1.4 Adjacent Side	Left	Right

Hillside Slope	Very Steep	Very Steep
Continuous w/	Always	
Win 1 Bankfill	Always	Always
Texture	Bedrock	Bedrock
1.5 Valley Features		
Valley Width (ft)	183	
Width Determination	Estimated	
Confinement Type	Semi-confined	
Rock Gorge?	Yes	
Human-caused Change?	No	

**Step 2. Stream Channel**

2.1 Bankfull Width	0
2.2 Max Depth (ft)	0.00
2.3 Mean Depth (ft)	0.00
2.4 Floodprone Width (ft)	0

Notes:

Reach consists of the lower clarendon gorge carved through the Cambrian Dalton formation and Cheshire Quartzite. The Dalton formation lies on Precambrian rocks of the Green Mountain core at the upstream end of the gorge. Only a partial assessment was

**Provisional Step 2. (Continued)**

2.5 Aband. Floodpin	0.00 ft.
Human Elev Floodpin	0.00 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 (ft)	0
2.12 Substrate Composition	

Silt/Clay Present?	0 %
Detritus	0
# Large Woody	0
2.13 Average Largest Particle on	
Bed	0.0
Bar	0.0

2.14 Stream Type		
Stream Type:		
Bed Material:		
Subclass Slope:		
Bed Form:		
Field Measured Slope:		
2.15 Reference Stream Type		
(if different from Phase 1)		
3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

**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)	0	0
Erosion Height (ft)	0.00	0.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0
Near Bank Veg. Type	Left	Right
Dominant	Coniferous	Deciduous
Sub-dominant	Deciduous	Coniferous
Bank Canopy	Left	Right
Canopy %	51-75	51-75
Mid-Channel Canopy		Open
3.2 Riparian Buffer		
Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	26-50
W less than 25	0	0
Buffer Veg. Type	Left	Right
Dominant	Coniferous	Coniferous
Sub-dominant	Deciduous	Deciduous
3.3 Riparian Corridor		
Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	Residential
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

**Step 4. Flow & Flow Modifiers**

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

**Step 5. Channel Bed and Planform Changes**

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

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: **Otter Creek - Mill River**      Phase 2 Reach Summary      page 2 of 2      December 12, 2007  
 Stream: **Mill River**      Reach # **M02**      Segment: **0**      Completion Date: **September 13,**  
 Organization: **Rutland RPC**      Observers: **Michael Blazewicz**      Rain: **No**  
 Segment Length (ft): **3,158**      Segment Location: **Lower Clarendon Gorge.**

**1.6 Grade Controls**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	Mid-segment	0.00	0.00	No	
Ledge	Mid-segment	0.00	0.00	Yes	

**Step 7. Rapid Geomorphic Assessment Data**

Confinement Type

Channel Evolution Model  
 Channel Evolution Stage  
 Geomorphic Condition  
 Stream Sensitivity

**Step 6. Rapid Habitat Assessment Data**

Stream Gradient Type      **High**

**4.8 Channel Constrictions**      **None**

Type	Width Taken?	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Narrative:

Habitat Stream Condition

Project: **Otter Creek - Mill River**  
 Stream: **Mill River**  
 Organization: **Rutland RPC**  
 Segment Length (ft): **3,500**

Reach # **M03**  
 Observers: **Michael Blazewicz, Sarah Lade**  
 Segment Location: **From below the Kingsley Covered Bridge on East St. to the top of the lower Clarendon**

December 12, 2007 SGAT Version: 4.56  
 Completion Date: **September 25, 2007**  
 Rain: **No**

**QC Status - Staff: Provisional Cons**

**Step 1. Valley and Floodplain**

1.1 Segmentation **Grade Controls**  
 1.2 Alluvial Fan **None**  
 1.3 Corridor Encroachments  
 Length (ft) One Both

Berms **0** **0**  
 height **0** **0**  
 Roads **194** **0**  
 height **0** **0**  
 Railroads **0** **0**  
 height **0** **0**  
 Improved Paths **0** **0**  
 height **0** **0**  
 Development **0** **0**  
 1.4 Adjacent Side **Left** **Right**  
 Hillside Slope **Steep** **Steep**  
 Continuous w/**Sometimes** **Sometimes**  
 W/in 1 Bankfill **Sometimes** **Sometimes**

Texture **Bedrock** **Bedrock**  
 1.5 Valley Features  
 Valley Width (ft) **551**  
 Width Determination **Measured**  
 Confinement Type **Broad**  
 Rock Gorge? **No**  
 Human-caused Change? **No**

**Step 2. Stream Channel**  
 2.1 Bankfull Width **105**  
 2.2 Max Depth (ft) **4.00**  
 2.3 Mean Depth (ft) **2.70**  
 2.4 Floodprone Width (ft) **551**

Notes:  
 This segment between two bedrock grade controlled sections is slightly incised, however, it seems to be an area of sediment and flood attenuation. It appears that much of the land is owned by the state and well forested on both banks. This will likely

**Provisional Step 2. (Continued)**

2.5 Aband. Floodpln **6.20 ft.**  
 Human Elev Floodpln **0.00 ft.**  
 2.6 Width/Depth Ratio **38.89**  
 2.7 Entrenchment Ratio **5.24**  
 2.8 Incision Ratio **1.55**  
 Human Elevated Inc Rat **0.00**  
 2.9 Sinuosity **Low**

2.10 Riffles Type **Sedimented**  
 2.11 Riffle/Step Spacing (ft) **500**  
 2.12 Substrate Composition  
 Bedrock **5%**  
 Boulder **18%**  
 Cobble **36%**  
 Coarse Gravel **29%**  
 Fine Gravel **10%**  
 Sand **1%**  
 Silt and smaller **1%**

Silt/Clay Present? **No**  
 Detritus **2 %**  
 # Large Woody **10**  
 2.13 Average Largest Particle on  
 Bed **12.0 inches**  
 Bar **6.0 inches**

2.14 Stream Type  
 Stream Type: **C**  
 Bed Material: **Cobble**  
 Subclass Slope: **None**  
 Bed Form: **Riffle-Pool**  
 Field Measured Slope:

2.15 Reference Stream Type  
 (if different from Phase 1)  
 3.3 old Amount Mean Height  
 Failures **None** **0.00**  
 Gullies **None** **0.00**

**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/Cobb/Boulder/Cobb**  
 Consistency **Non-cohesive** **Non-cohesive**

Bank Erosion **Left** **Right**  
 Erosion Length (ft) **1,165** **531**  
 Erosion Height (ft) **6.25** **3.00**  
 Revetmt. Type **None** **None**  
 Revetmt. Length (ft) **0** **0**  
 Near Bank Veg. Type **Left** **Right**

Dominant **Coniferous** **Coniferous**  
 Sub-dominant **Deciduous Shrubs/Saplin**  
 Bank Canopy **Left** **Right**  
 Canopy % **26-50** **1-25**  
 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** **0**  
 Buffer Veg. Type **Left** **Right**  
 Dominant **Coniferous** **Coniferous**  
 Sub-dominant **Deciduous** **Deciduous**

3.3 Riparian Corridor  
 Corridor Land **Left** **Right**  
 Dominant **Forest** **Forest**  
 Sub-dominant **None** **None**  
 Mass Failures **0** **0**  
 Height **0** **0**  
 Gullies **0** **0**  
 Height **0** **0**

**Step 4. Flow & Flow Modifiers**

4.1 Springs / Seeps **Minimal**  
 4.2 Adjacent Wetlands **Minimal**  
 4.3 Flow Status **Low**  
 4.4 # of Debris Jams **0**  
 4.5 Flow Regulation Type **None**  
 Flow Regulation Use  
 Impoundments **None**  
 Impoundmt. Location

4.6 Up/Down strfm flow reg **None**  
 (old) Upstrm Flow Reg **None**  
 4.7 StormwaterInputs  
 Field Ditch **0** Road Ditch **0**  
 Other **0** Tile Drain **0**  
 Overland Flow **0** Urb Strm Wtr Pipe **0**  
 4.9 # of Beaver Dams **0**  
 Affected Length (ft) **0**

**Step 5. Channel Bed and Planform Changes**  
 5.1 Bar Types  
 Mid **2** Point **1** Side **2**  
 Diagonal **0** Delta **0** Island **0**  
 5.2 Other Features **0** Braiding **0**  
 Flood Neck Cutoff Avulsion **0**

5.3 Steep Riffles and Head Cuts  
 Steep Riffles Head Cuts Trib Rejuv.  
**2** **0** **No**  
 5.4 Stream Ford or Animal **No**  
 5.5 Straightening **None**  
 Straightening Length: **0**  
 5.5 Dredging **None**

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

**1.6 Grade Controls** **None**      Step 7. Rapid Geomorphic Assessment Data

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken	Confinement Type	Score	STD	Historic
						<b>Unconfined</b>			
7.1	Channel Degradation						<b>11</b>	<b>None</b>	<b>Yes</b>
7.2	Channel Aggradation						<b>11</b>	<b>None</b>	<b>No</b>
7.3	Widening Channel						<b>10</b>		<b>No</b>
7.4	Change in Planform						<b>13</b>		<b>No</b>

Total Score **45**  
 Geomorphic Rating **0.5625**

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	13
6.2 Embeddedness	11
6.3 Velocity/Depth Patterns	11
6.4 Sediment Deposition	11
6.5 Channel Flow Status	10
6.6 Channel Alteration	18
6.7 Frequency of Riffles/Steps	16
6.8 Bank Stability	Left: 7    Right: 6
6.9 Bank Vegetation Protection	Left: 8    Right: 6
6.10 Riparian Vegetation Zone Width	Left: 9    Right: 8

Total Score **134**  
 Habitat Rating **0.67**

Habitat Stream Condition **Good**

**Narrative:**

No evidence of human intervention in channel, however evidence of historic channel incision. Active aggradation and widening and some planform adjustment as stream builds floodplain bars.

QC Status - Staff: Provisional Cons		Step 2. (Continued)		Step 3. Riparian Features		Step 4. Flow & Flow Modifiers	
<b>Step 1. Valley and Floodplain</b>							
1.1 Segmentation	Grade Controls	2.5 Aband. Floodpln	0.00 ft.	3.1 Stream Banks	Steep	4.1 Springs / Seeps	None
1.2 Alluvial Fan	None	Human Elev Floodpln	0.00 ft.	Typical Bank Slope		4.2 Adjacent Wetlands	None
1.3 Corridor Encroachments		2.6 Width/Depth Ratio	0.00	Bank Texture	Left	4.3 Flow Status	Low
		2.7 Entrenchment Ratio	0.00	Upper		4.4 # of Debris Jams	0
		2.8 Incision Ratio	0.00	Material Type	Bedrock	4.5 Flow Regulation Type	None
		Human Elevated Inc Rat	0.00	Consistency	Cohesive	Flow Regulation Use	
		2.9 Sinuosity		Lower		Impoundments	None
		2.10 Riffles Type		Material Type	Bedrock	Impoundmt. Location	
		2.11 Riffle/Step Spacing (ft)	0	Consistency	Cohesive	4.6 Up/Down strfm flow reg	None
		2.12 Substrate Composition		Bank Erosion	Right	(old) Upstrm Flow Reg	None
				Erosion Length (ft)	50	4.7 StormwaterInputs	
				Erosion Height (ft)	15.00	Field Ditch	0 Road Ditch
				Revetmt. Type	None	Other	0 Tile Drain
				Revetmt. Length (ft)	0	Overland Flow	0 Urb Strm Wtr Pipe
				Near Bank Veg. Type	Left	4.9 # of Beaver Dams	0
				Dominant	Coniferous	Affected Length (ft)	0
				Sub-dominant	Deciduous	<b>Step 5. Channel Bed and Planform Changes</b>	
				Bank Canopy	Left	<b>5.1 Bar Types</b>	
				Canopy %	76-100	Mid	Point
				Mid-Channel Canopy	Open	0	0
				3.2 Riparian Buffer		Diagonal	Delta
				Buffer Width	Left	0	0
				Dominant	26-50	Island	
				Sub-dominant	0-25	Braiding	
				W less than 25	170	Flood Neck Cutoff	Avulsion
				Buffer Veg. Type	Left	0	0
				Dominant	Coniferous	5.2 Other Features	
				Sub-dominant	Deciduous	269	0
				3.3 Riparian Corridor		5.3 Steep Riffles and Head Cuts	
				Corridor Land	Left	Steep Riffles	Head Cuts
				Dominant	Residential	0	0
				Sub-dominant	None	Trib Rejuv.	
				Mass Failures	0	5.4 Stream Ford or Animal	
				Height	0	5.5 Straightening	
				Gullies	0	Straightening Length:	
				Height	0	5.5 Dredging	
				Failures	None	0	
				Gullies	None	None	
						Note: Step 1.6 - Grade Controls	
						and Step 4.8 - Channel Constrictions	
						are on The second page of this	
						report - with Steps 6 through 7.	

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	Mid-segment	0.00	0.00	Yes	

Channel Evolution Model  
 Channel Evolution Stage  
 Geomorphic Condition  
 Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type      **High**

4.8 Channel Constrictions      **None**

Type	Width Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Narrative:

Habitat Stream Condition

Project: Otter Creek - Mill River  
 Stream: Mill River  
 Organization: Rutland RPC  
 Segment Length (ft): 3,111

Reach # M03  
 Observers: Michael Blazewicz, Sarah Lade  
 Segment Location: From the end of the Upper Clarendon Gorge to where another section of bedrock dominated

December 12, 2007 SGAT Version: 4.56  
 Completion Date: October 15, 2007  
 Rain: No

**QC Status - Staff: Provisional Cons**

**Step 1. Valley and Floodplain**

1.1 Segmentation Grade Controls  
 1.2 Alluvial Fan None  
 1.3 Corridor Encroachments  
 Length (ft) One Both

Berms 0 0  
 height 0 0  
 Roads 0 0  
 height 0 0  
 Railroads 0 0  
 height 0 0  
 Improved Paths 0 0  
 height 0 0  
 Development 479 0  
 1.4 Adjacent Side Left Right  
 Hillside Slope Steep Steep  
 Continuous w/ Never Never  
 Win 1 Bankfill Sometimes Sometimes  
 Texture Not Evalua Not Evalua

**1.5 Valley Features**

Valley Width (ft) 300  
 Width Determination Estimated  
 Confinement Type Semi-confined  
 Rock Gorge? No  
 Human-caused Change? No

**Step 2. Stream Channel**

2.1 Bankfull Width 111  
 2.2 Max Depth (ft) 4.90  
 2.3 Mean Depth (ft) 3.29  
 2.4 Floodprone Width (ft) 194

Notes:  
 This segment is located between the Upper Clarendon Gorge (a bedrock controlled section) and the bedrock controlled segment at the old Kingsley Mill. Channel incision observed here may be a result of the river working back through sediments that were

**Provisional Step 2. (Continued)**

2.5 Aband. Floodpin 7.90 ft.  
 Human Elev Floodpin 0.00 ft.  
 2.6 Width/Depth Ratio 33.74  
 2.7 Entrenchment Ratio 1.74  
 2.8 Incision Ratio 1.61  
 Human Elevated Inc Rat 0.00  
 2.9 Sinuosity Low

2.10 Riffles Type Not Applicable  
 2.11 Riffle/Step Spacing (ft) 0  
 2.12 Substrate Composition  
 Bedrock 0%  
 Boulder 6%  
 Cobble 42%  
 Coarse Gravel 39%  
 Fine Gravel 12%  
 Sand 1%  
 Silt and smaller 0%

Silt/Clay Present? No  
 Detritus 1 %  
 # Large Woody 7  
 2.13 Average Largest Particle on Bed 24.0 inches  
 Bar N/A inches

2.14 Stream Type  
 Stream Type: B  
 Bed Material: Gravel  
 Subclass Slope: None  
 Bed Form: Plane Bed  
 Field Measured Slope:

2.15 Reference Stream Type  
 (if different from Phase 1)  
 B 4 Non Plane Bed  
 3.3 old Amount Mean Height  
 Failures None 0.00  
 Gullies None 0.00

**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/Cobb/Boulder/Cobb  
 Consistency Non-cohesive Non-cohesive

Bank Erosion Left Right  
 Erosion Length (ft) 270 0  
 Erosion Height (ft) 4.00 0.00  
 Revetmt. Type None None  
 Revetmt. Length (ft) 0 0  
 Near Bank Veg. Type Left Right  
 Dominant Coniferous Deciduous  
 Sub-dominant None Coniferous  
 Bank Canopy Left Right  
 Canopy % 51-75 26-50

Mid-Channel Canopy Open  
 3.2 Riparian Buffer  
 Buffer Width Left Right  
 Dominant >100 0-25  
 Sub-dominant 0-25 26-50  
 W less than 25 440 0  
 Buffer Veg. Type Left Right  
 Dominant Coniferous Mixed Trees  
 Sub-dominant Deciduous Shrubs/Saplin

3.3 Riparian Corridor  
 Corridor Land Left Right  
 Dominant Forest Hay  
 Sub-dominant Residential Residential  
 Mass Failures 0 0  
 Height 0 0  
 Gullies 0 0  
 Height 0 0

**Step 4. Flow & Flow Modifiers**

4.1 Springs / Seeps None  
 4.2 Adjacent Wetlands Minimal  
 4.3 Flow Status Low  
 4.4 # of Debris Jams 0  
 4.5 Flow Regulation Type None  
 Flow Regulation Use  
 Impoundments None  
 Impoundmt. Location  
 4.6 Up/Down strfm flow reg None  
 (old) Upstrm Flow Reg None  
 4.7 StormwaterInputs

Field Ditch 0 Road Ditch 0  
 Other 0 Tile Drain 0  
 Overland Flow 0 Urb Strm Wtr Pipe 0  
 4.9 # of Beaver Dams 0  
 Affected Length (ft) 0

**Step 5. Channel Bed and Planform Changes**

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

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

**Step 7. Rapid Geomorphic Assessment Data**

Confinement Type	Plane Bed	Score	STD	Historic
7.1 Channel Degradation		12	None	Yes
7.2 Channel Aggradation		13	None	No
7.3 Widening Channel		9		No
7.4 Change in Planform		13		No
Total Score		47		
Geomorphic Rating		0.5875		
Channel Evolution Model		D		
Channel Evolution Stage		III		
Geomorphic Condition		Fair		
Stream Sensitivity		High		

**Step 6. Rapid Habitat Assessment Data**

Stream Gradient Type	High	Score
6.1 Epifaunal Substrate - Available Cover		13
6.2 Embeddedness		13
6.3 Velocity/Depth Patterns		8
6.4 Sediment Deposition		13
6.5 Channel Flow Status		10
6.6 Channel Alteration		16
6.7 Frequency of Riffles/Steps		11
6.8 Bank Stability	Left: 6 Right: 6	
6.9 Bank Vegetation Protection	Left: 6 Right: 8	
6.10 Riparian Vegetation Zone Width	Left: 3 Right: 3	
Total Score		116
Habitat Rating		0.58
Habitat Stream Condition		Fair

**1.6 Grade Controls**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	Mid-segment	0.00	0.00	Yes	

**4.8 Channel Constrictions**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
				None	

**Narrative:**

Stream segment is located between two grade controls. Past widening and planform adjustment. May be indicative of an aggradation/ degradation/aggradation cycle where the stream is taken from and depositing in this area in response upstream changes

**QC Status - Staff: Provisional Cons**

**Step 1. Valley and Floodplain**

1.1 Segmentation	None	Both
1.2 Alluvial Fan	None	
1.3 Corridor Encroachments		
Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0
1.4 Adjacent Side	Left	Right

Hillside Slope	Very Steep	Very Steep
Continuous w/	Always	
Win 1 Bankfill	Always	Always
Texture	Bedrock	Bedrock

1.5 Valley Features	
Valley Width (ft)	198
Width Determination	Estimated
Confinement Type	Semi-confined
Rock Gorge?	Yes
Human-caused Change?	No

<b>Step 2. Stream Channel</b>	
2.1 Bankfull Width	0
2.2 Max Depth (ft)	0.00
2.3 Mean Depth (ft)	0.00
2.4 Floodprone Width (ft)	0

Notes:  
 This segment consists of the Upper Clarendon Gorge.

**Provisional Step 2. (Continued)**

2.5 Aband. Floodpin	0.00 ft.
Human Elev Floodpin	0.00 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 (ft)	0
2.12 Substrate Composition	

Silt/Clay Present?	
Detritus	0 %
# Large Woody	0
2.13 Average Largest Particle on	
Bed	0.0
Bar	0.0

2.14 Stream Type		
Stream Type:	B	
Bed Material:	Bedrock	
Subclass Slope:	None	
Bed Form:	Bedrock	
Field Measured Slope:		
2.15 Reference Stream Type		
(if different from Phase 1)		
3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

**Step 3. Riparian Features**

3.1 Stream Banks	
Typical Bank Slope	Steep
Bank Texture	Left
Upper	Right
Material Type	Bedrock
Consistency	Cohesive
Lower	
Material Type	Bedrock
Consistency	Cohesive
Bank Erosion	Right
Erosion Length (ft)	183
Erosion Height (ft)	0.00
Revetmt. Type	None
Revetmt. Length (ft)	0
Near Bank Veg. Type	Left
Dominant	Coniferous
Sub-dominant	Bare
Bank Canopy	Left
Canopy %	51-75
Mid-Channel Canopy	Open

3.2 Riparian Buffer	
Buffer Width	Left
Dominant	>100
Sub-dominant	None
W less than 25	0
Buffer Veg. Type	Left
Dominant	Coniferous
Sub-dominant	Mixed Trees
3.3 Riparian Corridor	
Corridor Land	Left
Dominant	Forest
Sub-dominant	None
Mass Failures	0
Height	0
Gullies	0
Height	0

**Step 4. Flow & Flow Modifiers**

4.1 Springs / Seeps	None
4.2 Adjacent Wetlands	None
4.3 Flow Status	Low
4.4 # of Debris Jams	0
4.5 Flow Regulation Type	None
Flow Regulation Use	
Impoundments	None
Impoundmt. Location	
4.6 Up/Down strfm flow reg	None
(old) Upstrfm Flow Reg	None
4.7 StormwaterInputs	
Field Ditch	0
Road Ditch	0
Other	0
Tile Drain	0
Overland Flow	0
Urb Strm Wtr Pipe	0
4.9 # of Beaver Dams	0
Affected Length (ft)	0

**Step 5. Channel Bed and Planform Changes**

5.1 Bar Types		
Mid	Point	Side
0	0	0
Diagonal	Delta	Island
0	0	0
5.2 Other Features		
Flood Neck Cutoff	Avulsion	Braiding
0	0	0

5.3 Steep Riffles and Head Cuts		
Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No
5.4 Stream Ford or Animal		
5.5 Straightening		
Straightening Length:		
5.5 Dredging		
0		
None		

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: **Otter Creek - Mill River**      Phase 2 Reach Summary      page 2 of 2      December 12, 2007  
 Stream: **Mill River**      Reach # **M04**      Segment: **0**      Completion Date: **September 13,**  
 Organization: **Rutland RPC**      Observers: **Michael Blazewicz**      Rain: **No**  
 Segment Length (ft): **2,220**      Segment Location: **The upper Clarendon Gorge.**

**1.6 Grade Controls**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	Mid-segment	0.00	0.00	Yes	
Ledge	Mid-segment	0.00	0.00	No	
Ledge	Mid-segment	0.00	0.00	Yes	

**Step 7. Rapid Geomorphic Assessment Data**

**Confinement Type**

Channel Evolution Model  
 Channel Evolution Stage  
 Geomorphic Condition  
 Stream Sensitivity

**4.8 Channel Constrictions**      **None**

Type	Width Taken?	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

**Step 6. Rapid Habitat Assessment Data**

**Stream Gradient Type**      **High**

**Narrative:**

Habitat Stream Condition

Project: Otter Creek - Mill River  
 Stream: Mill River  
 Organization: Rutland RPC  
 Segment Length (ft): 11,799

Reach # M05  
 Observers: Michael Blazewicz, Sarah Lade  
 Segment Location: From below a Route 103 bridge downstream of Cuttingsville to the beginning of the Upper

December 12, 2007 SGAT Version: 4.56  
 Completion Date: October 15, 2007  
 Rain: No

**QC Status - Staff: Provisional Cons**

**Step 1. Valley and Floodplain**

1.1 Segmentation	Planform and Scope	
1.2 Alluvial Fan	None	
1.3 Corridor Encroachments		Both
Length (ft)	One	
Berms	0	0
height	0	0
Roads	675	0
height	20	0
Railroads	3,241	0
height	39	0
Improved Paths	0	0
height	0	0
Development	163	0
1.4 Adjacent Side	Left	Right
Hillside Slope	Very Steep	Very Steep
Continuous w/Sometimes	Sometimes	Sometimes
Win 1 Bankfill	Sometimes	Sometimes
Texture	Gravel	Gravel

**Provisional Step 2. (Continued)**

2.5 Aband. Floodpin	7.20 ft.
Human Elev Floodpin	0.00 ft.
2.6 Width/Depth Ratio	26.84
2.7 Entrenchment Ratio	4.76
2.8 Incision Ratio	1.57
Human Elevated Inc Rat	0.00
2.9 Sinuosity	Low
2.10 Riffles Type	Sedimented
2.11 Riffle/Step Spacing (ft)	0
2.12 Substrate Composition	
Bedrock	0%
Boulder	23%
Cobble	27%
Coarse Gravel	29%
Fine Gravel	7%
Sand	7%
Silt and smaller	7%
Silt/Clay Present?	No
Detritus	1 %
# Large Woody	39
2.13 Average Largest Particle on	
Bed	24.0 inches
Bar	6.0 inches

**Step 3. Riparian Features**

3.1 Stream Banks	
Typical Bank Slope	Steep
Bank Texture	Left
Upper	Right
Material Type	Sand
Consistency	Non-cohesive
Lower	Non-cohesive
Material Type	Boulder/Cobb/Boulder/Cobb
Consistency	Non-cohesive
Bank Erosion	Left
Erosion Length (ft)	3,560
Erosion Height (ft)	5.58
Revetmt. Type	None
Revetmt. Length (ft)	0
Near Bank Veg. Type	Left
Dominant	Deciduous
Sub-dominant	Shrubs/Saplin
Bank Canopy	Left
Canopy %	26-50
Mid-Channel Canopy	Open
3.2 Riparian Buffer	
Buffer Width	Left
Dominant	>100
Sub-dominant	None
W less than 25	0
Buffer Veg. Type	Left
Dominant	Mixed Trees
Sub-dominant	Shrubs/Saplin
3.3 Riparian Corridor	
Corridor Land	Left
Dominant	Forest
Sub-dominant	Commercial
Mass Failures	773
Height	150
Gullies	0
Height	0

**Step 4. Flow & Flow Modifiers**

4.1 Springs / Seeps	Minimal
4.2 Adjacent Wetlands	Minimal
4.3 Flow Status	Low
4.4 # of Debris Jams	0
4.5 Flow Regulation Type	None
Flow Regulation Use	
Impoundments	None
Impoundmt. Location	
4.6 Up/Down strfm flow reg	None
(old) Upstrm Flow Reg	None
4.7 StormwaterInputs	
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

**Step 5. Channel Bed and Planform Changes**

5.1 Bar Types		
Mid	Point	Side
3	6	4
Diagonal	Delta	Island
2	0	2
5.2 Other Features		
Flood Neck Cutoff	Avulsion	Braiding
5	0	0
5.3 Steep Riffles and Head Cuts		
Steep Riffles	Head Cuts	Trib Rejuv.
0	0	Yes
5.4 Stream Ford or Animal		
5.5 Straightening		Straightening
Straightening Length:		5,302
5.5 Dredging		Dredging

**Step 2. Stream Channel**

2.1 Bankfull Width	84
2.2 Max Depth (ft)	4.60
2.3 Mean Depth (ft)	3.13
2.4 Floodprone Width (ft)	400

**2.14 Stream Type**

Stream Type:	C
Bed Material:	Gravel
Subclass Slope:	None
Bed Form:	Riffle-Pool

**2.15 Reference Stream Type**

(if different from Phase 1)		
3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

**Notes:**

This segment flows through a predominately forested corridor (except for some encroachment by the railroad). It is a channel that has incised enough to abandon an old floodplain and begin to develop a juvenile floodplain. There is not too much incision so

**Note:**

Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

1.6 Grade Controls **None**      Step 7. Rapid Geomorphic Assessment Data

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken	Confinement Type	Score	STD	Historic
7.1 Channel Degradation						<b>Unconfined</b>	<b>9</b>	<b>None</b>	<b>Yes</b>
7.2 Channel Aggradation							<b>11</b>	<b>None</b>	<b>No</b>
7.3 Widening Channel							<b>12</b>		<b>No</b>
7.4 Change in Planform							<b>10</b>		<b>No</b>

Total Score **42**

Geomorphic Rating **0.525**

Channel Evolution Model **F**

Channel Evolution Stage **IV**

Geomorphic Condition **Fair**

Stream Sensitivity **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type	High	Score
6.1 Epifaunal Substrate - Available Cover		11
6.2 Embeddedness		10
6.3 Velocity/Depth Patterns		13
6.4 Sediment Deposition		13
6.5 Channel Flow Status		10
6.6 Channel Alteration		15
6.7 Frequency of Riffles/Steps		13
6.8 Bank Stability	Left: 7 Right: 7	
6.9 Bank Vegetation Protection	Left: 9 Right: 9	
6.10 Riparian Vegetation Zone Width	Left: 9 Right: 9	
Total Score		135
Habitat Rating		0.675

Habitat Stream Condition **Good**

**Narrative:**

Historic incision. Active aggradation and planform adjustment as the channel works to create more floodplain access.

Project: Otter Creek - Mill River  
 Stream: Mill River  
 Organization: Rutland RPC  
 Segment Length (ft): 4,900

Reach # M05  
 Observers: Michael Blazewicz, Sarah Lade  
 Segment Location: From below Cuttingsville to below the Route 103 bridge.

December 12, 2007 SGAT Version: 4.56  
 Completion Date: October 15, 2007  
 Rain: No

**QC Status - Staff: Provisional Cons**

**Step 1. Valley and Floodplain**

1.1 Segmentation	Corridor Encroachment	
1.2 Alluvial Fan	None	
1.3 Corridor Encroachments		Both
Length (ft)	One	
Berms	700	0
height	10	0
Roads	2,884	0
height	6	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	2,037	0
1.4 Adjacent Side	Left	Right
Hillside Slope	Steep	Very Steep
Continuous w/	Never	Sometimes
Win 1 Bankfill	Never	Sometimes
Texture	Not Evalua	Mixed
1.5 Valley Features		
Valley Width (ft)	400	
Width Determination	Estimated	
Confinement Type	Narrow	
Rock Gorge?	No	
Human-caused Change?	Yes	
<b>Step 2. Stream Channel</b>		
2.1 Bankfull Width	106	
2.2 Max Depth (ft)	4.60	
2.3 Mean Depth (ft)	3.00	
2.4 Floodprone Width (ft)	190	

Notes:  
 This segment like many upstream is heavily influenced by recent and historic channel management activities including berming, armoring, dredging and windrowing. Floodplain encroachment from VT 103 and residences along with significant channel

**Provisional Step 2. (Continued)**

2.5 Aband. Floodpln	8.00 ft.	
Human Elev Floodpln	0.00 ft.	
2.6 Width/Depth Ratio	35.33	
2.7 Entrenchment Ratio	1.79	
2.8 Incision Ratio	1.74	
Human Elevated Inc Rat	0.00	
2.9 Sinuosity	Low	
2.10 Riffles Type	Eroded	
2.11 Riffle/Step Spacing (ft)	0	
2.12 Substrate Composition		
Bedrock	0%	
Boulder	23%	
Cobble	34%	
Coarse Gravel	29%	
Fine Gravel	11%	
Sand	2%	
Silt and smaller	1%	
Silt/Clay Present?	No	
Detritus	1 %	
# Large Woody	33	
2.13 Average Largest Particle on		
Bed	18.0	inches
Bar	4.0	inches
2.14 Stream Type		
Stream Type:	B	
Bed Material:	Cobble	
Subclass Slope:	None	
Bed Form:	Plane Bed	
Field Measured Slope:		
2.15 Reference Stream Type		
(if different from Phase 1)		
3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

**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/Cobb/Boulder/Cobb	
Consistency	Non-cohesive	Non-cohesive
Bank Erosion	Left	Right
Erosion Length (ft)	1,029	632
Erosion Height (ft)	6.50	5.50
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	1,066	852
Near Bank Veg. Type	Left	Right
Dominant	Coniferous	Deciduous
Sub-dominant	Herbaceous Shrubs/Saplin	
Bank Canopy	Left	Right
Canopy %	26-50	26-50
Mid-Channel Canopy		Open
3.2 Riparian Buffer		
Buffer Width	Left	Right
Dominant	0-25	>100
Sub-dominant	26-50	26-50
W less than 25	1,362	325
Buffer Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Mixed Trees
Sub-dominant	Herbaceous	Herbaceous
3.3 Riparian Corridor		
Corridor Land	Left	Right
Dominant	Residential	Commercial
Sub-dominant	Commercial	Forest
Mass Failures	0	87
Height	0	80
Gullies	0	0
Height	0	0

**Step 4. Flow & Flow Modifiers**

4.1 Springs / Seeps	Minimal		
4.2 Adjacent Wetlands	Minimal		
4.3 Flow Status	Low		
4.4 # of Debris Jams	0		
4.5 Flow Regulation Type	None		
Flow Regulation Use			
Impoundments	None		
Impoundmt. Location			
4.6 Up/Down strfm flow reg	None		
(old) Upstrm Flow Reg	None		
4.7 StormwaterInputs			
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		
<b>Step 5. Channel Bed and Planform Changes</b>			
5.1 Bar Types			
Mid	Point	Side	
0	0	1	
Diagonal	Delta	Island	
0	0	0	
5.2 Other Features			
Flood Neck Cutoff	Avulsion	Braiding	
0	0	0	
5.3 Steep Riffles and Head Cuts			
Steep Riffles	Head Cuts	Trib Rejuv.	
0	0	No	
5.4 Stream Ford or Animal			
5.5 Straightening	With Windrowing		
Straightening Length:	4,715		
5.5 Dredging		Dredging	

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: **Otter Creek - Mill River**      page 2 of 2      **Phase 2 Reach Summary**      December 12, 2007  
 Stream: **Mill River**      Reach # **M05**      Segment: **B**      Completion Date: **October 15, 2007**  
 Organization: **Rutland RPC**      Observers: **Michael Blazewicz, Sarah Lade**      Rain: **No**  
 Segment Length (ft): **4,900**      Segment Location: **From below Cuttingsville to below the Route 103 bridge.**

**1.6 Grade Controls** **None**      Step 7. Rapid Geomorphic Assessment Data

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken	Confinement Type	Score	STD	Historic
7.1 Channel Degradation						<b>Unconfined</b>	<b>8</b>	<b>C to B</b>	<b>Yes</b>
7.2 Channel Aggradation							<b>14</b>	<b>None</b>	<b>No</b>
7.3 Widening Channel							<b>8</b>		<b>No</b>
7.4 Change in Planform							<b>13</b>		<b>No</b>

Total Score **43**  
 Geomorphic Rating **0.5375**

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

4.8 Channel Constrictions

Type      Width      210.      Yes      No      Yes      No      Yes  
 Bridge      Problem      Deposition Above, Deposition Below, Scour

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

Stream Gradient Type	Score
6.1 Epifaunal Substrate - Available Cover	8
6.2 Embeddedness	13
6.3 Velocity/Depth Patterns	8
6.4 Sediment Deposition	15
6.5 Channel Flow Status	10
6.6 Channel Alteration	5
6.7 Frequency of Riffles/Steps	10
6.8 Bank Stability	Left: 8    Right: 6
6.9 Bank Vegetation Protection	Left: 6    Right: 6
6.10 Riparian Vegetation Zone Width	Left: 6    Right: 3

Total Score **104**  
 Habitat Rating **0.52**

Habitat Stream Condition **Fair**

**Narrative:**

Historic incision. Active major widening. Planform and widening limited by valley wall location, riprapping and dredging. Has been turned into a transport reach, however, major planform shifts could be expected in the future.

**QC Status - Staff: Provisional Cons**

**Step 1. Valley and Floodplain**

1.1 Segmentation	None	Both
1.2 Alluvial Fan	None	
1.3 Corridor Encroachments		
Length (ft)	One	Both
Berms	1,820	0
height	9	0
Roads	3,534	0
height	5	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	1,864	926
1.4 Adjacent Side	Left	Right
Hillside Slope	Hilly	Flat
Continuous w/Sometimes	Sometimes	Never
Win 1 Bankfill	Sometimes	Sometimes
Texture	Bedrock	Not Evalua
1.5 Valley Features		
Valley Width (ft)	512	
Width Determination	Estimated	
Confinement Type	Broad	
Rock Gorge?	No	
Human-caused Change?	Yes	
<b>Step 2. Stream Channel</b>		
2.1 Bankfull Width	84	
2.2 Max Depth (ft)	3.80	
2.3 Mean Depth (ft)	2.62	
2.4 Floodprone Width (ft)	512	

**Provisional Step 2. (Continued)**

2.5 Aband. Floodpin	7.00 ft.	
Human Elev Floodpin	0.00 ft.	
2.6 Width/Depth Ratio	32.06	
2.7 Entrenchment Ratio	6.10	
2.8 Incision Ratio	1.84	
Human Elevated Inc Rat	0.00	
2.9 Sinuosity	Low	
2.10 Riffles Type	Eroded	
2.11 Riffle/Step Spacing (ft)	0	
2.12 Substrate Composition		
Bedrock	0%	
Boulder	15%	
Cobble	41%	
Coarse Gravel	26%	
Fine Gravel	13%	
Sand	4%	
Silt and smaller	1%	
Silt/Clay Present?	No	
Detritus	2 %	
# Large Woody	41	
2.13 Average Largest Particle on		
Bed	18.0 inches	
Bar	4.0 inches	
2.14 Stream Type		
Stream Type:	C	
Bed Material:	Cobble	
Subclass Slope:	None	
Bed Form:	Plane Bed	
Field Measured Slope:		
2.15 Reference Stream Type		
(if different from Phase 1)		
3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

**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/Cobb	Boulder/Cobb
Consistency	Non-cohesive	Non-cohesive
Bank Erosion	Left	Right
Erosion Length (ft)	672	1,230
Erosion Height (ft)	5.33	4.89
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	643	2,250
Near Bank Veg. Type	Left	Right
Dominant	Coniferous Shrubs/Saplin	Coniferous Shrubs/Saplin
Sub-dominant	Shrubs/Saplin	Deciduous
Bank Canopy	Left	Right
Canopy %	51-75	1-25
Mid-Channel Canopy		Open
3.2 Riparian Buffer		
Buffer Width	Left	Right
Dominant	>100	0-25
Sub-dominant	0-25	26-50
W less than 25	832	4,173
Buffer Veg. Type	Left	Right
Dominant	Coniferous	Mixed Trees
Sub-dominant	Deciduous Shrubs/Saplin	Deciduous Shrubs/Saplin
3.3 Riparian Corridor		
Corridor Land	Left	Right
Dominant	Forest	Residential
Sub-dominant	Commercial	Commercial
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

**Step 4. Flow & Flow Modifiers**

4.1 Springs / Seeps	Minimal		
4.2 Adjacent Wetlands	None		
4.3 Flow Status	Low		
4.4 # of Debris Jams	0		
4.5 Flow Regulation Type	None		
Flow Regulation Use			
Impoundments	None		
Impoundmt. Location			
4.6 Up/Down strfm flow reg	None		
(old) Upstrm Flow Reg	None		
4.7 StormwaterInputs			
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		

**Step 5. Channel Bed and Planform Changes**

5.1 Bar Types			
Mid	Point	Side	
3	0	1	
Diagonal	Delta	Island	
1	1	5	
5.2 Other Features			
Flood Neck Cutoff	Avulsion	Braiding	
2	0	0	
5.3 Steep Riffles and Head Cuts			
Steep Riffles	Head Cuts	Trib Rejuv.	
0	0	Yes	
5.4 Stream Ford or Animal			
5.5 Straightening	With Windrowing		
Straightening Length:	6,543		
5.5 Dredging		Dredging	

Notes:  
 This reach goes through Cuttingsville with a great deal of human alteration, both historic and recent. Channel straightening, berming, dredging, armoring, and windrowing were all observed. It appears that the stream may have been pushed up against the left valley

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

**1.6 Grade Controls**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	Mid-segment	0.00	0.00	Yes	

**Step 7. Rapid Geomorphic Assessment Data**

Confinement Type	Score	STD	Historic
<b>Unconfined</b>			
7.1 Channel Degradation	<b>8</b>	<b>None</b>	<b>Yes</b>
7.2 Channel Aggradation	<b>12</b>	<b>None</b>	<b>No</b>
7.3 Widening Channel	<b>8</b>		<b>No</b>
7.4 Change in Planform	<b>8</b>		<b>No</b>

Total Score **36**

Geomorphic Rating **0.45**

Channel Evolution Model **F**

Channel Evolution Stage **III**

Geomorphic Condition **Fair**

Stream Sensitivity **High**

**Step 6. Rapid Habitat Assessment Data**

**Stream Gradient Type High**

Stream Gradient Type	Score
6.1 Epifaunal Substrate - Available Cover	8
6.2 Embeddedness	11
6.3 Velocity/Depth Patterns	8
6.4 Sediment Deposition	11
6.5 Channel Flow Status	9
6.6 Channel Alteration	8
6.7 Frequency of Riffles/Steps	10
6.8 Bank Stability	Left: 6 Right: 5
6.9 Bank Vegetation Protection	Left: 8 Right: 6
6.10 Riparian Vegetation Zone Width	Left: 8 Right: 2

Total Score **100**

Habitat Rating **0.5**

Habitat Stream Condition **Fair**

**Narrative:**

Historic degradation associated with channel straightening, berming, and floodplain encroachment. Current widening and planform adjustment.

Project: Otter Creek - Mill River  
 Stream: Mill River  
 Organization: Rutland RPC  
 Segment Length (ft): 2,380

Phase 2 Segment Summary page 1 of 2  
 Reach # M07  
 Observers: Michael Blazewicz, Sarah Lade  
 Segment Location: Begins near the Wallingford/Shrewsbury town line and ends where Freeman Brook enters

December 12, 2007 SGAT Version: 4.56  
 Completion Date: September 22, 2007  
 Rain: No

**QC Status - Staff: Provisional Cons**

**Step 1. Valley and Floodplain**

1.1 Segmentation	None	Both
1.2 Alluvial Fan	None	
1.3 Corridor Encroachments		
Length (ft)	One	Both
Berms	1,616	0
height	9	0
Roads	339	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	454	0
1.4 Adjacent Side	Left	Right
Hillside Slope	Steep	Steep
Continuous w/	Never	Never
Win 1 Bankfill	Sometimes	Never
Texture	Not Evalua	Not Evalua
1.5 Valley Features		
Valley Width (ft)	600	
Width Determination	Estimated	
Confinement Type	Broad	
Rock Gorge?	No	
Human-caused Change?	Yes	

**Provisional Step 2. (Continued)**

2.5 Aband. Floodpin	5.10 ft.
Human Elev Floodpin	8.10 ft.
2.6 Width/Depth Ratio	45.79
2.7 Entrenchment Ratio	1.29
2.8 Incision Ratio	1.65
Human Elevated Inc Rat	2.61
2.9 Sinuosity	Low
2.10 Riffles Type	Eroded
2.11 Riffle/Step Spacing (ft)	0
2.12 Substrate Composition	
Bedrock	0%
Boulder	16%
Cobble	33%
Coarse Gravel	26%
Fine Gravel	18%
Sand	6%
Silt and smaller	1%
Silt/Clay Present?	No
Detritus	1 %
# Large Woody	2
2.13 Average Largest Particle on	
Bed	20.0 inches
Bar	10.0 inches

**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/Cobb/Boulder/Cobb	
Consistency	Non-cohesive	Non-cohesive
Bank Erosion	Left	Right
Erosion Length (ft)	964	481
Erosion Height (ft)	6.67	6.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0
Near Bank Veg. Type	Left	Right
Dominant	Deciduous Shrubs/Saplin	
Sub-dominant	Coniferous	Deciduous
Bank Canopy	Left	Right
Canopy %	51-75	1-25
Mid-Channel Canopy		Open
3.2 Riparian Buffer		
Buffer Width	Left	Right
Dominant	>100	0-25
Sub-dominant	None	51-100
W less than 25	0	683
Buffer Veg. Type	Left	Right
Dominant	Coniferous Shrubs/Saplin	
Sub-dominant	Deciduous	Herbaceous
3.3 Riparian Corridor		
Corridor Land	Left	Right
Dominant	Forest	Hay
Sub-dominant	None	Residential
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

**Step 4. Flow & Flow Modifiers**

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

**Step 5. Channel Bed and Planform Changes**

5.1 Bar Types			
Mid	0	Point	Side
Diagonal	0	Delta	Island
5.2 Other Features			
Flood Neck Cutoff	0	Avulsion	Braiding
2	0	0	0
5.3 Steep Riffles and Head Cuts			
Steep Riffles	Head Cuts	Trib Rejuv.	
0	0	Yes	No
5.4 Stream Ford or Animal			
5.5 Straightening			
Straightening Length:			2,362
5.5 Dredging			Dredging

Notes:  
 A short reach that appears to have been pushed up against the left valley wall in order to make more room for agriculture. Significant berming has occurred in order to lock the channel in its location thereby eliminating most of the water and sediment

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: **Otter Creek - Mill River**      **Phase 2 Reach Summary**      page 2 of 2      December 12, 2007  
 Stream: **Mill River**      Reach # **M07**      Segment: **0**      Completion Date: **September 22,**  
 Organization: **Rutland RPC**      Observers: **Michael Blazewicz, Sarah Lade**      Rain: **No**  
 Segment Length (ft): **2,380**      Segment Location: **Begins near the Wallingford/Shrewsbury town line and ends where Freeman Brook**

**1.6 Grade Controls** **None**      Step 7. Rapid Geomorphic Assessment Data

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken	Confinement Type	Score	STD	Historic
						<b>Unconfined</b>			
7.1	Channel Degradation						<b>3</b>	<b>C to F</b>	<b>Yes</b>
7.2	Channel Aggradation						<b>11</b>	<b>None</b>	<b>No</b>
7.3	Widening Channel						<b>5</b>		<b>No</b>
7.4	Change in Planform						<b>11</b>		<b>No</b>

Total Score **30**  
 Geomorphic Rating **0.375**

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type	High	Score
6.1 Epifaunal Substrate - Available Cover		7
6.2 Embeddedness		9
6.3 Velocity/Depth Patterns		8
6.4 Sediment Deposition		10
6.5 Channel Flow Status		8
6.6 Channel Alteration		5
6.7 Frequency of Riffles/Steps		5
6.8 Bank Stability	Left: 6 Right: 7	
6.9 Bank Vegetation Protection	Left: 8 Right: 4	
6.10 Riparian Vegetation Zone Width	Left: 10 Right: 2	

Total Score **89**  
 Habitat Rating **0.445**

Habitat Stream Condition **Fair**

**Narrative:**

STD from C to F channel. Riffle pool has become planebed. Dredging, straightening and berming a major influence on channel adjustment. Major widening has occurred. Evolution to stage IV will be limited if channel management continues.

Project: Otter Creek - Mill River  
 Stream: Mill River  
 Organization: Rutland RPC  
 Segment Length (ft): 1,900

Reach # M08  
 Observers: Michael Blazewicz, Sarah Lade  
 Segment Location: In a narrow valley north of East Wallingford Village, where the railroad crosses the river

December 12, 2007 SGAT Version: 4.56  
 Completion Date: September 24, 2007  
 Rain: No

**QC Status - Staff: Provisional Cons**

**Step 1. Valley and Floodplain**

1.1 Segmentation	None	Both
1.2 Alluvial Fan	None	
1.3 Corridor Encroachments		
Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	1,369	0
height	4	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	352	0
1.4 Adjacent Side	Left	Right
Hillside Slope	Very Steep	Very Steep
Continuous w/Sometimes	Sometimes	Sometimes
W/in 1 Bankfill	Always	Sometimes
Texture	Mixed	Bedrock
1.5 Valley Features		
Valley Width (ft)	250	
Width Determination	Estimated	
Confinement Type	Semi-confined	
Rock Gorge?	No	
Human-caused Change?	Yes	
<b>Step 2. Stream Channel</b>		
2.1 Bankfull Width	73	
2.2 Max Depth (ft)	4.00	
2.3 Mean Depth (ft)	2.88	
2.4 Floodprone Width (ft)	253	

Notes:  
 A short reach in a semi-confined valley that has been further confined by a road. Despite a high degree of incision the stream has maintained a C type channel (almost an F type). Although there is no stream type departure or bedform change (planebed by

**Provisional Step 2. (Continued)**

2.5 Aband. Floodpin	7.60 ft.	
Human Elev Floodpin	0.00 ft.	
2.6 Width/Depth Ratio	25.35	
2.7 Entrenchment Ratio	3.47	
2.8 Incision Ratio	1.90	
Human Elevated Inc Rat	0.00	
2.9 Sinuosity	Low	
2.10 Riffles Type	Eroded	
2.11 Riffle/Step Spacing (ft)	0	
2.12 Substrate Composition		
Bedrock	0%	
Boulder	24%	
Cobble	30%	
Coarse Gravel	27%	
Fine Gravel	14%	
Sand	5%	
Silt and smaller	0%	
Silt/Clay Present?	No	
Detritus	1 %	
# Large Woody	1	
2.13 Average Largest Particle on		
Bed	20.0 inches	
Bar	8.0 inches	
2.14 Stream Type		
Stream Type:	C	
Bed Material:	Cobble	
Subclass Slope:	None	
Bed Form:	Plane Bed	
Field Measured Slope:		
2.15 Reference Stream Type		
(if different from Phase 1)		
3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

**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/Cobb/Boulder/Cobb	
Consistency	Non-cohesive	Non-cohesive
Bank Erosion	Left	Right
Erosion Length (ft)	76	489
Erosion Height (ft)	8.00	7.00
Revetmt. Type	Rip-Rap	None
Revetmt. Length (ft)	99	0
Near Bank Veg. Type	Left	Right
Dominant	Coniferous Shrubs/Saplin	Deciduous
Sub-dominant	Shrubs/Saplin	Deciduous
Bank Canopy	Left	Right
Canopy %	26-50	1-25
Mid-Channel Canopy		Open
3.2 Riparian Buffer		
Buffer Width	Left	Right
Dominant	>100	26-50
Sub-dominant	None	0-25
W less than 25	0	388
Buffer Veg. Type	Left	Right
Dominant	Coniferous Shrubs/Saplin	Deciduous
Sub-dominant	Shrubs/Saplin	Deciduous
3.3 Riparian Corridor		
Corridor Land	Left	Right
Dominant	Forest	Commercial
Sub-dominant	None	Residential
Mass Failures	263	0
Height	75	0
Gullies	0	0
Height	0	0

**Step 4. Flow & Flow Modifiers**

4.1 Springs / Seeps	Minimal		
4.2 Adjacent Wetlands	None		
4.3 Flow Status	Low		
4.4 # of Debris Jams	0		
4.5 Flow Regulation Type	None		
Flow Regulation Use			
Impoundments	None		
Impoundmt. Location			
4.6 Up/Down strfm flow reg	None		
(old) Upstrm Flow Reg	None		
4.7 StormwaterInputs			
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		

**Step 5. Channel Bed and Planform Changes**

5.1 Bar Types			
Mid	Point	Side	
1	0	0	
Diagonal	Delta	Island	
0	0	0	
5.2 Other Features			
Flood Neck Cutoff	Avulsion	Braiding	
1	0	0	
5.3 Steep Riffles and Head Cuts			
Steep Riffles	Head Cuts	Trib Rejuv.	
0	0	No	
5.4 Stream Ford or Animal			
5.5 Straightening			
Straightening Length:		813	
5.5 Dredging			None

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

**1.6 Grade Controls**      **None**      **Step 7. Rapid Geomorphic Assessment Data**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
<b>Confinement Type      <b>Plane Bed</b></b>					
		Score	STD	Historic	
7.1 Channel Degradation		<b>9</b>	<b>None</b>	<b>Yes</b>	
7.2 Channel Aggradation		<b>14</b>	<b>None</b>	<b>No</b>	
7.3 Widening Channel		<b>12</b>		<b>No</b>	
7.4 Change in Planform		<b>13</b>		<b>No</b>	

Total Score **48**  
 Geomorphic Rating **0.6**  
 Channel Evolution Model **F**  
 Channel Evolution Stage **III**  
 Geomorphic Condition **Fair**  
 Stream Sensitivity **High**

**Step 6. Rapid Habitat Assessment Data**

**Stream Gradient Type      High**

	Score
6.1 Epifaunal Substrate - Available Cover	11
6.2 Embeddedness	9
6.3 Velocity/Depth Patterns	13
6.4 Sediment Deposition	13
6.5 Channel Flow Status	13
6.6 Channel Alteration	8
6.7 Frequency of Riffles/Steps	13
6.8 Bank Stability	Left: 8    Right: 7
6.9 Bank Vegetation Protection	Left: 8    Right: 6
6.10 Riparian Vegetation Zone Width	Left: 8    Right: 5
Total Score	122
Habitat Rating	0.61

**Habitat Stream Condition      Fair**

**Narrative:**

Channel has incised historically. Some channel mangement has occurred in this reach. Widening has occurred and may continue to occur along with planform adjstmnts as the stream works to create floodplain

**QC Status - Staff: Provisional Cons**

**Step 1. Valley and Floodplain**

1.1 Segmentation	None	Both
1.2 Alluvial Fan	None	
1.3 Corridor Encroachments		
Length (ft)	One	Both
Berms	848	0
height	11	0
Roads	2,975	0
height	8	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	508	0
1.4 Adjacent Side	Left	Right
Hillside Slope	Steep	Very Steep
Continuous w/Sometimes	Sometimes	Never
Win 1 Bankfill	Sometimes	Sometimes
Texture	Gravel	Not Evalua
1.5 Valley Features		
Valley Width (ft)	320	
Width Determination	Estimated	
Confinement Type	Narrow	
Rock Gorge?	No	
Human-caused Change?	Yes	
<b>Step 2. Stream Channel</b>		
2.1 Bankfull Width	87	
2.2 Max Depth (ft)	3.20	
2.3 Mean Depth (ft)	2.20	
2.4 Floodprone Width (ft)	111	

Notes:  
 Channel encroachment has caused a change in valley width from Broad to narrow in this reach. Extensive berming and channel armoring are present in the reach. There is a high degree of incision and a stream type departure from a C channel to a B plane bed

**Provisional Step 2. (Continued)**

2.5 Aband. Floodpin	5.90 ft.	
Human Elev Floodpin	0.00 ft.	
2.6 Width/Depth Ratio	39.55	
2.7 Entrenchment Ratio	1.28	
2.8 Incision Ratio	1.84	
Human Elevated Inc Rat	0.00	
2.9 Sinuosity	Low	
2.10 Riffles Type	Eroded	
2.11 Riffle/Step Spacing (ft)	0	
2.12 Substrate Composition		
Bedrock	0%	
Boulder	21%	
Cobble	40%	
Coarse Gravel	26%	
Fine Gravel	10%	
Sand	3%	
Silt and smaller	0%	
Silt/Clay Present?	No	
Detritus	1 %	
# Large Woody	10	
2.13 Average Largest Particle on		
Bed	24.0 inches	
Bar	8.0 inches	
2.14 Stream Type		
Stream Type:	B	
Bed Material:	Cobble	
Subclass Slope:	c	
Bed Form:	Plane Bed	
Field Measured Slope:		
2.15 Reference Stream Type		
(if different from Phase 1)		
3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

**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/Cobb	Boulder/Cobb
Consistency	Non-cohesive	Non-cohesive
Bank Erosion	Left	Right
Erosion Length (ft)	618	444
Erosion Height (ft)	6.50	5.67
Revetmt. Type	None	Rip-Rap
Revetmt. Length (ft)	0	1,995
Near Bank Veg. Type	Left	Right
Dominant	Deciduous Shrubs/Saplin	
Sub-dominant	Coniferous	Herbaceous
Bank Canopy	Left	Right
Canopy %	51-75	1-25
Mid-Channel Canopy		Open
3.2 Riparian Buffer		
Buffer Width	Left	Right
Dominant	>100	0-25
Sub-dominant	None	26-50
W less than 25	0	1,844
Buffer Veg. Type	Left	Right
Dominant	Mixed Trees Shrubs/Saplin	
Sub-dominant	None	Herbaceous
3.3 Riparian Corridor		
Corridor Land	Left	Right
Dominant	Forest	Commercial
Sub-dominant	None	Residential
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

**Step 4. Flow & Flow Modifiers**

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

**Step 5. Channel Bed and Planform Changes**

5.1 Bar Types			
Mid	Point	Side	
4	0	1	
Diagonal	Delta	Island	
0	0	0	
5.2 Other Features		Braiding	
Flood Neck Cutoff	Avulsion		0
1	0		
5.3 Steep Riffles and Head Cuts			
Steep Riffles	Head Cuts	Trib Rejuv.	
0	0	No	
5.4 Stream Ford or Animal		No	
5.5 Straightening		Straightening	693
Straightening Length:		Dredging	
5.5 Dredging			

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: **Otter Creek - Mill River**      page 2 of 2      December 12, 2007  
 Stream: **Mill River**      Reach # **M09**      Segment: **0**      Completion Date: **September 25,**  
 Organization: **Rutland RPC**      Observers: **Michael Blazewicz, Sarah Lade**      Rain: **No**  
 Segment Length (ft): **3,609**      Segment Location: **Begins just downstream of the Village Street bridge in East Wallingford and continues**

**1.6 Grade Controls** **None**      **Step 7. Rapid Geomorphic Assessment Data**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
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Confinement Type	<b>Unconfined</b>	Score	STD	Historic
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7.1 Channel Degradation	<b>4</b>	<b>C to B</b>	<b>Yes</b>
7.2 Channel Aggradation	<b>13</b>	<b>None</b>	<b>No</b>
7.3 Widening Channel	<b>5</b>		<b>No</b>
7.4 Change in Planform	<b>12</b>		<b>No</b>

Total Score **34**  
 Geomorphic Rating **0.425**  
 Channel Evolution Model **F**  
 Channel Evolution Stage **III**  
 Geomorphic Condition **Fair**  
 Stream Sensitivity **High**

**Step 6. Rapid Habitat Assessment Data**

Stream Gradient Type **High**

6.1 Epifaunal Substrate - Available Cover	Score
6.2 Embeddedness	11
6.3 Velocity/Depth Patterns	11
6.4 Sediment Deposition	8
6.5 Channel Flow Status	9
6.6 Channel Alteration	8
6.7 Frequency of Riffles/Steps	6
6.8 Bank Stability	9
6.9 Bank Vegetation Protection	Left: 8 Right: 8
6.10 Riparian Vegetation Zone Width	Left: 8 Right: 3
	Left: 9 Right: 2

Total Score	100
Habitat Rating	0.5

Habitat Stream Condition **Fair**

**Narrative:**

Historic degradation has led to STD. Extensive channel management (riprap, dredging, straightening, has kept channel from moving into stage IV). Expect extensive widening and minor planform adjustments to continue.

**QC Status - Staff: Provisional Cons**

**Step 1. Valley and Floodplain**

1.1 Segmentation	<b>None</b>	Both
1.2 Alluvial Fan	<b>None</b>	
1.3 Corridor Encroachments		
Length (ft)	One	Both
Berms	<b>146</b>	<b>0</b>
height	<b>5</b>	<b>0</b>
Roads	<b>1,070</b>	<b>257</b>
height	<b>7</b>	<b>0</b>
Railroads	<b>0</b>	<b>0</b>
height	<b>0</b>	<b>0</b>
Improved Paths	<b>0</b>	<b>0</b>
height	<b>0</b>	<b>0</b>
Development	<b>1,222</b>	<b>0</b>
1.4 Adjacent Side	Left	Right
Hillside Slope	<b>Flat</b>	<b>Steep</b>
Continuous w/	<b>Never</b>	<b>Sometimes</b>
Win 1 Bankfill	<b>Sometimes</b>	<b>Sometimes</b>
Texture	<b>Not Evalua</b>	<b>Mixed</b>
1.5 Valley Features		
Valley Width (ft)	<b>400</b>	
Width Determination	<b>Estimated</b>	
Confinement Type	<b>Broad</b>	
Rock Gorge?	<b>No</b>	
Human-caused Change?	<b>Yes</b>	
<b>Step 2. Stream Channel</b>		
2.1 Bankfull Width	<b>63</b>	
2.2 Max Depth (ft)	<b>4.40</b>	
2.3 Mean Depth (ft)	<b>2.85</b>	
2.4 Floodprone Width (ft)	<b>135</b>	

Notes:  
 This reach flows through East Wallingford Village. It is highly managed with evidence of channel straightening and armoring. The high incision ratio has caused a stream type departure from a C channel to a B plane bed system. This is likely to be maintained in

**Provisional Step 2. (Continued)**

2.5 Aband. Floodpin	<b>7.90 ft.</b>	
Human Elev Floodpin	<b>0.00 ft.</b>	
2.6 Width/Depth Ratio	<b>22.11</b>	
2.7 Entrenchment Ratio	<b>2.14</b>	
2.8 Incision Ratio	<b>1.80</b>	
Human Elevated Inc Rat	<b>0.00</b>	
2.9 Sinuosity	<b>Low</b>	
2.10 Riffles Type	<b>Eroded</b>	
2.11 Riffle/Step Spacing (ft)	<b>0</b>	
2.12 Substrate Composition		
Bedrock	<b>0%</b>	
Boulder	<b>21%</b>	
Cobble	<b>40%</b>	
Coarse Gravel	<b>25%</b>	
Fine Gravel	<b>11%</b>	
Sand	<b>3%</b>	
Silt and smaller	<b>1%</b>	
Silt/Clay Present?	<b>No</b>	
Detritus	<b>1 %</b>	
# Large Woody	<b>2</b>	
2.13 Average Largest Particle on		
Bed	<b>20.0 inches</b>	
Bar	<b>N/A inches</b>	
2.14 Stream Type		
Stream Type:	<b>B</b>	
Bed Material:	<b>Cobble</b>	
Subclass Slope:	<b>c</b>	
Bed Form:	<b>Plane Bed</b>	
Field Measured Slope:		
2.15 Reference Stream Type		
(if different from Phase 1)		
3.3 old	Amount	Mean Height
Failures	<b>None</b>	<b>0.00</b>
Gullies	<b>None</b>	<b>0.00</b>

**Step 3. Riparian Features**

3.1 Stream Banks		
Typical Bank Slope	<b>Steep</b>	
Bank Texture	Left	Right
Upper		
Material Type	<b>Gravel</b>	<b>Gravel</b>
Consistency	<b>Non-cohesive</b>	<b>Non-cohesive</b>
Lower		
Material Type	<b>Boulder/Cobb</b>	<b>Boulder/Cobb</b>
Consistency	<b>Non-cohesive</b>	<b>Non-cohesive</b>
Bank Erosion	Left	Right
Erosion Length (ft)	<b>0</b>	<b>157</b>
Erosion Height (ft)	<b>0.00</b>	<b>4.00</b>
Revetmt. Type	<b>Rip-Rap</b>	<b>Rip-Rap</b>
Revetmt. Length (ft)	<b>901</b>	<b>1,051</b>
Near Bank Veg. Type	Left	Right
Dominant	<b>Shrubs/Saplin</b>	<b>Shrubs/Saplin</b>
Sub-dominant	<b>Herbaceous</b>	<b>Herbaceous</b>
Bank Canopy	Left	Right
Canopy %	<b>1-25</b>	<b>1-25</b>
Mid-Channel Canopy		<b>Open</b>
3.2 Riparian Buffer		
Buffer Width	Left	Right
Dominant	<b>0-25</b>	<b>0-25</b>
Sub-dominant	<b>26-50</b>	<b>26-50</b>
W less than 25	<b>1,322</b>	<b>955</b>
Buffer Veg. Type	Left	Right
Dominant	<b>Herbaceous</b>	<b>Herbaceous</b>
Sub-dominant	<b>Deciduous</b>	<b>Deciduous</b>
3.3 Riparian Corridor		
Corridor Land	Left	Right
Dominant	<b>Residential</b>	<b>Commercial</b>
Sub-dominant	<b>Commercial</b>	<b>Residential</b>
Mass Failures	<b>0</b>	<b>100</b>
Height	<b>0</b>	<b>50</b>
Gullies	<b>0</b>	<b>0</b>
Height	<b>0</b>	<b>0</b>

**Step 4. Flow & Flow Modifiers**

4.1 Springs / Seeps	<b>None</b>
4.2 Adjacent Wetlands	<b>None</b>
4.3 Flow Status	<b>Low</b>
4.4 # of Debris Jams	<b>0</b>
4.5 Flow Regulation Type	<b>None</b>
Flow Regulation Use	
Impoundments	<b>None</b>
Impoundmt. Location	
4.6 Up/Down strfm flow reg	<b>None</b>
(old) Upstrm Flow Reg	<b>None</b>
4.7 StormwaterInputs	
Field Ditch	<b>0</b>
Road Ditch	<b>0</b>
Other	<b>0</b>
Tile Drain	<b>0</b>
Overland Flow	<b>0</b>
Urb Strm Wtr Pipe	<b>2</b>
4.9 # of Beaver Dams	<b>0</b>
Affected Length (ft)	<b>0</b>

**Step 5. Channel Bed and Planform Changes**

5.1 Bar Types			
Mid	Point	Side	
<b>2</b>	<b>1</b>	<b>0</b>	
Diagonal	Delta	Island	
<b>1</b>	<b>0</b>	<b>0</b>	
5.2 Other Features			
Flood Neck Cutoff	Avulsion	Braiding	
<b>0</b>	<b>0</b>	<b>0</b>	
5.3 Steep Riffles and Head Cuts			
Steep Riffles	Head Cuts	Trib Rejuv.	
<b>0</b>	<b>0</b>	<b>No</b>	
5.4 Stream Ford or Animal			
5.5 Straightening			
Straightening Length:		<b>1,977</b>	
5.5 Dredging			<b>Dredging</b>

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

**1.6 Grade Controls** **None**      Step 7. Rapid Geomorphic Assessment Data

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
<b>Confinement Type    <b>Unconfined</b></b>					
				Score	STD    Historic
7.1 Channel Degradation				<b>8</b>	<b>C to B</b> <b>Yes</b>
7.2 Channel Aggradation				<b>13</b>	<b>None</b> <b>No</b>
7.3 Widening Channel				<b>13</b>	<b>No</b> <b>No</b>
7.4 Change in Planform				<b>12</b>	<b>No</b> <b>No</b>

Total Score **46**  
 Geomorphic Rating **0.575**  
 Channel Evolution Model **F**  
 Channel Evolution Stage **III**  
 Geomorphic Condition **Fair**  
 Stream Sensitivity **High**

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	168.	Yes	Yes	No	Yes
Problem: Deposition Below, Scour Below					

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	8
6.2 Embeddedness	13
6.3 Velocity/Depth Patterns	8
6.4 Sediment Deposition	14
6.5 Channel Flow Status	11
6.6 Channel Alteration	3
6.7 Frequency of Riffles/Steps	10
6.8 Bank Stability	Left: 7    Right: 8
6.9 Bank Vegetation Protection	Left: 4    Right: 4
6.10 Riparian Vegetation Zone Width	Left: 2    Right: 2

Total Score **94**  
 Habitat Rating **0.47**

Habitat Stream Condition **Fair**

**Narrative:**

Channel has incised historically and floodplain has been built up. Riprap and dredging are likely to be keeping more major adjustment from occurring in this reach. Continued planform and widening pressures expected as river develops floodplain.

**QC Status - Staff: Provisional Cons**

**Step 1. Valley and Floodplain**

1.1 Segmentation	<b>Planform and Scope</b>	
1.2 Alluvial Fan	<b>None</b>	
1.3 Corridor Encroachments		
Length (ft)	One	Both
Berms	<b>564</b>	<b>0</b>
height	<b>10</b>	<b>0</b>
Roads	<b>1,498</b>	<b>0</b>
height	<b>12</b>	<b>0</b>
Railroads	<b>0</b>	<b>0</b>
height	<b>0</b>	<b>0</b>
Improved Paths	<b>0</b>	<b>0</b>
height	<b>0</b>	<b>0</b>
Development	<b>1,081</b>	<b>0</b>
1.4 Adjacent Side	Left	Right
Hillside Slope	<b>Steep</b>	<b>Hilly</b>
Continuous w/ <b>Sometimes</b>		<b>Never</b>
W/in 1 Bankfill	<b>Sometimes</b>	<b>Never</b>
Texture	<b>Not Evalua</b>	<b>Not Evalua</b>

**Provisional Step 2. (Continued)**

2.5 Aband. Floodpin	<b>10.20 ft.</b>
Human Elev Floodpin	<b>0.00 ft.</b>
2.6 Width/Depth Ratio	<b>36.00</b>
2.7 Entrenchment Ratio	<b>1.37</b>
2.8 Incision Ratio	<b>3.19</b>
Human Elevated Inc Rat	<b>0.00</b>
2.9 Sinuosity	<b>Low</b>
2.10 Riffles Type	<b>Eroded</b>
2.11 Riffle/Step Spacing (ft)	<b>0</b>
2.12 Substrate Composition	
Bedrock	<b>0%</b>
Boulder	<b>11%</b>
Cobble	<b>44%</b>
Coarse Gravel	<b>32%</b>
Fine Gravel	<b>11%</b>
Sand	<b>2%</b>
Silt and smaller	<b>0%</b>
Silt/Clay Present?	<b>No</b>
Detritus	<b>1 %</b>
# Large Woody	<b>2</b>
2.13 Average Largest Particle on	
Bed	<b>15.0 inches</b>
Bar	<b>N/A inches</b>

**Step 3. Riparian Features**

3.1 Stream Banks		
Typical Bank Slope	<b>Steep</b>	
Bank Texture	Left	Right
Upper		
Material Type	<b>Gravel</b>	<b>Gravel</b>
Consistency	<b>Non-cohesive</b>	<b>Non-cohesive</b>
Lower		
Material Type	<b>Boulder/Cobb/Boulder/Cobb</b>	
Consistency	<b>Non-cohesive</b>	<b>Non-cohesive</b>
Bank Erosion	Left	Right
Erosion Length (ft)	<b>285</b>	<b>0</b>
Erosion Height (ft)	<b>6.00</b>	<b>0.00</b>
Revetmt. Type	<b>Rip-Rap</b>	<b>Rip-Rap</b>
Revetmt. Length (ft)	<b>124</b>	<b>1,127</b>
Near Bank Veg. Type	Left	Right
Dominant	<b>Deciduous</b>	<b>Herbaceous</b>
Sub-dominant	<b>Coniferous Shrubs/Saplin</b>	
Bank Canopy	Left	Right
Canopy %	<b>26-50</b>	<b>1-25</b>
Mid-Channel Canopy		<b>Open</b>
3.2 Riparian Buffer		
Buffer Width	Left	Right
Dominant	<b>&gt;100</b>	<b>0-25</b>
Sub-dominant	<b>None</b>	<b>None</b>
W less than 25	<b>326</b>	<b>948</b>
Buffer Veg. Type	Left	Right
Dominant	<b>Mixed Trees</b>	<b>Herbaceous</b>
Sub-dominant	<b>None</b>	<b>None</b>
3.3 Riparian Corridor		
Corridor Land	Left	Right
Dominant	<b>Forest</b>	<b>Residential</b>
Sub-dominant	<b>Residential</b>	<b>Commercial</b>
Mass Failures	<b>0</b>	<b>0</b>
Height	<b>0</b>	<b>0</b>
Gullies	<b>0</b>	<b>0</b>
Height	<b>0</b>	<b>0</b>

**Step 4. Flow & Flow Modifiers**

4.1 Springs / Seeps	<b>Minimal</b>
4.2 Adjacent Wetlands	<b>None</b>
4.3 Flow Status	<b>Low</b>
4.4 # of Debris Jams	<b>0</b>
4.5 Flow Regulation Type	<b>None</b>
Flow Regulation Use	
Impoundments	<b>None</b>
Impoundmt. Location	
4.6 Up/Down strfm flow reg	<b>None</b>
(old) Upstrm Flow Reg	<b>None</b>
4.7 StormwaterInputs	
Field Ditch	<b>0</b>
Road Ditch	<b>0</b>
Other	<b>0</b>
Tile Drain	<b>0</b>
Overland Flow	<b>0</b>
Urb Strm Wtr Pipe	<b>1</b>
4.9 # of Beaver Dams	<b>0</b>
Affected Length (ft)	<b>0</b>

**Step 5. Channel Bed and Planform Changes**

5.1 Bar Types			
Mid	<b>2</b>	Point	<b>0</b>
Diagonal	<b>0</b>	Delta	<b>0</b>
Island	<b>0</b>	Island	<b>0</b>
5.2 Other Features			
Flood Neck Cutoff	<b>0</b>	Avulsion	<b>0</b>
Braiding	<b>0</b>		<b>0</b>
5.3 Steep Riffles and Head Cuts			
Steep Riffles	Head Cuts	Trib Rejuv.	
<b>0</b>	<b>0</b>	<b>Yes</b>	
5.4 Stream Ford or Animal			
5.5 Straightening			
Straightening Length:			<b>1,754</b>
5.5 Dredging			<b>Dredging</b>

**Notes:**

Channel straightening, armoring, and dredging have altered this channel to an F plane bed system lacking in habitat and water and sediment storage capabilities. Vermont Route 155 and residences have significantly encroached on the channel. The bridge at

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

**Step 7. Rapid Geomorphic Assessment Data**

Confinement Type	Score	STD	Historic
<b>Unconfined</b>			
7.1 Channel Degradation	4	C to F	No
7.2 Channel Aggradation	12	None	No
7.3 Widening Channel	8		No
7.4 Change in Planform	11		No
Total Score <b>35</b>			
Geomorphic Rating <b>0.4375</b>			
Channel Evolution Model <b>F</b>			
Channel Evolution Stage <b>II</b>			
Geomorphic Condition <b>Fair</b>			
Stream Sensitivity <b>Extreme</b>			

**Step 6. Rapid Habitat Assessment Data**

Stream Gradient Type	High	Score
6.1 Epifaunal Substrate - Available Cover		8
6.2 Embeddedness		13
6.3 Velocity/Depth Patterns		8
6.4 Sediment Deposition		13
6.5 Channel Flow Status		11
6.6 Channel Alteration		3
6.7 Frequency of Riffles/Steps		8
6.8 Bank Stability	Left: 7 Right: 7	
6.9 Bank Vegetation Protection	Left: 6 Right: 2	
6.10 Riparian Vegetation Zone Width	Left: 5 Right: 2	
Total Score		93
Habitat Rating		0.465

Habitat Stream Condition **Fair**

**1.6 Grade Controls None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

**4.8 Channel Constrictions**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	39.0	Yes	Yes	Yes	Yes
Problem Scour Above, Scour Below					

**Narrative:**

Historic channel incision caused by extensive straightening. Widening and planform adjustment limited by boundary materials (riprap) and management.

**QC Status - Staff: Provisional Cons**

**Step 1. Valley and Floodplain**

1.1 Segmentation	<b>Planform and Scope</b>	
1.2 Alluvial Fan	<b>None</b>	
1.3 Corridor Encroachments		
Length (ft)	One	Both
Berms height	<b>0</b>	<b>0</b>
Roads height	<b>653</b>	<b>0</b>
Railroads height	<b>12</b>	<b>0</b>
Improved Paths height	<b>0</b>	<b>0</b>
Development height	<b>423</b>	<b>0</b>
1.4 Adjacent Side	Left	Right
Hillside Slope	<b>Steep</b>	<b>Hilly</b>
Continuous w/	<b>Sometimes</b>	<b>Sometimes</b>
Win 1 Bankfill	<b>Sometimes</b>	<b>Sometimes</b>
Texture	<b>Not Evalua</b>	<b>Bedrock</b>

**Provisional Step 2. (Continued)**

2.5 Aband. Floodpin	<b>7.70 ft.</b>
Human Elev Floodpin	<b>0.00 ft.</b>
2.6 Width/Depth Ratio	<b>29.74</b>
2.7 Entrenchment Ratio	<b>1.54</b>
2.8 Incision Ratio	<b>2.33</b>
Human Elevated Inc Rat	<b>0.00</b>
2.9 Sinuosity	<b>Low</b>
2.10 Riffles Type	<b>Eroded</b>
2.11 Riffle/Step Spacing (ft)	<b>0</b>
2.12 Substrate Composition	
Bedrock	<b>0%</b>
Boulder	<b>16%</b>
Cobble	<b>35%</b>
Coarse Gravel	<b>34%</b>
Fine Gravel	<b>13%</b>
Sand	<b>2%</b>
Silt and smaller	<b>0%</b>
Silt/Clay Present?	<b>No</b>
Detritus	<b>1 %</b>
# Large Woody	<b>7</b>
2.13 Average Largest Particle on	
Bed	<b>15.0 inches</b>
Bar	<b>5.0 inches</b>

**Step 3. Riparian Features**

3.1 Stream Banks	
Typical Bank Slope	<b>Steep</b>
Bank Texture	Left
Upper	Right
Material Type	<b>Gravel</b>
Consistency	<b>Non-cohesive</b>
Lower	<b>Non-cohesive</b>
Material Type	<b>Boulder/Cobb/Boulder/Cobb</b>
Consistency	<b>Non-cohesive</b>
Bank Erosion	Left
Erosion Length (ft)	<b>870</b>
Erosion Height (ft)	<b>5.29</b>
Revetmt. Type	<b>Rip-Rap</b>
Revetmt. Length (ft)	<b>932</b>
Near Bank Veg. Type	Left
Dominant	<b>Deciduous</b>
Sub-dominant	<b>Herbaceous</b>
Bank Canopy	Left
Canopy %	<b>26-50</b>
Mid-Channel Canopy	<b>Open</b>
3.2 Riparian Buffer	
Buffer Width	Left
Dominant	<b>&gt;100</b>
Sub-dominant	<b>None</b>
W less than 25	<b>1,072</b>
Buffer Veg. Type	Left
Dominant	<b>Mixed Trees</b>
Sub-dominant	<b>Shrubs/Saplin</b>
3.3 Riparian Corridor	
Corridor Land	Left
Dominant	<b>Forest</b>
Sub-dominant	<b>Residential</b>
Mass Failures	<b>0</b>
Height	<b>0</b>
Gullies	<b>0</b>
Height	<b>0</b>

**Step 4. Flow & Flow Modifiers**

4.1 Springs / Seeps	<b>Minimal</b>
4.2 Adjacent Wetlands	<b>Minimal</b>
4.3 Flow Status	<b>Low</b>
4.4 # of Debris Jams	<b>0</b>
4.5 Flow Regulation Type	<b>None</b>
Flow Regulation Use	
Impoundments	<b>None</b>
Impoundmt. Location	
4.6 Up/Down strfm flow reg	<b>None</b>
(old) Upstrm Flow Reg	<b>None</b>
4.7 StormwaterInputs	
Field Ditch	<b>0</b>
Road Ditch	<b>2</b>
Other	<b>0</b>
Tile Drain	<b>0</b>
Overland Flow	<b>0</b>
Urb Strm Wtr Pipe	<b>0</b>
4.9 # of Beaver Dams	<b>0</b>
Affected Length (ft)	<b>0</b>

**Step 5. Channel Bed and Planform Changes**

5.1 Bar Types	
Mid	<b>1</b>
Point	<b>3</b>
Side	<b>2</b>
Diagonal	<b>0</b>
Delta	<b>0</b>
Island	<b>0</b>
5.2 Other Features	
Flood Neck Cutoff	<b>0</b>
Avulsion	<b>0</b>
Braiding	<b>0</b>
5.3 Steep Riffles and Head Cuts	
Steep Riffles	Head Cuts
Trib Rejuv.	
Steep Riffles	<b>1</b>
Head Cuts	<b>0</b>
Animal	<b>Yes</b>
5.4 Stream Ford or Animal	<b>No</b>
5.5 Straightening	<b>Straightening</b>
Straightening Length:	<b>3,387</b>
5.5 Dredging	<b>Dredging</b>

**Notes:**

Appears to have been a high degree of channel straightening. Active gravel extraction in the reach. High degree of channel incision has caused a departure from a C channel to a B plane bed. This channel management has caused a significant loss of

**2.14 Stream Type**

Stream Type:	<b>B</b>
Bed Material:	<b>Cobble</b>
Subclass Slope:	<b>c</b>
Bed Form:	<b>Plane Bed</b>

**2.15 Reference Stream Type**

(if different from Phase 1)	
3.3 old	<b>None</b>
Amount	<b>Mean Height</b>
Failures	<b>0.00</b>
Gullies	<b>0.00</b>

**Note:**

Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

**1.6 Grade Controls**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	Mid-segment	0.00	0.00	Yes	

**Step 7. Rapid Geomorphic Assessment Data**

Confinement Type	Score	STD	Historic
<b>Unconfined</b>			
7.1 Channel Degradation	<b>4</b>	<b>C to B</b>	<b>Yes</b>
7.2 Channel Aggradation	<b>10</b>	<b>None</b>	<b>No</b>
7.3 Widening Channel	<b>10</b>		<b>No</b>
7.4 Change in Planform	<b>10</b>		<b>No</b>

Total Score **34**

Geomorphic Rating **0.425**

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

**Step 6. Rapid Habitat Assessment Data**

Stream Gradient Type **High**

Stream Gradient Type	Score
6.1 Epifaunal Substrate - Available Cover	13
6.2 Embeddedness	13
6.3 Velocity/Depth Patterns	13
6.4 Sediment Deposition	13
6.5 Channel Flow Status	11
6.6 Channel Alteration	10
6.7 Frequency of Riffles/Steps	10
6.8 Bank Stability	Left: 6 Right: 6
6.9 Bank Vegetation Protection	Left: 5 Right: 5
6.10 Riparian Vegetation Zone Width	Left: 6 Right: 2
Total Score	113
Habitat Rating	0.565

Habitat Stream Condition **Fair**

**4.8 Channel Constrictions**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	30.0	Yes	Yes	Yes	Yes
Problem	Scour Above, Scour Below				

**Narrative:**

Historic channel incision caused by straightening. Recent gravel mining in reach. Widening and planform adjustments as channel works to develop a floodplain.

Project: Otter Creek - Mill River  
 Stream: Mill River  
 Organization: Rutland RPC  
 Segment Length (ft): 3,166

Phase 2 Segment Summary page 1 of 2  
 Reach # M12  
 Observers: Michael Blazewicz, Sarah Lade  
 Segment Location: Runs along the east side of route 155 south of East Wallingford Village.

December 12, 2007 SGAT Version: 4.56  
 Completion Date: October 16, 2007  
 Rain: No

**QC Status - Staff: Provisional Cons**

**Step 1. Valley and Floodplain**

1.1 Segmentation	None	Both
1.2 Alluvial Fan	None	
1.3 Corridor Encroachments		
Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	1,126	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0
1.4 Adjacent Side	Left	Right
Hillside Slope	Very Steep	Very Steep
Continuous w/Sometimes	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Gravel	Gravel

**Provisional Step 2. (Continued)**

2.5 Aband. Floodpln	5.30 ft.	
Human Elev Floodpln	0.00 ft.	
2.6 Width/Depth Ratio	30.48	
2.7 Entrenchment Ratio	4.88	
2.8 Incision Ratio	1.89	
Human Elevated Inc Rat	0.00	
2.9 Sinuosity	Moderate	
2.10 Riffles Type	Eroded	
2.11 Riffle/Step Spacing (ft)	0	
2.12 Substrate Composition		
Bedrock	0%	
Boulder	19%	
Cobble	31%	
Coarse Gravel	38%	
Fine Gravel	11%	
Sand	1%	
Silt and smaller	0%	
Silt/Clay Present?	No	
Detritus	1 %	
# Large Woody	20	
2.13 Average Largest Particle on		
Bed	15.0 inches	
Bar	5.0 inches	
2.14 Stream Type		
Stream Type:	C	
Bed Material:	Gravel	
Subclass Slope:	None	
Bed Form:	Riffle-Pool	
Field Measured Slope:		
2.15 Reference Stream Type		
(if different from Phase 1)		
3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

**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/Cobb/Boulder/Cobb	
Consistency	Non-cohesive	Non-cohesive
Bank Erosion	Left	Right
Erosion Length (ft)	764	485
Erosion Height (ft)	5.40	4.33
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0
Near Bank Veg. Type	Left	Right
Dominant	Coniferous	Coniferous
Sub-dominant	Deciduous	Deciduous
Bank Canopy	Left	Right
Canopy %	26-50	26-50
Mid-Channel Canopy		Open
3.2 Riparian Buffer		
Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	None
W less than 25	0	0
Buffer Veg. Type	Left	Right
Dominant	Coniferous	Coniferous
Sub-dominant	Deciduous	Deciduous
3.3 Riparian Corridor		
Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Commercial	None
Mass Failures	0	102
Height	0	60
Gullies	0	0
Height	0	0

**Step 4. Flow & Flow Modifiers**

4.1 Springs / Seeps	Minimal		
4.2 Adjacent Wetlands	Minimal		
4.3 Flow Status	Low		
4.4 # of Debris Jams	0		
4.5 Flow Regulation Type	None		
Flow Regulation Use			
Impoundments	None		
Impoundmt. Location			
4.6 Up/Down strfm flow reg	None		
(old) Upstrm Flow Reg	None		
4.7 StormwaterInputs			
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		

**Step 5. Channel Bed and Planform Changes**

5.1 Bar Types			
Mid	Point	Side	
0	0	2	
Diagonal	Delta	Island	
0	0	1	
5.2 Other Features			
Flood Neck Cutoff	Avulsion	Braiding	
4	0	0	
5.3 Steep Riffles and Head Cuts			
Steep Riffles	Head Cuts	Trib Rejuv.	
0	0	No	
5.4 Stream Ford or Animal			
5.5 Straightening			
Straightening Length:			
5.5 Dredging			

Notes:  
 This reach is a C type channel that flows through a well forested corridor. Historic incision has led to a great degree of instability in the channel. The stream is actively accessing flood chutes as it adjusts laterally and redevelops gravel bars and new

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: **Otter Creek - Mill River**      page 2 of 2      **Phase 2 Reach Summary**      December 12, 2007  
 Stream: **Mill River**      Reach # **M12**      Segment: **0**      Completion Date: **October 16, 2007**  
 Organization: **Rutland RPC**      Observers: **Michael Blazewicz, Sarah Lade**      Rain: **No**  
 Segment Length (ft): **3,166**      Segment Location: **Runs along the east side of route 155 south of East Wallingford Village.**

**1.6 Grade Controls** **None**      Step 7. Rapid Geomorphic Assessment Data

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken	Confinement Type	Score	STD	Historic	
							<b>Unconfined</b>			
7.1	Channel Degradation						<b>10</b>	<b>None</b>	<b>Yes</b>	
7.2	Channel Aggradation						<b>11</b>	<b>None</b>	<b>No</b>	
7.3	Widening Channel						<b>10</b>		<b>No</b>	
7.4	Change in Planform						<b>8</b>		<b>No</b>	

Total Score **39**  
 Geomorphic Rating **0.4875**

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type	High	Score
6.1 Epifaunal Substrate - Available Cover		13
6.2 Embeddedness		13
6.3 Velocity/Depth Patterns		13
6.4 Sediment Deposition		10
6.5 Channel Flow Status		10
6.6 Channel Alteration		18
6.7 Frequency of Riffles/Steps		13
6.8 Bank Stability	Left: 6 Right: 6	
6.9 Bank Vegetation Protection	Left: 7 Right: 7	
6.10 Riparian Vegetation Zone Width	Left: 9 Right: 7	
Total Score		132
Habitat Rating		0.66

Habitat Stream Condition **Good**

**Narrative:**

Channel has incised. Major widening, aggradation, and planform adjustments are evident as the stream creates new bar features and shifts into flood chutes and multiple channels.

Project: **Otter Creek - Mill River**  
 Stream: **Mill River**  
 Organization: **Rutland RPC**  
 Segment Length (ft): **2,299**

Reach # **M13**  
 Observers: **Michael Blazewicz, Sarah Lade**  
 Segment Location: **Runs along the east side of Route 155 south of East Wallingford Village.**

December 12, 2007 SGAT Version: 4.56  
 Completion Date: **October 16, 2007**  
 Rain: **No**

**QC Status - Staff: Provisional Cons**

**Step 1. Valley and Floodplain**

1.1 Segmentation	Valley Width	Both
1.2 Alluvial Fan	None	
1.3 Corridor Encroachments		
Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0
1.4 Adjacent Side	Left	Right
Hillside Slope	Very Steep	Very Steep
Continuous w/	Never	Sometimes
Win 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua
1.5 Valley Features		
Valley Width (ft)	350	
Width Determination	Estimated	
Confinement Type	Broad	
Rock Gorge?	No	
Human-caused Change?	No	
<b>Step 2. Stream Channel</b>		
2.1 Bankfull Width	60	
2.2 Max Depth (ft)	3.30	
2.3 Mean Depth (ft)	2.13	
2.4 Floodprone Width (ft)	350	

Notes:  
 A short segment of unentrenched valley where the river has adjusted through several flood chutes and stored a significant amount of gravel in a large bar. The well forested buffer in this corridor is an asset for the river.

**Provisional Step 2. (Continued)**

2.5 Aband. Floodpin	6.10 ft.	
Human Elev Floodpin	0.00 ft.	
2.6 Width/Depth Ratio	28.17	
2.7 Entrenchment Ratio	5.83	
2.8 Incision Ratio	1.85	
Human Elevated Inc Rat	0.00	
2.9 Sinuosity	Low	
2.10 Riffles Type	Eroded	
2.11 Riffle/Step Spacing (ft)	0	
2.12 Substrate Composition		
Bedrock	0%	
Boulder	16%	
Cobble	32%	
Coarse Gravel	35%	
Fine Gravel	16%	
Sand	1%	
Silt and smaller	0%	
Silt/Clay Present?	No	
Detritus	2 %	
# Large Woody	5	
2.13 Average Largest Particle on		
Bed	18.0 inches	
Bar	6.0 inches	
2.14 Stream Type		
Stream Type:	C	
Bed Material:	Gravel	
Subclass Slope:	None	
Bed Form:	Riffle-Pool	
Field Measured Slope:		
2.15 Reference Stream Type		
(if different from Phase 1)		
3.3 old	Amount	Mean Height
Failures	None	0.00
Gullies	None	0.00

**Step 3. Riparian Features**

3.1 Stream Banks	Steep
Typical Bank Slope	Steep
Bank Texture	Left
Upper	Right
Material Type	Gravel
Consistency	Non-cohesive
Lower	Non-cohesive
Material Type	Boulder/Cobb/Boulder/Cobb
Consistency	Non-cohesive
Bank Erosion	Left
Erosion Length (ft)	549
Erosion Height (ft)	7.67
Revetmt. Type	None
Revetmt. Length (ft)	0
Near Bank Veg. Type	Left
Dominant	Deciduous
Sub-dominant	Coniferous
Bank Canopy	Left
Canopy %	26-50
Mid-Channel Canopy	Open
3.2 Riparian Buffer	
Buffer Width	Left
Dominant	>100
Sub-dominant	None
W less than 25	0
Buffer Veg. Type	Left
Dominant	Mixed Trees
Sub-dominant	Shrubs/Saplin Shrubs/Saplin
3.3 Riparian Corridor	
Corridor Land	Left
Dominant	Forest
Sub-dominant	None
Mass Failures	0
Height	0
Gullies	0
Height	0

**Step 4. Flow & Flow Modifiers**

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

**Step 5. Channel Bed and Planform Changes**

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

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

**1.6 Grade Controls** **None**      **Step 7. Rapid Geomorphic Assessment Data**

Confinement Type	Score	STD	Historic
<b>Unconfined</b>			
7.1 Channel Degradation	<b>10</b>	<b>None</b>	<b>Yes</b>
7.2 Channel Aggradation	<b>11</b>	<b>None</b>	<b>No</b>
7.3 Widening Channel	<b>11</b>		<b>No</b>
7.4 Change in Planform	<b>10</b>		<b>No</b>

Total Score **42**

Geomorphic Rating **0.525**

Channel Evolution Model **F**

Channel Evolution Stage **IV**

Geomorphic Condition **Fair**

Stream Sensitivity **Very High**

**Step 6. Rapid Habitat Assessment Data**

Stream Gradient Type	High	Score
6.1 Epifaunal Substrate - Available Cover		13
6.2 Embeddedness		13
6.3 Velocity/Depth Patterns		13
6.4 Sediment Deposition		10
6.5 Channel Flow Status		10
6.6 Channel Alteration		18
6.7 Frequency of Riffles/Steps		13
6.8 Bank Stability	Left: 8    Right: 7	
6.9 Bank Vegetation Protection	Left: 7    Right: 7	
6.10 Riparian Vegetation Zone Width	Left: 9    Right: 8	
Total Score		136
Habitat Rating		0.68

Habitat Stream Condition **Good**

**Narrative:**  
 Historic incision. Current active aggradation, widening and planform shifts as the stream works to regain floodplain access.

**4.8 Channel Constrictions** **None**

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?

Project: Otter Creek - Mill River  
 Stream: Mill River  
 Organization: Rutland RPC  
 Segment Length (ft): 1,100

Reach # M13  
 Observers: Michael Blazewicz, Sarah Lade  
 Segment Location: Runs along the east side of Route 155 south of East Wallingford Village.

December 12, 2007 SGAT Version: 4.56  
 Completion Date: October 16, 2007  
 Rain: No

**QC Status - Staff: Provisional Cons**

**Step 1. Valley and Floodplain**

1.1 Segmentation	Valley Width	Both
1.2 Alluvial Fan	None	
1.3 Corridor Encroachments	One	
Length (ft)		
Berms	0	
height	0	
Roads	0	
height	0	
Railroads	0	
height	0	
Improved Paths	0	
height	0	
Development	0	
1.4 Adjacent Side	Left	Right

Hillside Slope **Very Steep** **Very Steep**

Continuous w/**Sometimes** **Sometimes**

W/in 1 Bankfill **Always** **Always**

Texture **Mixed** **Not Evalua**

**1.5 Valley Features**

Valley Width (ft) **120**

Width Determination **Measured**

Confinement Type **Semi-confined**

Rock Gorge? **No**

Human-caused Change? **No**

**Step 2. Stream Channel**

2.1 Bankfull Width **64**

2.2 Max Depth (ft) **3.10**

2.3 Mean Depth (ft) **2.30**

2.4 Floodprone Width (ft) **112**

Notes:

A short segment where the valley wall closes in creating a semi-confined channel that is a B3 planebed by reference. Some corridor encroachment has occurred along the left. Some landowner education in this area to ensure that the forested buffer remains intact

**Provisional Step 2. (Continued)**

2.5 Aband. Floodpln **6.10 ft.**

Human Elev Floodpln **0.00 ft.**

2.6 Width/Depth Ratio **27.83**

2.7 Entrenchment Ratio **1.75**

2.8 Incision Ratio **1.97**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Not Applicable**

2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Bedrock **0%**

Boulder **17%**

Cobble **41%**

Coarse Gravel **27%**

Fine Gravel **10%**

Sand **4%**

Silt and smaller **1%**

Silt/Clay Present? **No**

Detritus **1 %**

# Large Woody **19**

2.13 Average Largest Particle on

Bed **18.0 inches**

Bar **N/A inches**

2.14 Stream Type

Stream Type: **B**

Bed Material: **Cobble**

Subclass Slope: **None**

Bed Form: **Plane Bed**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

**B 3 Non Plane Bed**

3.3 old Amount **Mean Height**

Failures **None** **0.00**

Gullies **None** **0.00**

**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/Cobb/Boulder/Cobb**

Consistency **Non-cohesive** **Non-cohesive**

Bank Erosion **Left** **Right**

Erosion Length (ft) **0** **0**

Erosion Height (ft) **0.00** **0.00**

Revetmt. Type **None** **None**

Revetmt. Length (ft) **0** **0**

Near Bank Veg. Type **Left** **Right**

Dominant **Coniferous** **Coniferous**

Sub-dominant **Deciduous** **Deciduous**

Bank Canopy **Left** **Right**

Canopy % **26-50** **26-50**

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width **Left** **Right**

Dominant **51-100** **>100**

Sub-dominant **None** **None**

W less than 25 **0** **0**

Buffer Veg. Type **Left** **Right**

Dominant **Mixed Trees** **Mixed Trees**

Sub-dominant **Coniferous** **Coniferous**

3.3 Riparian Corridor

Corridor Land **Left** **Right**

Dominant **Forest** **Forest**

Sub-dominant **None** **None**

Mass Failures **0** **0**

Height **0** **0**

Gullies **0** **0**

Height **0** **0**

**Step 4. Flow & Flow Modifiers**

4.1 Springs / Seeps **Minimal**

4.2 Adjacent Wetlands **None**

4.3 Flow Status **Low**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments **None**

Impoundmt. Location

4.6 Up/Down strfm flow reg **None**

(old) Upstrfm Flow Reg **None**

4.7 StormwaterInputs

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**

**Step 5. Channel Bed and Planform Changes**

**5.1 Bar Types**

Mid **0** Point **0** Side **0**

Diagonal **0** Delta **0** Island **0**

5.2 Other Features **0** Braiding **0**

Flood Neck Cutoff **0** Avulsion **0**

5.3 Steep Riffles and Head Cuts

Steep Riffles **0** Head Cuts **0** Trib Rejuv. **0**

5.4 Stream Ford or Animal **No**

5.5 Straightening **None**

Straightening Length: **0**

5.5 Dredging **None**

Note: Step 1.6 - Grade Controls

and Step 4.8 - Channel Constrictions

are on The second page of this

report - with Steps 6 through 7.

**1.6 Grade Controls** **None**      **Step 7. Rapid Geomorphic Assessment Data**

Confinement Type	Plane Bed	Score	STD	Historic
7.1 Channel Degradation		11	None	Yes
7.2 Channel Aggradation		16	None	No
7.3 Widening Channel		11		No
7.4 Change in Planform		16		No

Total Score **54**  
 Geomorphic Rating **0.675**

Channel Evolution Model **F**  
 Channel Evolution Stage **III**  
 Geomorphic Condition **Good**  
 Stream Sensitivity **High**

**Step 6. Rapid Habitat Assessment Data**

Stream Gradient Type	High	Score
6.1 Epifaunal Substrate - Available Cover		13
6.2 Embeddedness		15
6.3 Velocity/Depth Patterns		8
6.4 Sediment Deposition		14
6.5 Channel Flow Status		13
6.6 Channel Alteration		18
6.7 Frequency of Riffles/Steps		8
6.8 Bank Stability	Left: 8    Right: 8	
6.9 Bank Vegetation Protection	Left: 6    Right: 6	
6.10 Riparian Vegetation Zone Width	Left: 7    Right: 7	
Total Score		131
Habitat Rating		0.655

Habitat Stream Condition **Good**

**Narrative:**

Channel incised. Has widened. Reference stream type has assisted in maintaining its stability as a transport system. Incision has likely had more aggradational impacts on downstream reaches but with the exception of widening, not much impact here.

Project: **Otter Creek - Mill River**  
 Stream: **Mill River**  
 Organization: **Rutland RPC**  
 Segment Length (ft): **3,405**

Reach # **M14**  
 Observers: **Michael Blazewicz**  
 Segment Location: **Runs along the east side of Route 155 south of East Wallingford Village with the**

December 12, 2007 SGAT Version: 4.56  
 Completion Date: **October 3, 2007**  
 Rain: **No**

**QC Status - Staff: Provisional Cons**

**Step 1. Valley and Floodplain**

1.1 Segmentation	<b>None</b>	Both
1.2 Alluvial Fan	<b>None</b>	
1.3 Corridor Encroachments		
Length (ft)	One	Both
Berms	<b>0</b>	<b>0</b>
height	<b>0</b>	<b>0</b>
Roads	<b>818</b>	<b>0</b>
height	<b>0</b>	<b>0</b>
Railroads	<b>0</b>	<b>0</b>
height	<b>0</b>	<b>0</b>
Improved Paths	<b>0</b>	<b>0</b>
height	<b>0</b>	<b>0</b>
Development	<b>0</b>	<b>0</b>
1.4 Adjacent Side	Left	Right
Hillside Slope	<b>Flat</b>	<b>Very Steep</b>
Continuous w/Sometimes	<b>Sometimes</b>	<b>Sometimes</b>
W/in 1 Bankfill	<b>Sometimes</b>	<b>Sometimes</b>
Texture	<b>Sand</b>	<b>Mixed</b>
1.5 Valley Features		
Valley Width (ft)	<b>590</b>	
Width Determination	<b>Estimated</b>	
Confinement Type	<b>Very Broad</b>	
Rock Gorge?	<b>No</b>	
Human-caused Change?	<b>No</b>	
<b>Step 2. Stream Channel</b>		
2.1 Bankfull Width	<b>41</b>	
2.2 Max Depth (ft)	<b>3.10</b>	
2.3 Mean Depth (ft)	<b>2.00</b>	
2.4 Floodprone Width (ft)	<b>83</b>	

Notes:  
 A reach that borders agricultural (some no longer in production) land. The river through this reach appears to have been straightened and pushed up against the right valley wall. Deep incision has occurred (ratio of 3.1). A stream type departure has ensued from a C

**Provisional Step 2. (Continued)**

2.5 Aband. Floodpin	<b>9.80 ft.</b>
Human Elev Floodpin	<b>0.00 ft.</b>
2.6 Width/Depth Ratio	<b>20.50</b>
2.7 Entrenchment Ratio	<b>2.02</b>
2.8 Incision Ratio	<b>3.16</b>
Human Elevated Inc Rat	<b>0.00</b>
2.9 Sinuosity	<b>Low</b>
2.10 Riffles Type	<b>Eroded</b>
2.11 Riffle/Step Spacing (ft)	<b>0</b>
2.12 Substrate Composition	
Bedrock	<b>0%</b>
Boulder	<b>21%</b>
Cobble	<b>38%</b>
Coarse Gravel	<b>19%</b>
Fine Gravel	<b>14%</b>
Sand	<b>8%</b>
Silt and smaller	<b>0%</b>
Silt/Clay Present?	<b>No</b>
Detritus	<b>2 %</b>
# Large Woody	<b>11</b>
2.13 Average Largest Particle on	
Bed	<b>20.0 inches</b>
Bar	<b>N/A inches</b>
2.14 Stream Type	
Stream Type:	<b>B</b>
Bed Material:	<b>Cobble</b>
Subclass Slope:	<b>None</b>
Bed Form:	<b>Plane Bed</b>
Field Measured Slope:	
2.15 Reference Stream Type	
(if different from Phase 1)	
3.3 old	<b>Amount</b>
Failures	<b>None</b>
Gullies	<b>None</b>
	<b>Mean Height</b>
	<b>0.00</b>
	<b>0.00</b>

**Step 3. Riparian Features**

3.1 Stream Banks		
Typical Bank Slope	<b>Steep</b>	
Bank Texture	Left	Right
Upper		
Material Type	<b>Gravel</b>	<b>Gravel</b>
Consistency	<b>Non-cohesive</b>	<b>Non-cohesive</b>
Lower		
Material Type	<b>Boulder/Cobb/Boulder/Cobb</b>	
Consistency	<b>Non-cohesive</b>	<b>Non-cohesive</b>
Bank Erosion	Left	Right
Erosion Length (ft)	<b>825</b>	<b>336</b>
Erosion Height (ft)	<b>3.86</b>	<b>4.33</b>
Revetmt. Type	<b>Rip-Rap</b>	<b>Rip-Rap</b>
Revetmt. Length (ft)	<b>141</b>	<b>211</b>
Near Bank Veg. Type	Left	Right
Dominant	<b>Shrubs/Saplin</b>	<b>Coniferous</b>
Sub-dominant	<b>Herbaceous Shrubs/Saplin</b>	
Bank Canopy	Left	Right
Canopy %	<b>26-50</b>	<b>51-75</b>
Mid-Channel Canopy		<b>Open</b>
3.2 Riparian Buffer		
Buffer Width	Left	Right
Dominant	<b>0-25</b>	<b>&gt;100</b>
Sub-dominant	<b>26-50</b>	<b>26-50</b>
W less than 25	<b>1,342</b>	<b>0</b>
Buffer Veg. Type	Left	Right
Dominant	<b>Deciduous</b>	<b>Coniferous</b>
Sub-dominant	<b>Shrubs/Saplin</b>	<b>Mixed Trees</b>
3.3 Riparian Corridor		
Corridor Land	Left	Right
Dominant	<b>Shrubs/Saplin</b>	<b>Forest</b>
Sub-dominant	<b>Hay</b>	<b>Residential</b>
Mass Failures	<b>118</b>	<b>0</b>
Height	<b>40</b>	<b>0</b>
Gullies	<b>0</b>	<b>0</b>
Height	<b>0</b>	<b>0</b>

**Step 4. Flow & Flow Modifiers**

4.1 Springs / Seeps	<b>Minimal</b>
4.2 Adjacent Wetlands	<b>Minimal</b>
4.3 Flow Status	<b>Low</b>
4.4 # of Debris Jams	<b>0</b>
4.5 Flow Regulation Type	<b>None</b>
Flow Regulation Use	
Impoundments	<b>None</b>
Impoundmt. Location	
4.6 Up/Down strfm flow reg	<b>None</b>
(old) Upstrm Flow Reg	<b>None</b>
4.7 StormwaterInputs	
Field Ditch	<b>0</b>
Road Ditch	<b>1</b>
Other	<b>0</b>
Tile Drain	<b>0</b>
Overland Flow	<b>0</b>
Urb Strm Wtr Pipe	<b>0</b>
4.9 # of Beaver Dams	<b>0</b>
Affected Length (ft)	<b>0</b>

**Step 5. Channel Bed and Planform Changes**

5.1 Bar Types			
Mid	<b>1</b>	Point	<b>Side</b>
Diagonal	<b>0</b>	Delta	<b>Island</b>
5.2 Other Features			
Flood Neck Cutoff	<b>0</b>	Avulsion	<b>0</b>
5.3 Steep Riffles and Head Cuts			
Steep Riffles	<b>0</b>	Head Cuts	<b>Trib Rejuv.</b>
5.4 Stream Ford or Animal	<b>0</b>		<b>Yes</b>
5.5 Straightening			<b>Straightening</b>
Straightening Length:			<b>2,638</b>
5.5 Dredging			<b>None</b>

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: **Otter Creek - Mill River**      **Phase 2 Reach Summary**      page 2 of 2      December 12, 2007  
 Stream: **Mill River**      Reach # **M14**      Segment: **0**      Completion Date: **October 3, 2007**  
 Organization: **Rutland RPC**      Observers: **Michael Blazewicz**      Rain: **No**  
 Segment Length (ft): **3,405**      Segment Location: **Runs along the east side of Route 155 south of East Wallingford Village with the**

**1.6 Grade Controls** **None**      Step 7. Rapid Geomorphic Assessment Data

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken	Confinement Type	Score	STD	Historic
						<b>Unconfined</b>			
7.1	Channel Degradation						<b>5</b>	<b>C to B</b>	<b>Yes</b>
7.2	Channel Aggradation						<b>13</b>	<b>None</b>	<b>No</b>
7.3	Widening Channel						<b>10</b>		<b>No</b>
7.4	Change in Planform						<b>11</b>		<b>No</b>

Total Score **39**  
 Geomorphic Rating **0.4875**

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	13
6.2 Embeddedness	13
6.3 Velocity/Depth Patterns	8
6.4 Sediment Deposition	15
6.5 Channel Flow Status	11
6.6 Channel Alteration	11
6.7 Frequency of Riffles/Steps	13
6.8 Bank Stability	Left: 6 Right: 8
6.9 Bank Vegetation Protection	Left: 7 Right: 9
6.10 Riparian Vegetation Zone Width	Left: 8 Right: 2
Total Score	124
Habitat Rating	0.62

Habitat Stream Condition **Fair**

**Narrative:**

Channel has incised due to historic straightening. STD from C to B. Channel has major widening and planform adjustments occurring. Still in Stage III.

Project: Otter Creek - Mill River  
 Stream: Mill River  
 Organization: Rutland RPC  
 Segment Length (ft): 3,094

Reach # M15  
 Observers: Michael Blazewicz  
 Segment Location: Runs along the east side of Route 155 south of East Wallingford Village north of the

December 12, 2007 SGAT Version: 4.56  
 Completion Date: October 3, 2007  
 Rain: No

**QC Status - Staff: Provisional Cons**

**Step 1. Valley and Floodplain**

1.1 Segmentation	None	Both
1.2 Alluvial Fan	None	
1.3 Corridor Encroachments		
Length (ft)	One	Both
Berms	157	0
height	7	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	0	0
1.4 Adjacent Side	Left	Right
Hillside Slope	Hilly	Very Steep
Continuous w/	Never	Never
Win 1 Bankfill	Never	Sometimes
Texture	Not Evalua	Not Evalua

**1.5 Valley Features**

Valley Width (ft)	644
Width Determination	Estimated
Confinement Type	Very Broad
Rock Gorge?	No
Human-caused Change?	No

**Step 2. Stream Channel**

2.1 Bankfull Width	34
2.2 Max Depth (ft)	2.40
2.3 Mean Depth (ft)	1.96
2.4 Floodprone Width (ft)	73

Notes:  
 A reach that borders agricultural land. The river through this reach appears to have been straightened and pushed up against the right valley wall. Deep incision has occurred (ratio of 2). A stream type departure has ensued from a C channel to a B type plane bed that

**Provisional Step 2. (Continued)**

2.5 Aband. Floodpin	5.00 ft.
Human Elev Floodpin	0.00 ft.
2.6 Width/Depth Ratio	17.09
2.7 Entrenchment Ratio	2.18
2.8 Incision Ratio	2.08
Human Elevated Inc Rat	0.00
2.9 Sinuosity	Low
2.10 Riffles Type	Eroded
2.11 Riffle/Step Spacing (ft)	0
2.12 Substrate Composition	
Bedrock	3%
Boulder	23%
Cobble	36%
Coarse Gravel	13%
Fine Gravel	15%
Sand	10%
Silt and smaller	0%
Silt/Clay Present?	No
Detritus	3 %
# Large Woody	14
2.13 Average Largest Particle on	
Bed	16.0 inches
Bar	3.0 inches

**2.14 Stream Type**

Stream Type:	B
Bed Material:	Cobble
Subclass Slope:	c
Bed Form:	Plane Bed

**2.15 Reference Stream Type**

(if different from Phase 1)	
3.3 old	Amount
Failures	None
Gullies	None
	Mean Height
	0.00
	0.00

**Step 3. Riparian Features**

3.1 Stream Banks	Steep
Typical Bank Slope	Steep
Bank Texture	Left
Upper	Right
Material Type	Gravel
Consistency	Non-cohesive
Lower	Non-cohesive
Material Type	Boulder/Cobb/Boulder/Cobb
Consistency	Non-cohesive
Bank Erosion	Left
Erosion Length (ft)	887
Erosion Height (ft)	3.75
Revetmt. Type	None
Revetmt. Length (ft)	0
Near Bank Veg. Type	Left
Dominant	Deciduous
Sub-dominant	Shrubs/Saplin
Bank Canopy	Left
Canopy %	26-50
Mid-Channel Canopy	Open
3.2 Riparian Buffer	
Buffer Width	Left
Dominant	0-25
Sub-dominant	26-50
W less than 25	425
Buffer Veg. Type	Left
Dominant	Deciduous
Sub-dominant	Herbaceous
3.3 Riparian Corridor	
Corridor Land	Left
Dominant	Hay
Sub-dominant	Residential
Mass Failures	0
Height	0
Gullies	0
Height	0

**Step 4. Flow & Flow Modifiers**

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

**Step 5. Channel Bed and Planform Changes**

5.1 Bar Types	
Mid	Point
0	0
Diagonal	Delta
0	0
Island	Island
0	0
5.2 Other Features	Braiding
Flood Neck Cutoff	Avulsion
1	0
5.3 Steep Riffles and Head Cuts	
Steep Riffles	Head Cuts
0	0
Trib Rejuv.	Yes
5.4 Stream Ford or Animal	Yes
5.5 Straightening	Straightening
Straightening Length:	2,191
5.5 Dredging	None

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

Project: **Otter Creek - Mill River**      **Phase 2 Reach Summary**      page 2 of 2      December 12, 2007  
 Stream: **Mill River**      Reach # **M15**      Segment: **0**      Completion Date: **October 3, 2007**  
 Organization: **Rutland RPC**      Observers: **Michael Blazewicz**      Rain: **No**  
 Segment Length (ft): **3,094**      Segment Location: **Runs along the east side of Route 155 south of East Wallingford Village north of the**

**1.6 Grade Controls** **None**      Step 7. Rapid Geomorphic Assessment Data

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken	Confinement Type	Score	STD	Historic
						<b>Unconfined</b>			
7.1 Channel Degradation							<b>5</b>	<b>C to B</b>	<b>Yes</b>
7.2 Channel Aggradation							<b>16</b>	<b>None</b>	<b>No</b>
7.3 Widening Channel							<b>13</b>		<b>No</b>
7.4 Change in Planform							<b>11</b>		<b>No</b>

Total Score **45**  
 Geomorphic Rating **0.5625**

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	13
6.2 Embeddedness	13
6.3 Velocity/Depth Patterns	8
6.4 Sediment Deposition	13
6.5 Channel Flow Status	13
6.6 Channel Alteration	8
6.7 Frequency of Riffles/Steps	8
6.8 Bank Stability	Left: 6 Right: 6
6.9 Bank Vegetation Protection	Left: 5 Right: 9
6.10 Riparian Vegetation Zone Width	Left: 3 Right: 9

Total Score **114**  
 Habitat Rating **0.57**

Habitat Stream Condition **Fair**

**Narrative:**

Historic channel incision. Widening and planform adjustment limited by boundary conditions (cobble dominated streambed). Loss of bedform. Likely to see more future lateral migration.

**QC Status - Staff: Provisional Cons**

**Step 1. Valley and Floodplain**

1.1 Segmentation	Corridor Encroachment	
1.2 Alluvial Fan	None	
1.3 Corridor Encroachments		Both
Length (ft)	One	
Berms	165	0
height	10	0
Roads	1,447	899
height	8	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	523	0
1.4 Adjacent Side	Left	Right
Hillside Slope	Hilly	Flat
Continuous w/	Never	Never
Win 1 Bankfill	Never	Sometimes
Texture	Not Evalua	Not Evalua

**Provisional Step 2. (Continued)**

2.5 Aband. Floodpin	7.10 ft.
Human Elev Floodpin	0.00 ft.
2.6 Width/Depth Ratio	25.60
2.7 Entrenchment Ratio	1.30
2.8 Incision Ratio	2.29
Human Elevated Inc Rat	0.00
2.9 Sinuosity	Low
2.10 Riffles Type	Eroded
2.11 Riffle/Step Spacing (ft)	0
2.12 Substrate Composition	
Bedrock	0%
Boulder	20%
Cobble	32%
Coarse Gravel	23%
Fine Gravel	18%
Sand	7%
Silt and smaller	0%
Silt/Clay Present?	No
Detritus	1 %
# Large Woody	5
2.13 Average Largest Particle on	
Bed	15.0 inches
Bar	N/A inches

**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/Cobb Boulder/Cobb
Consistency	Non-cohesive Non-cohesive
Bank Erosion	Left Right
Erosion Length (ft)	289 0
Erosion Height (ft)	6.50 0.00
Revetmt. Type	Rip-Rap Rip-Rap
Revetmt. Length (ft)	436 890
Near Bank Veg. Type	Left Right
Dominant	Shrubs/Saplin Shrubs/Saplin
Sub-dominant	Herbaceous Herbaceous
Bank Canopy	Left Right
Canopy %	1-25 1-25
Mid-Channel Canopy	Open
3.2 Riparian Buffer	
Buffer Width	Left Right
Dominant	0-25 0-25
Sub-dominant	None None
W less than 25	1,253 1,153
Buffer Veg. Type	Left Right
Dominant	Deciduous Deciduous
Sub-dominant	Herbaceous Herbaceous
3.3 Riparian Corridor	
Corridor Land	Left Right
Dominant	Hay Residential
Sub-dominant	Residential Commercial
Mass Failures	0 0
Height	0 0
Gullies	0 0
Height	0 0

**Step 4. Flow & Flow Modifiers**

4.1 Springs / Seeps	None
4.2 Adjacent Wetlands	None
4.3 Flow Status	Low
4.4 # of Debris Jams	0
4.5 Flow Regulation Type	None
Flow Regulation Use	
Impoundments	None
Impoundmt. Location	
4.6 Up/Down strfm flow reg	None
(old) Upstrm Flow Reg	None
4.7 StormwaterInputs	
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

**Step 5. Channel Bed and Planform Changes**

5.1 Bar Types		
Mid	Point	Side
0	1	0
Diagonal	Delta	Island
0	0	0
5.2 Other Features		
Flood Neck Cutoff	Avulsion	Braiding
0	0	0
5.3 Steep Riffles and Head Cuts		
Steep Riffles	Head Cuts	Trib Rejuv.
0	0	No
5.4 Stream Ford or Animal		
5.5 Straightening		Straightening
Straightening Length:		2,367
5.5 Dredging		Dredging

**Notes:**

This segment has seen extensive historic channel straightening and armoring. There is also evidence of dredging and windrowing near the downstream structure. A stream type departure has taken place from C to an F type channel. The reach has lost all

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.

1.6 Grade Controls **None**      Step 7. Rapid Geomorphic Assessment Data

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken	Confinement Type	Score	STD	Historic
						<b>Unconfined</b>			
7.1	Channel Degradation						<b>4</b>	<b>C to F</b>	<b>Yes</b>
7.2	Channel Aggradation						<b>14</b>	<b>None</b>	<b>No</b>
7.3	Widening Channel						<b>10</b>		<b>No</b>
7.4	Change in Planform						<b>14</b>		<b>No</b>

Total Score **42**  
 Geomorphic Rating **0.525**

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	11
6.2 Embeddedness	10
6.3 Velocity/Depth Patterns	5
6.4 Sediment Deposition	10
6.5 Channel Flow Status	13
6.6 Channel Alteration	3
6.7 Frequency of Riffles/Steps	8
6.8 Bank Stability	Left: 7 Right: 6
6.9 Bank Vegetation Protection	Left: 4 Right: 2
6.10 Riparian Vegetation Zone Width	Left: 1 Right: 1

Total Score **81**  
 Habitat Rating **0.405**

Habitat Stream Condition **Fair**

**Narrative:**

Significant channelization has led to STD. Channel management and armoring of bank has locked channel into stage II. Potential for continued evolution into stage III exists.

QC Status - Staff: Provisional Cons		Step 2. (Continued)		Step 3. Riparian Features		Step 4. Flow & Flow Modifiers	
<b>Step 1. Valley and Floodplain</b>		<b>Step 2. (Continued)</b>		<b>Step 3. Riparian Features</b>		<b>Step 4. Flow &amp; Flow Modifiers</b>	
1.1 Segmentation	Corridor Encroachment	2.5 Aband. Floodpln	5.20 ft.	3.1 Stream Banks	Steep	4.1 Springs / Seeps	Minimal
1.2 Alluvial Fan	None	Human Elev Floodpln	0.00 ft.	Typical Bank Slope	Steep	4.2 Adjacent Wetlands	None
1.3 Corridor Encroachments		2.6 Width/Depth Ratio	26.98	Bank Texture	Left	4.3 Flow Status	Low
Length (ft)	One	2.7 Entrenchment Ratio	1.93	Upper		4.4 # of Debris Jams	0
Berms	0	2.8 Incision Ratio	1.93	Material Type	Gravel	4.5 Flow Regulation Type	None
height	0	Human Elevated Inc Rat	0.00	Consistency	Non-cohesive	Flow Regulation Use	None
Roads	2,715	2.9 Sinuosity	Moderate	Lower		Impoundments	None
height	0	2.10 Riffles Type	Complete	Material Type	Boulder/Cobb/Boulder/Cobb	Impoundmt. Location	None
Railroads	0	2.11 Riffle/Step Spacing (ft)	200	Consistency	Non-cohesive	4.6 Up/Down strfm flow reg	None
height	0	2.12 Substrate Composition		Bank Erosion	Left	(old) Upstrm Flow Reg	None
Improved Paths	0	Bedrock	0%	Erosion Length (ft)	1,019	4.7 StormwaterInputs	None
height	0	Boulder	16%	Erosion Height (ft)	4.00	Field Ditch	0
Development	828	Cobble	27%	Revetmt. Type	Rip-Rap	Other	0
Left	Right	Coarse Gravel	24%	Revetmt. Length (ft)	348	Overland Flow	0
Hilly	Hilly	Fine Gravel	21%	Near Bank Veg. Type	Left	4.9 # of Beaver Dams	0
Continuous w/Sometimes	Sometimes	Sand	11%	Dominant	Deciduous	Affected Length (ft)	0
W/in 1 Bankfill	Sometimes	Silt and smaller	1%	Sub-dominant	Shrubs/Saplin	Step 5. Channel Bed and Planform Changes	
Texture	Not Evalua	Silt/Clay Present?	No	Bank Canopy	Shrubs/Saplin	5.1 Bar Types	
Not Evalua	Not Evalua	Detritus	2 %	Canopy %	Left	Mid	Side
1.5 Valley Features		# Large Woody	13	Mid-Channel Canopy	26-50	1	2
Valley Width (ft)	400	2.13 Average Largest Particle on		Open		Diagonal	Delta
Width Determination	Estimated	Bed	15.0 inches	3.2 Riparian Buffer		0	0
Confinement Type	Broad	Bar	4.0 inches	Buffer Width	Left	5.2 Other Features	Braiding
Rock Gorge?	No	2.14 Stream Type		Dominant	Left	Flood Neck Cutoff	Avulsion
Human-caused Change?	Yes	Stream Type:	B	Sub-dominant	Mixed Trees	1	0
<b>Step 2. Stream Channel</b>		Bed Material:	Gravel	W less than 25	Shrubs/Saplin	0	0
2.1 Bankfull Width	46	Subclass Slope:	c	Buffer Veg. Type	Mixed Trees	5.3 Steep Riffles and Head Cuts	
2.2 Max Depth (ft)	2.70	Bed Form:	Riffle-Pool	Dominant	Shrubs/Saplin	Steep Riffles	Head Cuts
2.3 Mean Depth (ft)	1.69	Field Measured Slope:		Sub-dominant	Shrubs/Saplin	0	0
2.4 Floodprone Width (ft)	88	2.15 Reference Stream Type		3.3 Riparian Corridor	Shrubs/Saplin	5.4 Stream Ford or Animal	Trib Rejuv.
Notes:		(if different from Phase 1)		Corridor Land	Left	5.5 Straightening	Straightening
The upper portion of this tributary is in fair shape. It has undergone some major incision, however is actively working to redevelop floodplain and has a fairly well developed riffle-pool sequence that provides good habitat. As the channel continues to		Failures	None	Dominant	Residential	Straightening Length:	1,187
		Gullies	None	Sub-dominant	None	5.5 Dredging	None
		Amount	Mean Height	Mass Failures	0	Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constrictions are on The second page of this report - with Steps 6 through 7.	
		None	0.00	Height	0		
		None	0.00	Gullies	0		
		None	0.00	Height	0		

Project: **Otter Creek - Mill River**      **Phase 2 Reach Summary**      page 2 of 2      December 12, 2007  
 Stream: **Unnamed Trib to M10**      Reach # **T2.01**      Segment: **B**      Completion Date: **October 26, 2007**  
 Organization: **Rutland RPC**      Observers: **Michael Blazewicz**      Rain: **Yes**  
 Segment Length (ft): **4,115**      Segment Location: **From the Bowlsville Road Bridge downstream to the near the western entrance of**

**1.6 Grade Controls** **None**      Step 7. Rapid Geomorphic Assessment Data

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken	Confinement Type	Score	STD	Historic
						<b>Unconfined</b>			
7.1 Channel Degradation							<b>10</b>	<b>C to B</b>	<b>Yes</b>
7.2 Channel Aggradation							<b>13</b>	<b>None</b>	<b>No</b>
7.3 Widening Channel							<b>12</b>		<b>No</b>
7.4 Change in Planform							<b>10</b>		<b>No</b>

Total Score **45**  
 Geomorphic Rating **0.5625**

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	13
6.2 Embeddedness	10
6.3 Velocity/Depth Patterns	13
6.4 Sediment Deposition	10
6.5 Channel Flow Status	11
6.6 Channel Alteration	14
6.7 Frequency of Riffles/Steps	13
6.8 Bank Stability	Left: 6 Right: 6
6.9 Bank Vegetation Protection	Left: 7 Right: 7
6.10 Riparian Vegetation Zone Width	Left: 3 Right: 3

Total Score **116**  
 Habitat Rating **0.58**

Habitat Stream Condition **Fair**

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	22.5	Yes	Yes	Yes	Yes
Problem	Scour Below				

**Narrative:**

Channel has incised historically. Active planform adjustment has led to the development of small bars and a juvenile floodplain in areas. The stream has a decent riffle pool setup through much of the segment. Continued adjustment expected.

## Stream Geometry Data

### Otter Creek - Mill

Reach	Segment	Phase 2 Stream Type		Phase 1 Data										Phase 2 Channel Data					RGA		
		Stream Type	Bed	Subcl. Slope	Channel width	Bankfull width	Max. depth	Mean depth	Floodpr. width	Abandn Ratio	W/D Ratio	Entrenchment	Incision Ratio	Stage Evol.	Vol. Model.	CondrHA	QC				
M01	A	C	Gravel Riffle-Pool	None	No	0.98	85.61	147.0	3.9	2.7	1600.0	7.6	54.44	10.88	1.95	IV	F	Fair	F	P	
M01	B	C	Cobble Plane Bed	None	No	1.67	85.61	85.0	4.2	2.36	425.0	7.7	36.02	5.00	1.83	III	F	Fair	Fair	F	P
M02	0				No	2.22	84.69													F	F
M03	A	C	Cobble Riffle-Pool	None	No	3.14	84.55	105.0	4.0	2.7	550.5	6.2	38.89	5.24	1.55	IV	F	Fair	Good	F	P
M03	B	B	Bedrock Bedrock	None	Yes	6.67	84.55													F	F
M03	C	B	Gravel Plane Bed	None	Yes	3.54	84.55	111.0	4.9	3.29	193.5	7.9	33.74	1.74	1.61	III	D	Fair	Fair	F	P
M04	0	B	Bedrock Bedrock	None	No	2.25	83.66													F	F
M05	A	C	Gravel Riffle-Pool	None	No	1.40	83.57	84.0	4.6	3.13	400.0	7.2	26.84	4.76	1.57	IV	F	Fair	Good	F	P
M05	B	B	Cobble Plane Bed	None	No	3.37	83.57	106.0	4.6	3.0	190.0	8.0	35.33	1.79	1.74	III	F	Fair	Fair	F	P
M06	0	C	Cobble Plane Bed	None	No	1.33	77.16	84.0	3.8	2.62	512.0	7.0	32.06	6.10	1.84	III	F	Fair	Fair	F	P
M07	0	F	Gravel Plane Bed	None	No	1.85	75.84	87.0	3.1	1.9	112.0	5.1	45.79	1.29	1.65	III	F	Fair	Fair	F	P
M08	0	C	Cobble Plane Bed	None	No	1.16	67.90	73.0	4.0	2.88	253.0	7.6	25.35	3.47	1.90	III	F	Fair	Fair	F	P
M09	0	B	Cobble Plane Bed	c	No	1.36	67.46	87.0	3.2	2.2	111.0	5.9	39.55	1.28	1.84	III	F	Fair	Fair	F	P
M10	0	B	Cobble Plane Bed	c	No	0.80	66.43	63.0	4.4	2.85	135.0	7.9	22.11	2.14	1.80	III	F	Fair	Fair	F	P
M11	A	F	Cobble Plane Bed	c	No	4.21	55.09	81.0	3.2	2.25	111.0	10.2	36.00	1.37	3.19	II	F	Fair	Fair	F	P
M11	B	B	Cobble Plane Bed	c	No	1.85	55.09	69.0	3.3	2.32	106.0	7.7	29.74	1.54	2.33	III	F	Fair	Fair	F	P
M12	0	C	Gravel Riffle-Pool	None	No	1.74	46.50	64.0	2.8	2.1	312.0	5.3	30.48	4.88	1.89	IV	F	Fair	Good	F	P
M13	A	C	Gravel Riffle-Pool	None	No	2.74	45.92	60.0	3.3	2.13	350.0	6.1	28.17	5.83	1.85	IV	F	Fair	Good	F	P
M13	B	B	Cobble Plane Bed	None	Yes	5.73	45.92	64.0	3.1	2.3	112.0	6.1	27.83	1.75	1.97	III	F	Good	Good	F	P
M14	0	B	Cobble Plane Bed	None	No	2.29	45.41	41.0	3.1	2.0	83.0	9.8	20.50	2.02	3.16	III	F	Fair	Fair	F	P
M15	0	B	Cobble Plane Bed	c	No	0.45	35.91	33.5	2.4	1.96	73.0	5.0	17.09	2.18	2.08	III	F	Fair	Fair	F	P
T2.01	A	F	Cobble Plane Bed	c	No	3.96	41.14	43.0	3.1	1.68	56.0	7.1	25.60	1.30	2.29	II	F	Fair	Fair	F	P
T2.01	B	B	Gravel Riffle-Pool	c	No	2.31	41.14	45.6	2.7	1.69	88.0	5.2	26.98	1.93	1.93	IV	F	Fair	Fair	F	P

## Rapid Geomorphic Assessment

### Otter Creek - Mill

Reach	Seg- ment	Sub- Rch?	Degradation			Aggradation			Widening			Planform			Geo. Score	Geo. Condition	Evol. Stage	Confin- ement Type	Sens- itivity	QC Stf Aut
			STD	Historic	Score	STD	Historic	Score	STD	Historic	Score	Historic	Score	Historic						
M01	A	No	11	None	Yes	8	None	No	7	No	5	No	0.39	Fair	IV	VB	Very	F	P	
M01	B	No	8	None	Yes	11	None	No	9	No	9	No	0.46	Fair	III	VB	Very	F	P	
M02	0	No											0.00			SC		F	F	
M03	A	No	11	None	Yes	11	None	No	10	No	13	No	0.56	Fair	IV	BD	High	F	P	
M03	B	Yes											0.00			NC		F	F	
M03	C	Yes	12	None	Yes	13	None	No	9	No	13	No	0.59	Fair	III	SC	High	F	P	
M04	0	No											0.00			SC		F	F	
M05	A	No	9	None	Yes	11	None	No	12	No	10	No	0.53	Fair	IV	NW	Very	F	P	
M05	B	No	8	C to B	Yes	14	None	No	8	No	13	No	0.54	Fair	III	NW	High	F	P	
M06	0	No	8	None	Yes	12	None	No	8	No	8	No	0.45	Fair	III	BD	High	F	P	
M07	0	No	3	C to F	Yes	11	None	No	5	No	11	No	0.38	Fair	III	BD	Extreme	F	P	
M08	0	No	9	None	Yes	14	None	No	12	No	13	No	0.60	Fair	III	SC	High	F	P	
M09	0	No	4	C to B	Yes	13	None	No	5	No	12	No	0.43	Fair	III	NW	High	F	P	
M10	0	No	8	C to B	Yes	13	None	No	13	No	12	No	0.58	Fair	III	BD	High	F	P	
M11	A	No	4	C to F	No	12	None	No	8	No	11	No	0.44	Fair	II	NW	Extreme	F	P	
M11	B	No	4	C to B	Yes	10	None	No	10	No	10	No	0.43	Fair	III	VB	High	F	P	
M12	0	No	10	None	Yes	11	None	No	10	No	8	No	0.49	Fair	IV	VB	Very	F	P	
M13	A	No	10	None	Yes	11	None	No	11	No	10	No	0.53	Fair	IV	BD	Very	F	P	
M13	B	Yes	11	None	Yes	16	None	No	11	No	16	No	0.68	Good	III	SC	High	F	P	
M14	0	No	5	C to B	Yes	13	None	No	10	No	11	No	0.49	Fair	III	VB	High	F	P	
M15	0	No	5	C to B	Yes	16	None	No	13	No	11	No	0.56	Fair	III	VB	High	F	P	
T2.01	A	No	4	C to F	Yes	14	None	No	10	No	14	No	0.53	Fair	II	VB	Extreme	F	P	
T2.01	B	No	10	C to B	Yes	13	None	No	12	No	10	No	0.56	Fair	IV	BD	Very	F	P	

# APPENDIX B

## Channel Evolution Models

(Vermont Agency of Natural Resources, Appendix C, May 2007)

# Channel Evolution Models

## F-stage Channel Evolution Process

The capital letters used throughout the following discussions refer to the stream types (Rosgen, 1996) typically encountered as the channel form passes through the different stages of channel evolution. The F-stage adjustment process begins where the streams are not entrenched and have access to a floodplain at the 1-2 year flood stage. Moderately entrenched, semi-confined “B” streams may also go through an F-stage channel evolution. This channel evolution model (CEM) is based on the assumption that the stream has a bed and banks that are sufficiently erodible so that they can be shaped by the stream over the course of years or decades. Streams beginning this process are typically flowing in alluvium or other materials that may be eroded by an increase in stream power. As the incision process continues, they may degrade to bedrock or glacial till materials. When a stream with a low width to depth ratio (“E” stream types) goes through this process, the sequence of stream types may be **E-C-F-C-E** (other forms may include **E-C-G-F-C-E** or **C-G-F-C** or **C-F-C** or **C-B-F-B-C** or **B-G-F-B** or **B-G-F** or **C-B-C**).

**Stage I** - Channel in regime with access to floodplain or flood prone area at discharges at and above the average annual high flow. Planform is moderate to highly sinuous; supportive of energy dissipating bed features (steps, riffles, runs, pools) essential to channel stability (B, C and E Stream Types). Channel slope (vertical drop in relation to length) generates flow velocities and stream power in balance with the resistance of stream bed and bank materials. Sediment transport capacity in equilibrium with sediment load.

**Stage II** - Channel has lost access to its floodplain or flood prone area, at its historic bankfull discharge, through a bed degradation process or floodplain build up. Stream has become more entrenched as discharges in excess of the annual high flow are now contained in the channel (B or G or F Stream Type). Channel slope is increased with commensurate increase in velocity and power to erode the stream bed and banks (boundary materials). The result of preventing access to the floodplain and containing greater flows in the channel is to increase the stream’s power that must be resisted by the channel boundary materials; i.e., the rocks, soil, vegetation or man-made structures that make up the bed and banks of the river. Plane bed may begin to form as head cuts move upstream and step/riffle materials are eroded.

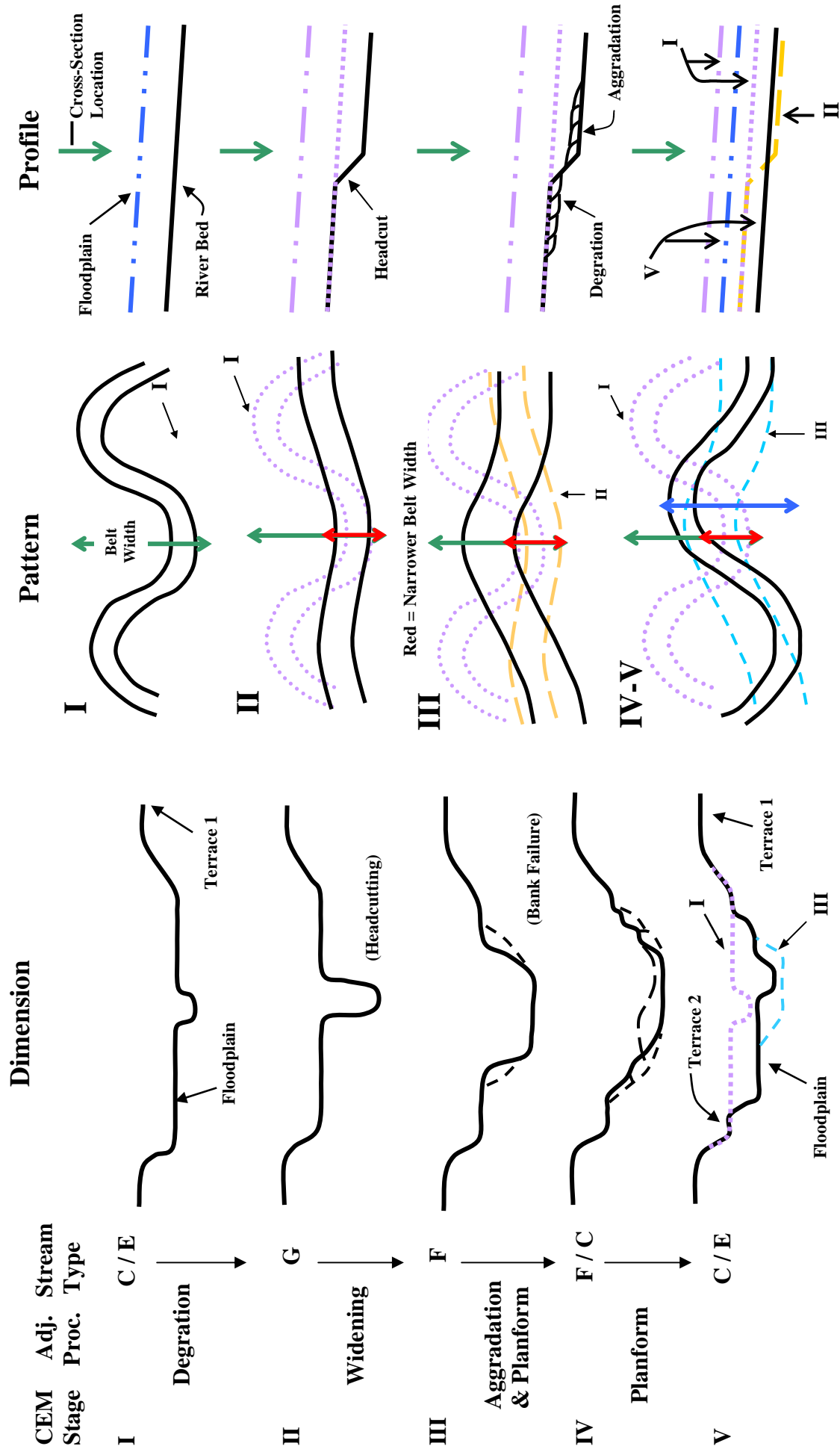
**Stage III** - Channel is still entrenched, widening and migrating laterally through bank erosion caused by the increased stream power (B or G or F Stream Type). The system regains balance between the power produced and the boundary materials as sinuosity increases and slope decreases. There are profound physical adjustments that occur upstream and downstream from the site of alteration as bed degradation (head cuts) migrates up through the system and aggradation in the form of sedimentation occurs downstream. Stream bed largely becomes a featureless plane bed.

**Stage IV** - Channel dimension and plan form adjustment process continues. Channel width begins to narrow through aggradation and the development of bar features. The main channel may shift back and forth through different flood chutes, continuing to erode terrace side slopes as a juvenile floodplain widens and forms. Weak step/riffle-pool bed features forming. Transverse bars may be common as planform continues to adjust. At Stage IV, erosion may be severe. Historically, channels have been dredged, bermed, and/or armored at this Stage pushing the process back to Stage II or III.

**Stage V** - Channel adjustment process is complete. Channel dimension, pattern, and profile are similar to the pre-adjustment form but at a lower elevation in the landscape (B, C and E Stream Types). Planform geometry, longitudinal profile, channel depth, and bed features produce an energy grade that is in balance with the sediment regime produced by the stream’s watershed.

Higher gradient, more entrenched streams (“A” or “B” stream types) with erodible beds also go through channel evolution processes that involves bed degradation. In these cases, the floodplain forming stages may be comparatively minor. A lowering of the bed elevation is more quickly followed by a re-sloping of the banks until the appropriate energy grade is achieved.

# F-stage Channel Evolution Process (VTDEC-Modified from Schumm, 1977 & 1984 and Thorne et al, 1997)



## D-stage Channel Evolution Process

**Only use the D stage CEM where the stream has no opportunity to incise. If the stream has incised and has now hit bedrock or clay and is currently widening, you would still use the F stage CEM.**

The capital letters used throughout the following discussions refer to the stream types (Rosgen, 1996) typically encountered as the channel form in the different stages of channel evolution. The difference between F and D-stage channel evolution processes is the degree of channel incision. In D-stage channel evolution, the dominant, active adjustment processes is **aggradation**, widening, and plan form change. In some situations, the stream may not experience any degradation because its bed is significantly more resistant to erosion than its banks. The process may start with limited vertical adjustment and goes right into aggradation and a lateral adjustment processes. Stream with low width to depth ratios ("E" Stream Types) may also go through this process.

**Stage I** - Channel in regime with access to floodplain or flood prone area at discharges at and above the average annual high flow (B, C and E Stream Types). Plan form is moderate to highly sinuous; supportive of energy dissipating bed features (steps, riffles, runs, pools) essential to channel stability. Channel slope (vertical drop in relation to length) generates flow velocities and stream power in balance with the resistance of stream bed and bank materials. **Then either of the following Stage II scenarios may occur:**

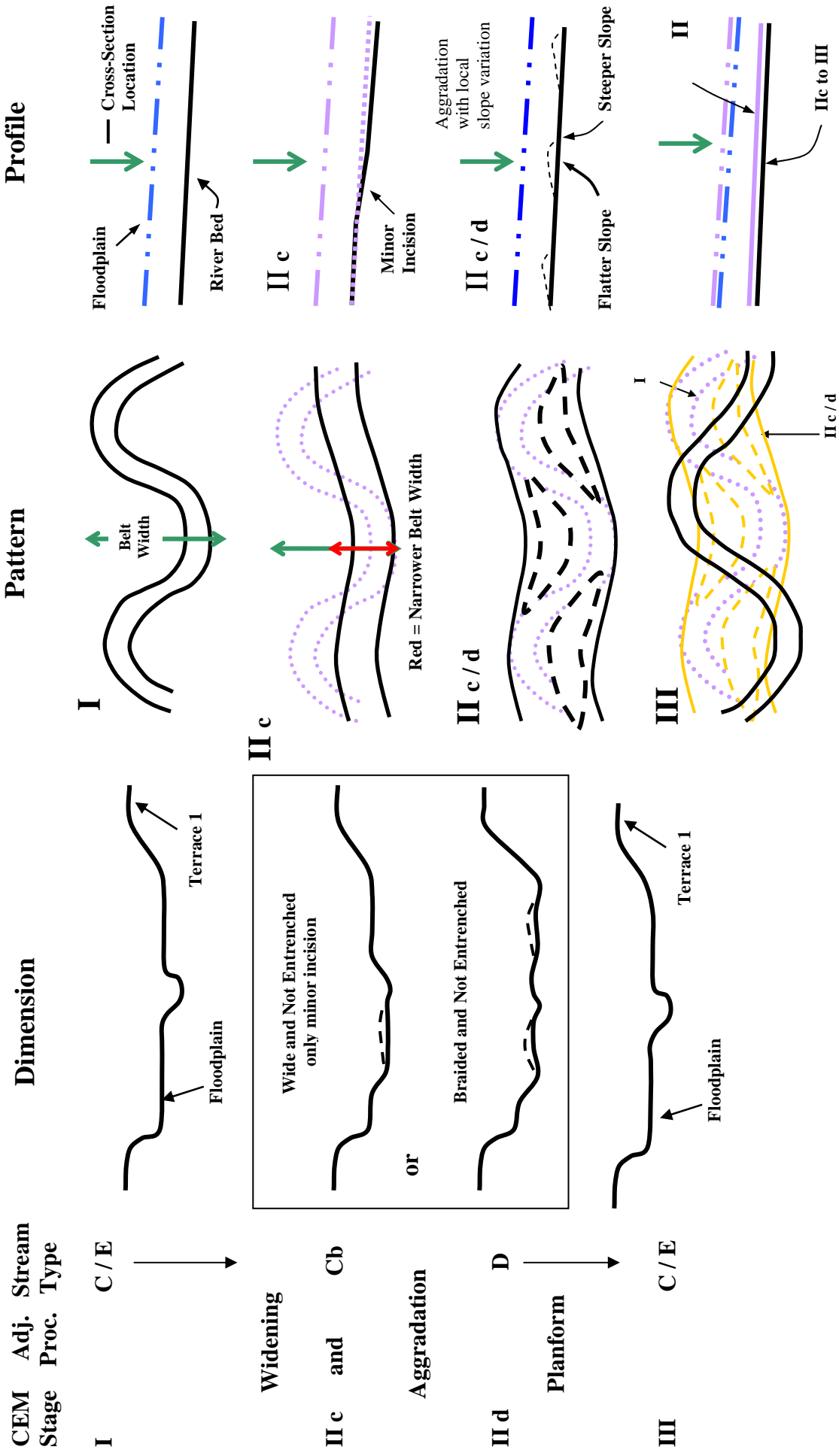
**Stage IIc** Steeper gradient may be imposed through activities such as channelization, but due to the resistance of the bed material, the stream has not incised significantly or lost access to its floodplain (remaining a "C" Stream Type). Channel is widening and migrating laterally through bank erosion caused by the increased stream power. The balance between stream power and boundary materials is re-established when the slope flattens after a process of channel lengthening and increased sinuosity. Stream bed may be a combination of poorly defined riffle-pool and plane bed features.

**Stage II d** Channel becomes extremely depositional and becomes braided with water flowing in multiple channels at low flow stage ("D" stream type). Dimension and plan form adjustment processes continue. Channel width begins to narrow through aggradation and the development of bar features. The main channel may shift back and forth through different channels and chute cut-offs, continuing to erode banks or terrace side slopes. Riffle-pool bed features develop as single thread channel begins forming. Transverse bars may be common as planform continues to adjust.

**Stage III** Channel adjustment process is complete (back to a B, C or E stream type). Channel dimension, pattern, and profile are similar to the pre-adjustment form. May or may not be at a lower elevation in the landscape. Planform geometry, longitudinal profile, channel depth, and bed features produce an energy grade (sediment transport capacity) that is in balance with the sediment regime produced by the stream watershed.

**Important Notes:** 1) The imposition of new constraints or changes at watershed, reach, or local scales, especially those related to large floods that energize the stream system with high flows of water, sediment, and debris, will affect the time scales associated with each stage of channel evolution. They may also have dramatic effects on the direction of a channel evolution process. The overlapping pulses of channel adjustment moving upstream and downstream in a watershed often makes the pinpointing of a specific channel evolution stage complicated. 2) Bedrock-controlled reaches in Vermont are presumed to be relatively fixed for the purposes of these protocols as little bed or bank erosion can be expected even over a century. Such reaches may, however, dramatically change or evolve due to rapid or catastrophic avulsions of the flow onto more erodible sediments nearby, leaving the bedrock channel wholly or partially abandoned.

# C-D-C Channel Evolution Process (VTDEC-Modified from Schumm, 1977 & 1984 and Thorne et al, 1997)



**APPENDIX C**  
**STANDARD DMS**  
**BRIDGE AND CULVERT REPORTS**

# Stream Geomorphic Assessment



## Failure Modes Report - Geomorphic Incompatibility

### Explanation of codes used in table header

Failure Modes	Existing Problems
<b>F1</b> Concern for structure due to fluvial condition or process	<b>P1</b> Upstream sediment deposit
<b>F2</b> Potential failure due to out-flanking	<b>P2</b> Upstream Scour and/or erosion present
<b>F3</b> Potential failure due to scour	<b>P3</b> Downstream Scour and/or erosion present
<b>F4</b> Potential failure due to ice or debris jam	<b>P4</b> Inlet obstruction present
<b>F5</b> Structure related damage due to flooding of adjacent property	<b>P5</b> Poor location or alignment
<b>F6</b> Structure related damage due to erosion of adjacent property	<b>P6</b> Beaver activity
	<b>P7</b> Floodplain filled entirely or partially by roadway approaches

**Width** Structure width divided by channel width as a percent (% bankfull width)

Town	Road	Stream Name	Structure: SGA / VOBCIT	Type	X = meets criteria MD = missing data														Width
					F1	F2	F3	F4	F5	F6	P1	P2	P3	P4	P5	P6	P7		
Clarendon	Railroad	Mill River	700000001111053 990002000311051	Bridge	-	-	-	X	-	X	X	-	-	X	-	-	X	154 %	
Clarendon	EAST ST	Mill River	101105002811051 990008000811051	Bridge	-	-	X	-	-	-	X	-	-	-	-	-	X	85 %	
Clarendon	ROUTE 7	Mill River	200019090S11052	Bridge	-	-	-	X	-	X	X	-	-	X	-	-	X	364 %	
Clarendon	ROUTE 7	Mill River	200019090N11052 990003000111051	Bridge	-	-	-	X	-	X	X	-	-	X	-	-	X	364 %	
Mount Holly	Private road	Mill River	700000000111123 700010018711123	Bridge	-	-	-	X	-	X	X	X	X	-	-	-	X	111 %	
Mount Holly	BARLOW RD	Mill River	101112006911121 700001007111123	Bridge	-	-	-	-	-	-	-	-	-	-	-	-	X	77 %	
Mount Holly	BOWLSVILLE RD N	Mill River Trib	101112006411121 700012020111123	Bridge	-	X	X	X	X	-	-	X	X	-	-	-	X	50 %	
Mount Holly	ROUTE 155	Mill River	200133001211122 700001006911123	Bridge	-	X	X	X	X	X	-	X	X	-	-	-	X	54 %	
Shrewsbury	VT RTE 103	Mill River	200025005111222 990002019811221	Bridge	-	-	-	X	-	X	X	-	X	X	-	-	X	237 %	
Shrewsbury	VT RTE 103	Mill River	200025005011222 990002019911221	Bridge	-	-	-	-	-	X	-	-	-	-	X	-	X	171 %	
Wallingford	Railroad	Mill River	200133001411122 990006000311251	Bridge	-	-	X	-	-	X	X	X	X	-	-	-	X	163 %	
Wallingford	Railroad	Mill River	200025004711252 990045000711251	Bridge	X	-	-	X	-	X	X	-	-	-	-	-	-	190 %	
Wallingford	ROUTE 140-EAST	Mill River	200138001011252 990043001511251	Bridge	-	-	-	X	-	X	X	-	X	X	-	-	X	172 %	
Wallingford	ROUTE 140-EAST	Mill River Trib	200138001111252 990038000111251	Bridge	-	X	X	X	X	X	X	X	-	X	X	-	X	61 %	
Wallingford	VILLAGE ST	Mill River	200133001511252 990042000511251	Bridge	-	-	X	X	-	X	-	-	X	-	-	-	X	253 %	

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# Stream Geomorphic Assessment



## Failure Modes Report - Problem Causes

### Explanation of codes used in table header

Upstream Sediment Deposition		Upstream Scour and Erosion		Downstream Scour and Erosion			Poor Location or Alignment			
C1	Opening obstructed by sediment	C4	Bank armoring failing	C7	Bank armoring failing		C12	Stream approach angle is sharp bend		
C2	Sediment deposits >= half bankfull	C5	Bank erosion high	C8	Bank erosion high		C13	Located at significant valley break		
C3	steep riffle upstream	C6	Scour under structure	C9	Scour under structure		C14	Avulsion follow road		
				C10	Banks higher downstream than upstream					
				C11	Culvert outlet is cascade or freefall					

Yes = Condition exists No = Condition does not exist MD = missing data

Town	Road	Stream Name	Structure: SGA / VOBCIT	Type	Bankfull Width Percent	Upstream Sediment Deposition			Upstream Scour and Erosion			Downstream Scour and Erosion					Poor Location or Alignment			
						C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	
Clarendon	Railroad	Mill River	700000001111053 990002000311051	Bridge	154 %	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No
Clarendon	EAST ST	Mill River	101105002811051 990008000811051	Bridge	85 %	No	No	No	No	No	Yes	No	No	No	No	No	No	No	No	No
Clarendon	ROUTE 7	Mill River	200019090N11052 990003000111051	Bridge	364 %	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No
Clarendon	ROUTE 7	Mill River	200019090S11052 700000000111123	Bridge	364 %	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No
Mount Holly	Private road	Mill River	700010018711123	Bridge	111 %	Yes	No	No	No	Yes	No	No	Yes	No	No	No	No	No	No	No
Mount Holly	BARLOW RD	Mill River	101112006911121 700001007111123	Bridge	77 %	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Mount Holly	BOWLSVILLE RD N	Mill River Trib	101112006411121 700012020111123	Bridge	50 %	No	No	No	No	No	Yes	No	No	Yes	No	No	No	No	No	No
Mount Holly	ROUTE 155	Mill River	200133001211122 700001006911123	Bridge	54 %	No	No	No	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No
Shrewsbury	VT RTE 103	Mill River	200025005011222 990002019911221	Bridge	171 %	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes
Shrewsbury	VT RTE 103	Mill River	200025005111222 990002019811221	Bridge	237 %	Yes	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No
Wallingford	Railroad	Mill River	200025004711252 990045000711251	Bridge	190 %	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No	No
Wallingford	Railroad	Mill River	200133001411122 990006000311251	Bridge	163 %	No	No	Yes	No	No	Yes	Yes	No	Yes	No	No	No	No	No	No
Wallingford	ROUTE 140-EAST	Mill River	200138001011252 990043001511251	Bridge	172 %	Yes	No	No	No	No	No	No	Yes	No	No	No	No	No	No	No
Wallingford	ROUTE 140-EAST	Mill River Trib	200138001111252 990038000111251	Bridge	61 %	Yes	Yes	No	Yes	Yes	No	No	No	No	No	No	No	Yes	No	No
Wallingford	VILLAGE ST	Mill River	200133001511252 990042000511251	Bridge	253 %	No	No	No	No	No	No	No	Yes	Yes	No	No	No	No	No	No

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## Stream Geomorphic Assessment

VT DEC

### Culvert Aquatic Organism Passage Report - Potential Barriers to Movement and Migration

There are no culverts.

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## Stream Geomorphic Assessment

## Wildlife Passage Report - Structures Potentially Suitable for Terrestrial Wildlife Movement

**Large Wildlife** = deer, moose, bear

**Medium Wildlife** = fisher, otter, coyote, fox

**Small Wildlife** = herps, small mammals

Town	Road	Stream Name	Structure SGA / VOBCIT	Type	X = meets criteria MD = missing data			Wildlife Species Observed		
					Small Wildlife	Medium Wildlife	Large Wildlife	Roadkill	Outside Structure	Inside Structure
Clarendon	Railroad	Mill River	700000001111053 990002000311051	Bridge	X	X	-	---	---	---
Clarendon	EAST ST	Mill River	101105002811051 990008000811051	Bridge	-	-	-	---	---	---
Clarendon	ROUTE 7	Mill River	200019090S11052	Bridge	X	X	-	---	---	---
Clarendon	ROUTE 7	Mill River	200019090N11052 990003000111051	Bridge	X	X	-	---	---	---
Mount Holly	Private road	Mill River	700000000111123 700010018711123	Bridge	-	-	-	---	---	---
Mount Holly	BARLOW RD	Mill River	101112006911121 700001007111123	Bridge	-	-	-	---	---	---
Mount Holly	BOWLSVILLE RD N	Mill River Trib	101112006411121 700012020111123	Bridge	-	-	-	---	---	---
Mount Holly	ROUTE 155	Mill River	200133001211122 700001006911123	Bridge	-	-	-	---	---	---
Shrewsbury	VT RTE 103	Mill River	200025005111222 990002019811221	Bridge	-	-	-	---	---	---
Shrewsbury	VT RTE 103	Mill River	200025005011222 990002019911221	Bridge	-	-	-	---	---	---
Wallingford	Railroad	Mill River	200133001411122 990006000311251	Bridge	-	-	-	---	---	---
Wallingford	Railroad	Mill River	200025004711252 990045000711251	Bridge	X	X	-	---	---	---
Wallingford	ROUTE 140-EAST	Mill River	200138001011252 990043001511251	Bridge	-	-	-	---	---	---
Wallingford	ROUTE 140-EAST	Mill River Trib	200138001111252 990038000111251	Bridge	-	-	-	---	---	---
Wallingford	VILLAGE ST	Mill River	200133001511252 990042000511251	Bridge	-	-	-	---	---	---

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