Muddy Brook Phase 1 and 2
Stream Geomorphic Assessment Summary

February 2, 2009

Muddy Brook below Van Sicklen Road

Prepared by:

Evan P. Fitzgerald
Principal Watershed Scientist

and

Samuel P. Parker
Staff Scientist

Fitzgerald Environmental Associates, LLC.

Applied Watershed Science & Ecology

Prepared under contact to:

Vermont River Management Program

Funding provided by:

Vermont Clean and Clear Program

List of Figures

List of Tables

Executive Summary

- Fitzgerald Environmental Associates, LLC. (FEA) was retained by the Vermont Agency of Natural Resources (VTANR) to carry out Phase 1 and 2 assessments in the Muddy Brook watershed utilizing the Stream Geomorphic Assessment (SGA) Protocols developed by the River Management Program (RMP). SGA data will be used for: 1) assessing the current geomorphic stability and habitat conditions in the watershed to compliment VTDEC biological sampling data, and 2) establishing baseline data for long-term monitoring purposes.

- The Muddy Brook watershed is found in the Winooski River Basin and occupies portions of Williston, South Burlington, Shelburne, and St. George. It has a drainage area of 31.8 square miles and includes Allen Brook and Sucker Brook as major tributaries. Biological sampling conducted by VTANR has led to the watershed being designated as impaired by impacts from toxins, nutrients, and temperature per the 2008 303(d) list submitted to EPA.

- The Phase 1 SGA included all significant surface waters in the watershed with the exception of Allen and Sucker Brooks, which were assessed in previous studies. A total of 19 reaches were identified for the mainstem, and 13 reaches on 7 major tributaries. Non-fluvial, lentic reaches associated with Shelburne Pond were excluded from the Phase 1 study.

- The Mainstem channel network has an overall slope of 0.3%, and a majority of its reaches are found in very broad valley settings, supporting channels with sand substrate and E-type geometry. Only three reaches were determined to have sediment transport regimes (B-type geometry) under reference conditions, and all were located in the lower watershed. The parent geologic material is dominated by lacustrine deposits in the western watershed, alluvial and outwash deposits in the northern watershed near the Winooski River, and glacial till in the eastern watershed.

- The watershed land cover is comprised of a mixture of forested lands (43%), agricultural lands (39%), and to a lesser degree by various types of developed lands (13%) and wetlands (5%). The overall watershed has a low degree of impervious cover (6.7%). Small, urbanizing watersheds in Chittenden County within a low range of impervious cover (5-10%) are often exhibit a decline of channel stability and biotic integrity (Fitzgerald, 2007). The lower zone of the watershed has 5 subwatersheds with high levels of impervious cover (>25%) typically associated with stream conditions that do not support reference biotic communities.

- Historical channel straightening associated with agriculture was extensive in the upper watershed, especially in the small stream channels above Shelburne Pond. Below Shelburne Pond, only three reaches had over 10% of their channel straightened due to agricultural impacts: M02, M07 and M10. The tributary draining the Taft Corners area, T3, has been highly straightened. This straightening is the result of both agricultural and the increasing pressures of urbanization.

- A total of 22 reaches encompassing 14.1 miles on the mainstem and two tributaries were identified for further Phase 2 assessments. During the Phase 2 surveys, the division of reaches resulted in a total of 30 segments. Each segment was walked entirely and detailed physical data was collected using the SGA Phase 2 methods. This included a summary of geomorphic stability (RGA rating), habitat conditions (RHA rating), channel evolution stage, and stream sensitivity ratings.

- Stream type departures were noted on two segments in the lower watershed on the tributary draining the urbanized area associated with Taft Corners (T3). On both segments (T3.01-E and T3.02-B), active headcuts have resulted in a disconnected floodplain with G-type channel geometry. The severe changes in channel geometry outside of the normal range of adjustments indicated that these areas are extremely sensitive to further watershed impacts.

- Of the 16 assessed bridges and culverts, only 7 accommodate 75% of the bankfull channel width. This width is typically cited in transportation design standards and represents a point of comparison for assessing compatibility of the structure with channel equilibrium conditions. In addition, 6 structures are causing significant upstream or downstream erosion or aggradation and are considered high-priority for replacement or retrofit by town and state agencies.

1.0 Project Background

1.1 Introduction and Study Goals

The Muddy Brook watershed is found within the Winooski River Basin in central Chittenden County (Figure 1 and Appendix A). It occupies portions of Williston, South Burlington, Shelburne, and St. George. The watershed has a drainage area of 31.8 square miles, and includes Allen Brook and Sucker Brook as major tributaries. Biological samples collected in the lower watershed zone on the Muddy Brook mainstem have shown an impaired condition due to a combination of impacted riparian buffers, land development, and bank erosion (VTDEC, 2008). Various studies have been conducted over the past 20 years in an attempt to identify the sources of impairment, including biological sampling of the tributaries draining the commercial-industrial areas near Taft Corners in Williston (VTDEC, 2005). The Vermont Agency of Natural Resources (VTANR) designated the watershed impaired by impacts from toxics, nutrients, and temperature on the 2008 303(d) list submitted to EPA. Despite a high degree of urbanization in the lower watershed, at present, it is not considered impaired by stormwater runoff because there is insufficient evidence to list the stream as such (Pease, 2008).

Muddy Brook was identified for geomorphic assessment by the Vermont Department of Environmental Conservation (VTDEC) in 2007 to collect data for: 1) assessing the current geomorphic stability and habitat conditions in the watershed to compliment VTDEC biological sampling data, and 2) establishing baseline data for long-term monitoring purposes. Fitzgerald Environmental Associates, LLC (FEA) was retained by the Vermont River Management Program (RMP) to carry out geomorphic assessments within the watershed. Assessed sections of the watershed (excluding Allen and Sucker Brooks) were reviewed and a total of 32 reaches along 24.4 stream miles were selected for Phase 1 Stream Geomorphic Assessments (SGA) following the protocols developed by the VTDEC's River Management Program (VTDEC, 2007a). Following the Phase 1 assessments, 22 reaches along 14 stream miles were selected for Phase 2 field assessments, including 19 mainstem reaches and 3 tributary reaches.

FEA used the Stream Geomorphic Assessment Tool (SGAT) to develop the baseline GIS data for the watershed in early 2008. The Phase 1 SGA approach results in watershed-scale data about the landscape (e.g., soils and land cover) and the stream channel (e.g., slope and form), providing a basis for understanding the natural and human-impacted conditions within the watershed. Detailed Phase 2 data collected in the field further aids in the identification of physical stability and habitat conditions of the channel, as well as specific stressors affecting the stream channel such as stormwater inputs and instream structures (e.g., bridges and culverts).

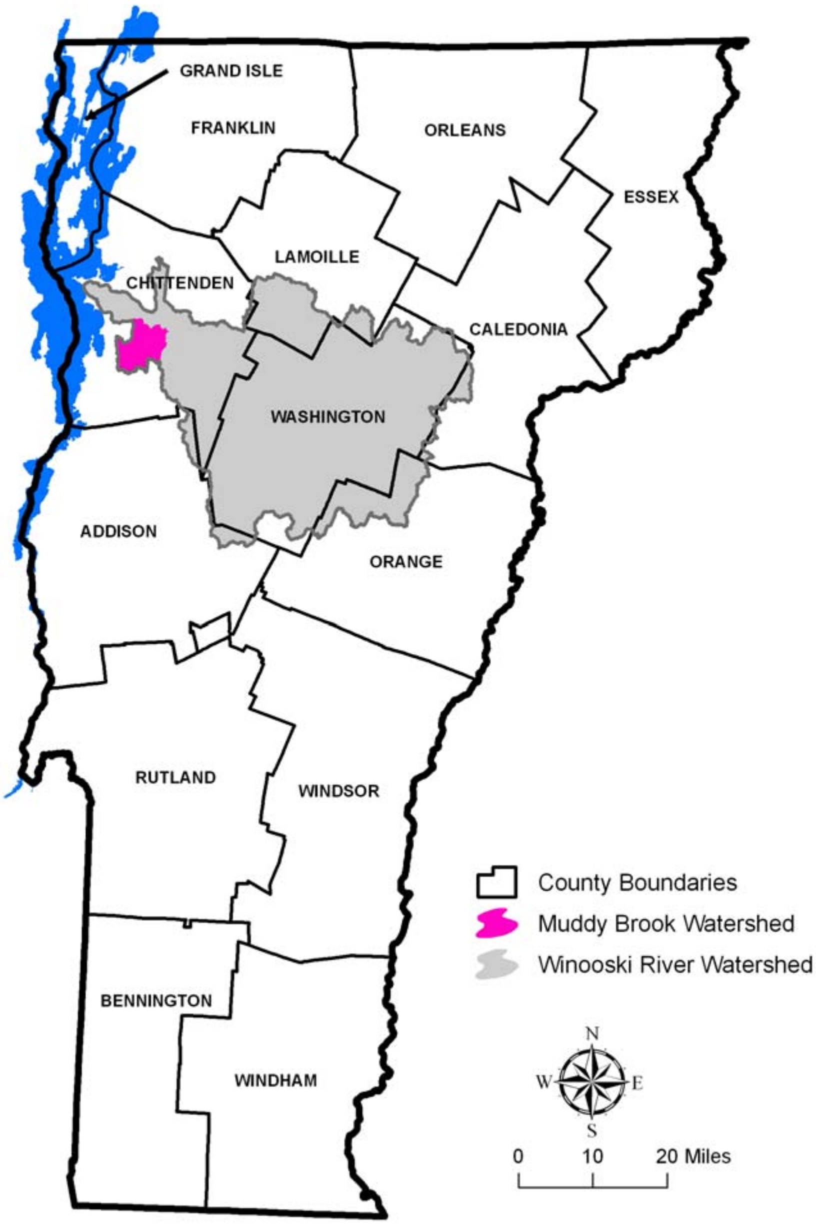


Figure 1. Watershed location map

The overall goal of the RMP is to "manage toward, protect, and restore the fluvial geomorphic equilibrium condition of Vermont rivers by resolving conflicts between human investments and river dynamics in the most economically and ecologically sustainable manner," (VTANR, 2007b) achieved through:

- Fluvial erosion hazard mitigation,
- Sediment and nutrient load reduction, and
- Aquatic and riparian habitat protection and restoration

The Phase 1 and 2 assessments of the Muddy Brook watershed provide the basis for identifying projects that could protect, sustain, or restore fluvial geomorphic equilibrium conditions, through the implementation of either passive or active stream corridor management strategies.

1.2 Previous Studies

Tributary SGA Studies
The two largest tributaries draining into Muddy Brook, Allen Brook and Sucker Brook, were previously studied as part of collaborative projects involving the University of Vermont (UVM), RMP and FEA. Allen Brook was identified for geomorphic assessment during 2005 as part of a joint UVM-VTDEC research project to collect data for: 1) assessing the relative contribution of endogenous sediment loading in the watershed, and 2) establishing baseline data for long-term monitoring purposes. As part of this project, 15 stream segments along the mainstem of Allen Brook were assessed using the Phase 2 approach of the SGA protocols. The assessments were carried out by Evan Fitzgerald and a crew of UVM graduate and undergraduate students in August, 2005. FEA was later retained by the RMP in 2007 to complete Phase 2 assessments on 2 additional tributary segments, making for a total of 17 assessed segments in the watershed. As part of this project, FEA also tested the RMP River Corridor Planning Guide (VTANR, 2007b) methods for identifying restoration projects in three urbanized watersheds in Chittenden County, including Allen Brook (FEA, 2008)

Sucker Brook was identified for assessment during 2005 as part of the same UVM-RMP project mentioned above. Due to its rural setting and limited urbanization, Sucker Brook reaches were chosen as reference sites for reaches in stormwater impaired watersheds in the Burlington area. The assessments for the Sucker Brook mainstem, which included a total of 10 Phase 1 reaches and 7 Phase 2 segments, were carried out by Evan Fitzgerald and the UVM field crew in August 2005. FEA was retained by the RMP in 2007 to 1) carry out Phase 1 and 2 analyses for 5 reaches on the north branch tributary, and 2) organize and review the data and produce a summary report of the Phase 1 and 2 assessments for the entire watershed (FEA, 2007).

Biological Sampling

Selected reaches within the Muddy Brook watershed have been sampled periodically by the VTDEC Biomonitoring Section, with the most recent sampling occurring in 2005 on Tributary 4 (Reach T3.01 in this study). Due to the low gradient nature of this tributary and the limited available substrate for colonization of the biological communities that are typically assessed, the degree of confidence for aquatic life use assessment was low. The data suggest a low to moderate level of impairment, and fish sampling data at the site support this conclusion (VTDEC, 2005). One cobble-bottomed reach located below Kimball Avenue on the mainstem (Reach M05 in this study) has also been sampled periodically for fish and benthic macroinvertebrates. While the condition of the mainstem has varied from poor to very good since 1988, the most recent sampling in 2003 indicated good conditions. A full summary of the biological sampling data has been provided in Appendix C.

Shelburne Pond

Shelburne Pond is the dominant surface water feature in the upper watershed. It has an area of 452 acres and is fed by the mainstem of Muddy Brook (Reaches M19-M21), as well as other smaller tributaries (T6 and T7). Shelburne Pond is a shallow water body and maintains a high alkalinity. The pond supports a healthy native fishery of northern pike (*Esox lucius)* and largemouth bass (*Micropterus salmoides).* However, large blooms of cyanobacteria and fish kills have been reported in the past due to the pond's high productivity. This level of productivity is due to the very high levels of phosphorus observed in the pond by VTDEC over many years of monitoring (VTDEC, 2008). See Appendix D for a complete narrative summary of past VTDEC studies of the Pond.

Shelburne Pond and the low gradient wetland areas surrounding it exert a strong influence on the channel form and processes in the upper watershed. Upstream of the pond, all of Reach M18 and the lower section of M19 are affected by the fluctuating levels of the pond and its adjacent wetlands. These areas lack well defined channels and were not fully assessed for Phase 2 data. Downstream of the pond, Reaches M15 and M14, both upslope of the Route 116 crossing, are affected by the wetlands extending north from the pond. These areas also lack well defined channels and were not fully assessed for Phase 2 data. There is likely a strong influence of the pond on the downstream water temperature and chemistry for a long distance, however, this has not been studied in detail in the past and was outside of the scope of the current assessment.

2.0 Watershed Background

2.1 Geographic Setting and Land Use History

The Muddy Brook watershed is located in the Winooski River Basin (VTDEC Basin 8) in central Chittenden County (Figure 1). The watershed has a drainage area of 31.8 square miles and outlets to the Winooski River in the vicinity of River Cove Road in Williston. The headwaters of Muddy Brook are found upslope of Shelburne Pond in the towns of Shelburne and South Burlington (see Figure 2 and watershed maps in Appendix A). The channel is very low gradient upstream and downstream of Shelburne Pond, with beaver ponding affecting many of the upper reaches. Downstream of Shelburne Pond the mainstem flows north and crosses Route 116. From this point to the outlet, Muddy Brook forms the boundary between the towns of Williston and South Burlington. From the Route 116 crossing downstream to the Van Sicklen Road crossing the channel is intermittently affected by beaver activity, and maintains a very sinuous planform with a silt and sand bottom. Sucker Brook enters from the east at stream mile 6.6 just downstream of a large beaver pond, increasing the overall drainage area by 91%. From Van Sicklen Road down to the I-89 crossing, beaver activity is sparse despite the low gradient of the channel, and there is very high sinuosity. The upper watershed, defined generally as the area upslope of the I-89 crossing, is characterized by a rural landscape with some low-to-medium-density residential development found off of Van Sicklen Road and Dorset Street.

Downstream of the I-89 crossing, the watershed land cover changes dramatically from rural to intensive commercial and industrial uses, particularly to the east of the channel in Williston. Two tributaries enter from the east (T2 and T3), draining the highly urbanized area of Taft Corners. The mainstem channel continues north, crossing Kimball Avenue and Williston Road (Route 2) before descending to the historical Winooski River floodplain. A final road crossing beneath River Cove Road is found prior to the confluence with Allen Brook. The outlet of Muddy Brook to the Winooski River is located approximately 800 feet downstream of River Cove Road.

Land cover data based on imagery from 2006 (NOAA, 2008a) are summarized in Table 1. Muddy Brook is drained by a watershed dominated by forest (43%) and agricultural (39%) land uses, with developed lands (13%), wetlands (4%) and water (3%) less dominant. As noted above, there is a stark contrast between land use in the upper and lower watershed. The upper watershed is largely rural with only 4% of the area developed. The lower watershed has less agricultural lands and fewer forested areas, with a moderate amount of development (23%) as a whole. However the two small tributary

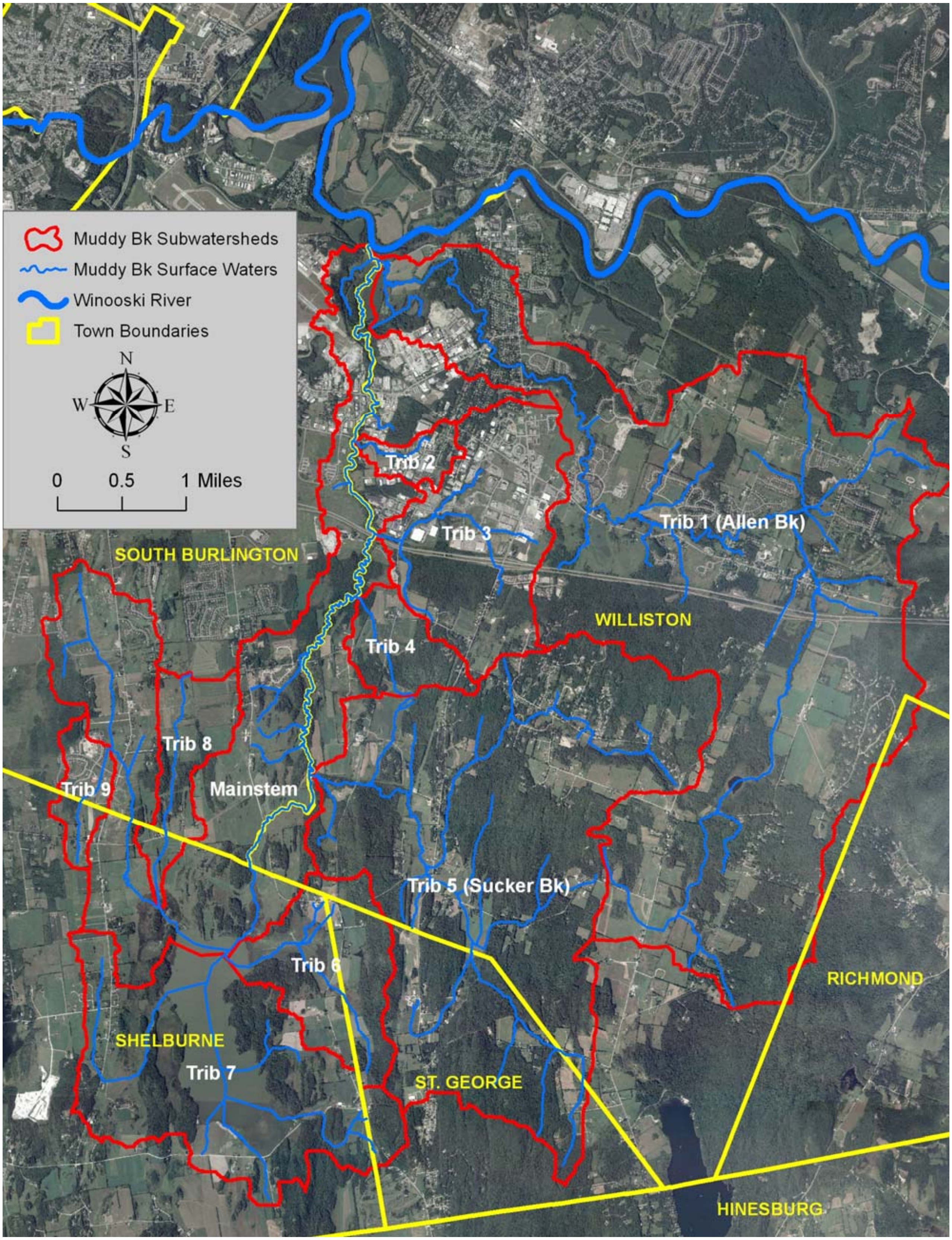


Figure 2. Muddy Brook subwatershed map.

watersheds associated with the Taft Corners area (T2 and T3) are highly developed and have limited areas of contiguous forest cover.

Table 1. 2006 NOAA Land Cover Data for Muddy Brook and Tributary Watersheds.

	Drainage Areas (SGA Reaches)						
Land Cover Type	Sucker Bk (T5)	Upper Watershed*	Taft Corners Tributary (T3)	Trib. 2 (T2)	Allen Bk (T1)	Lower Watershed*	Entire Watershed
Developed	2%	4%	50%	76%	14%	23%	13%
Agriculture	28%	43%	23%	13%	38%	34%	39%
Forest	69%	45%	26%	10%	44%	40%	43%
Wetland	1%	4%	1%	1%	4%	3%	3%
Water	0%	4%	0%	0%	0%	0%	2%

* defined by drainage areas to channel above (upper) and below (lower) I-89 crossing.

Historical Land Uses

The Muddy Brook watershed, like much of the state of Vermont, was largely devoid of forest vegetation in the middle part of the 1800's (Albers, 1998). This watershed-scale impact, along with the direct impacts to the channel associated with clearing and farming (e.g., straightening), left scars that are still healing today. In the absence of historic aerial photographs which predate 1937, only anecdotal information from historical records can be used to piece together the story of the watershed and its land use. Nevertheless, historic aerial photos taken in 1937 and 1962 provide a basis for using time-lapse analysis to understand the extent of the forest clearing and subsequent recovery in the 1900's as the economy shifted away from the traditional pastoral land uses.

As Vermont's farmers began to move to the Midwest in search of more productive farmland in the mid to late 1800's, the deciduous forests along the mountain and foothill slopes began to recover (Albers, 1998). Throughout the early and mid 1900's, as more family farms found on marginal lands were given up, the forests continued to recover. Time-lapse analysis also aids in understanding the extent of channel straightening that occurred in the lower watershed zone, and the degree to which the natural sinuosity of these streams has recovered. Provided below are a series of aerial photographs and discussion which help illustrate the changes in land cover that have occurred since the 1930's in the watershed (Figures 3 through 6).

Figure 3. Tafts Corners area in 1962.

Figure 4. Tafts Corners area in 2003.

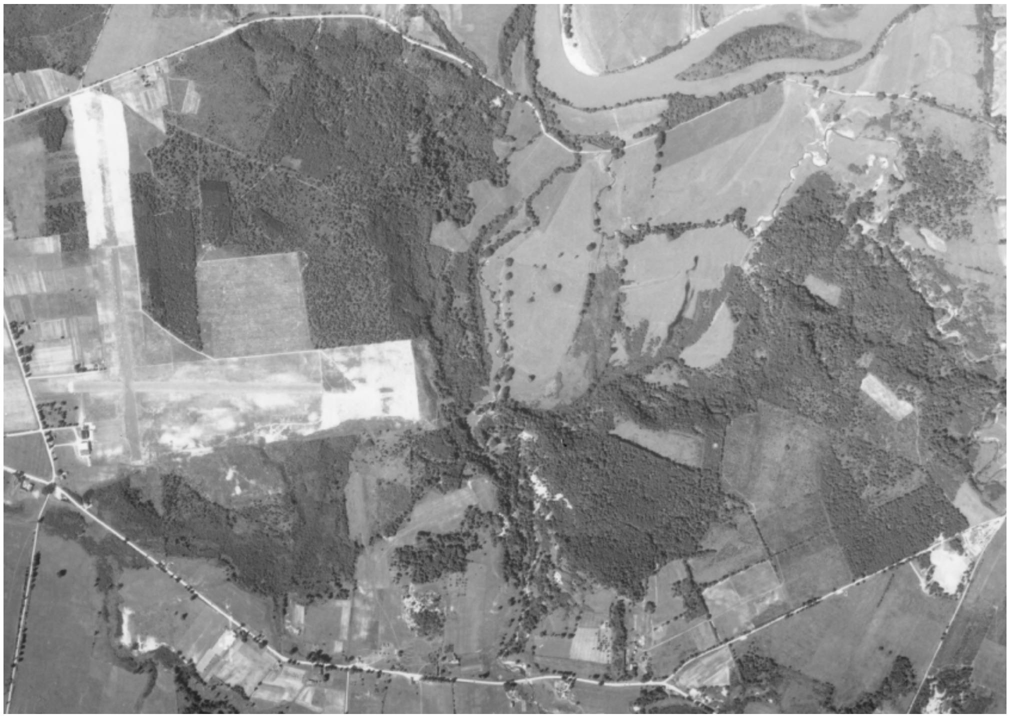


Figure 5. Lower Muddy Brook watershed north of Route 2 in 1937. Note the lack of industrial development and airport.

Figure 6. Lower Muddy Brook watershed north of Route 2 in 2003.

2.2 Geologic and Geomorphic Setting

Geologic Setting

The Muddy Brook watershed lies in the Champlain Valley and its surficial geology and soils have been shaped by three dominant processes of the landscape since the last period of glaciation: 1) Retreat of the Laurentide Ice Sheet; 2) Presence of Lake Vermont and the Champlain Sea; 3) Deposition from the Winooski River. Each of these historic geologic processes help to describe the current distribution of soil characteristics found throughout the watershed today.

As the Laurentide Ice Sheet retreated from Vermont approximately 14,000 years ago it left behind a "tongue" of ice extending through the lower elevations of the Champlain Valley. During a glacial retreat the rate of ice melt exceeds the rate at which the ice is flowing. For the Laurentide Ice Sheet this process and the southward movement (flow) that preceded it left a barren landscape with glacial till soils. During the retreat of the glaciers, a large freshwater lake formed as the meltwater draining to the north was blocked by the remaining "tongue" of ice in the northern Champlain Valley. This lake, which later became brackish, persisted for approximately 4,000 years at an elevation of 620 feet above sea level (Wright, 2003).

The presence of Glacial Lake Vermont shaped the soils that are presently found in the Muddy Brook watershed, especially throughout the western and northern portions (Figure 7). During this historic period of Lake Vermont, the surface elevation of the water extended east in the watershed in the vicinity of St. George Road, and along the current day location of I-89. Due to the quiescent waters of the Lake, large amounts of fine sediment settled in these areas, leaving behind the silt and sand rich soils found throughout the watershed today. The only section of the watershed that was not greatly affected by the presence of Lake Vermont was the upper headwaters of Sucker and Allen Brooks, where till soils are dominant. The surficial geology of the lower part of the watershed is dominated by a mix of silts, sands and coarse gravels associated with deposition in the Lake. In the lower section of the watershed below Route 2, alluvial and outwash soils associated with the historical Winooski River floodplain are also present. This outwash area represents an ancient delta of the Winooski River where coarser substrates were deposited when the elevation of the Lake was lowering.

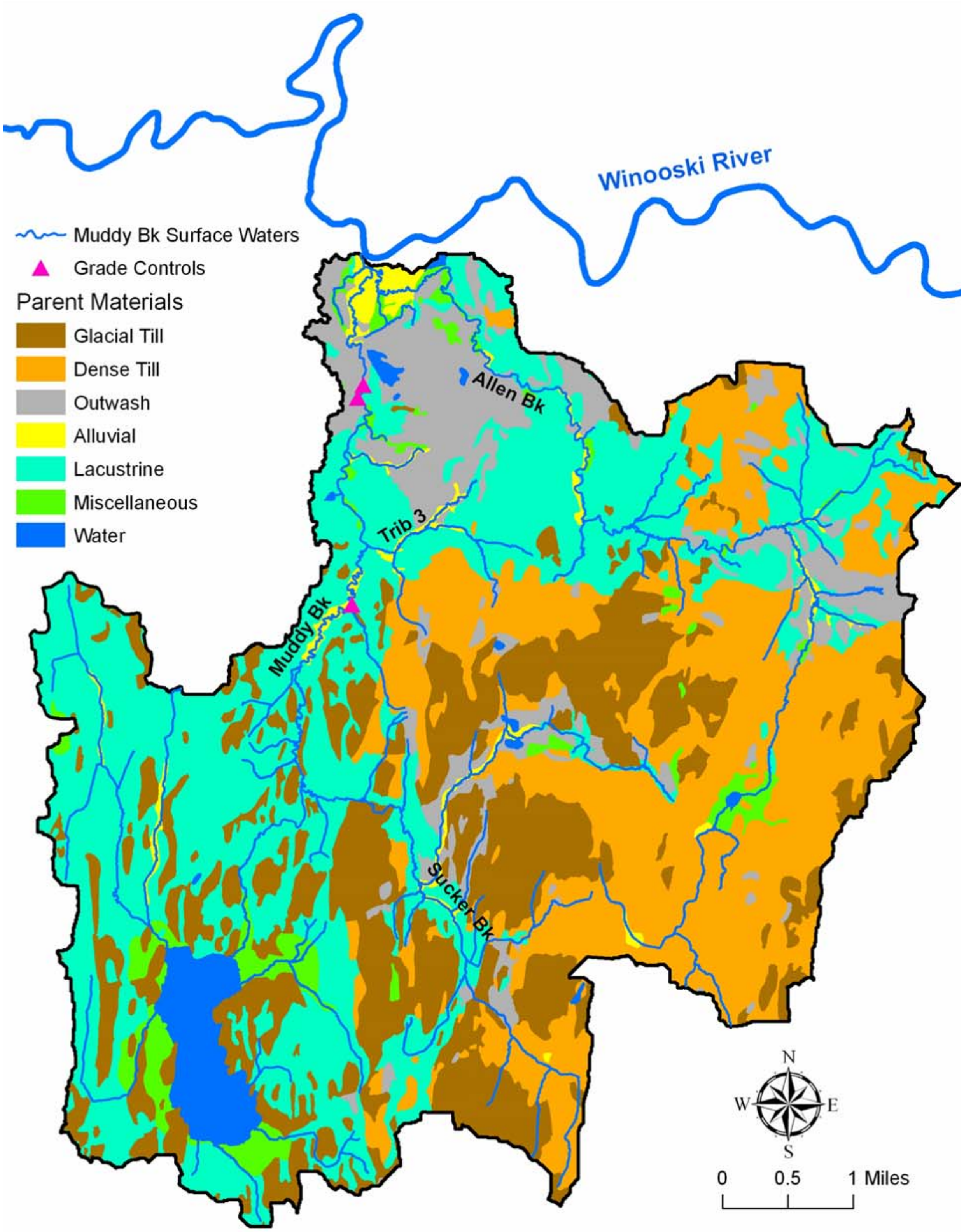


Figure 7. Parent material and natural grade controls in the Muddy Brook watershed.

Geomorphic Setting

The Muddy Brook watershed drains to the north into the Winooski River. A total of nine tributaries were identified during the Phase 1 assessment for data collection. Of these, two were selected for further Phase 2 assessment, and two were previously assessed as part of a separate study. Tributaries 2 and 3 were included in this Phase 2 study (in addition to the entire mainstem), and Allen Brook and Sucker Brook were assessed by FEA as part of past studies (FEA, 2007; FEA, 2008). Channel slope data for these subwatersheds are included below in Table 2.

Table 2. Average Channel Slopes for Mainstem and Tributary Channels Assessed for Phase 2.

Channel (SGA Reaches)	Average Slope
Muddy Brook Mainstem (M01 – M21)	0.3%
Allen Brook (T1)	1.0%
Tributary 2 (T2)	0.6%
Taft Corners Tributary (T3)	1.2 %
Sucker Brook (T5)	2.8%

The Muddy Brook mainstem (Reaches M01 – M21) has an overall channel slope of 0.3%, and a majority of the reaches are found in unconfined valley settings with alluvial and lacustrine deposits present in the floodplains. With the exception of a series of high gradient reaches in the lower watershed in the vicinity of Route 2, most of the mainstem reaches are highly sinuous by reference with fine bed substrate. In the upper watershed above and below Shelburne Pond, beaver activity is abundant and has a strong influence on the hydrology and physical habitat of the channel.

Allen Brook enters the Muddy Brook within the floodplain of the Winooski River. The Allen Brook mainstem channel has an overall channel slope of 1.0%, however, the lower reaches near the confluence share similar characteristics with Muddy Brook due to the alluvial and outwash material dominating the Winooski floodplain. Further information about the geologic and geomorphic background of Allen Brook can be referenced on the RMP online Database Management System (DMS). Two small tributaries enter the mainstem in the lower watershed (T2 and T3), draining urbanized watersheds to the east. Although the average mainstem channel slope downstream of I-89 is approximately 0.7%, cobble dominates the bed substrate for 5 of the 7 reaches. T2 and T3 are generally low gradient by reference with fine bed substrate and unconfined valley settings. Farther upstream, Sucker Brook enters the mainstem channel just west of St. George Road at river mile 6.6. Sucker Brook is higher gradient, found mainly within till soils with an overall channel slope of 2.8%. Further information about the geologic and geomorphic background of Sucker Brook can also be referenced on the DMS.

2.3 Ecological Setting and Hydrology

Ecological Setting

The Muddy Brook watershed is found within the Champlain Valley (CV) biophysical region (Thompson and Sorenson, 2000). The CV region extends from just north of Rutland up to the Canadian border, and is bound to the west by Lake Champlain and to the east by the foothills of the Green Mountains. The CV is much warmer and somewhat dryer than the other biophysical regions of the state. In South Burlington the average temperature is 45 degrees Fahrenheit and the average annual rainfall is 36.1 inches (NOAA, 2008b). As discussed above in the summary of the geological setting, the CV has been shaped by the presence of Lake Vermont and the Champlain Sea, leaving behind fine grained soils rich in calcium and well suited for agriculture. As such, much of the CV, including the Muddy Brook watershed, was extensively developed for agricultural uses during its original settlement in the 1700's and 1800's.

Very few areas of the original plant communities that occupied the CV exist today, as most were cleared for agriculture. Three forest types, in addition to the beaver meadows common along the Muddy Brook channel, likely occupied the watershed: 1) Sandplain forest: areas of coarse alluvial and outwash substrate in the lower watershed likely supported forests with white pine, pitch pine, oaks, and red maple; 2) Clayplain forest: in the upper watershed around Shelburne Pond where heavy lacustrine clays are found, the forest was likely comprised of red maple, beech, white ash, and various species of the white oak subfamily; 3) Northern Hardwood: in the upland areas where till soils are found, the forest was likely comprised of maple, birch and beech trees.

Elevations within the watershed range from 200 feet at the confluence with the Winooski River, up to approximately 1,160 feet in the headwaters of Sucker Brook in St. George. Extensive wetlands occupy large areas within the watershed along the mainstem, especially in the upper watershed above the I-89 crossing (NWI, 2003). Within the vicinity of Shelburne Pond, large wetlands with recurring beaver activity are common. Downstream of the crossing of Route 116, wetlands within the floodplain continue to be extensive, however the impact of beaver activity within these areas becomes less prevalent downstream of Van Sicklen Road. From this point downstream to the I-89 crossing, the channel maintains a highly sinuous planform with extensive wetlands found adjacent the channel that are accessible as floodplains during larger runoff events. Downstream of the I-89 crossing, large tracts of wetlands have been impacted or filled to make way for commercial and industrial land development. Along Tributary 3 there are still large, contiguous stretches of wetlands found within the stream corridor, providing critical floodplain area within the urban mosaic. Along the lower mainstem and Allen Brook, large wetlands are found adjacent to the channel within the Winooski floodplain.

Hydrology

No flow gauging data exists for the mainstem of Muddy Brook, but the USGS recently installed a real-time flow monitoring station on Allen Brook at the Route 2A crossing. The gauge has been in operation for 3 years and therefore provides limited insight into the magnitude of flow-frequency data. In order to provide some hydrologic context for the current study, average flow values for each month of the year were derived for Muddy Brook from the available Allen Brook discharge data. Allen and Muddy Brook watersheds share similar land use and soil characteristics (See Table 1), and can generally be expected to have similar hydrologic regimes. Average monthly discharges were normalized by drainage area to develop the data in Figure 8 for Muddy Brook.

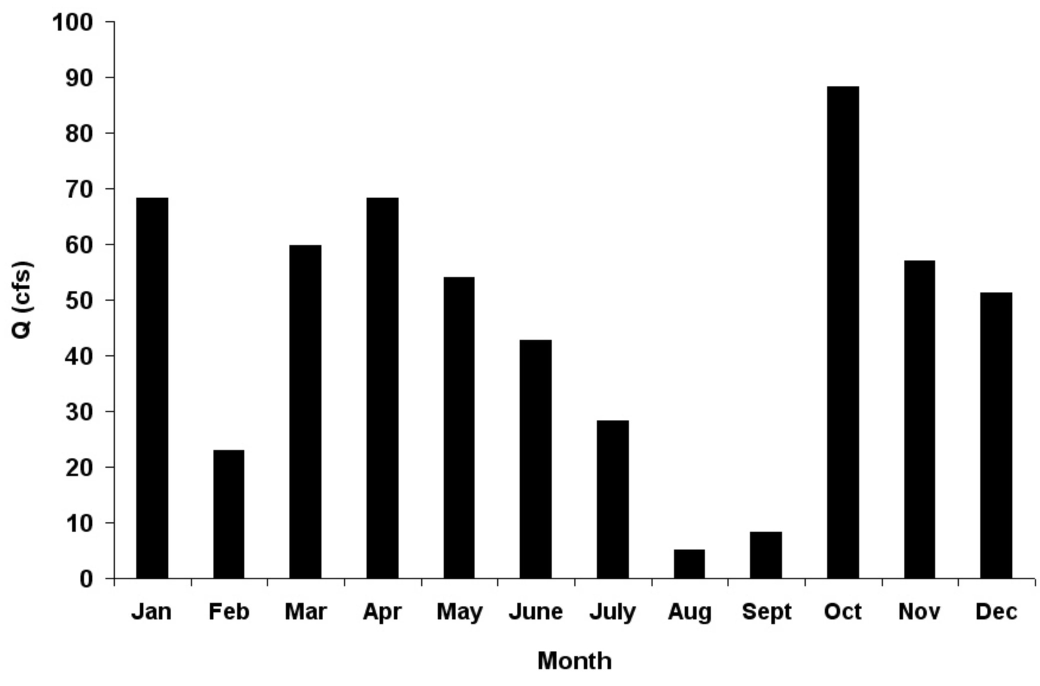


Figure 8. Average discharge data for Muddy Brook based on 3 years of record for Allen Brook. Data were normalized by drainage area.

2.4 Channel and Floodplain Management History

No historical records of gravel dredging or mining were found during Phase 1 research and data collection. This is not surprising given the predominantly sand substrate found within most reaches. While there is some gravel in the lower watershed, it is found within confined reaches that would have made it practically inaccessible.

A review of historic aerial photography reveals that channel straightening occurred within many reaches, especially in the upper watershed upstream of Shelburne Pond. Below Shelburne Pond there are few areas where obvious channel straightening had occurred, despite the land being cleared for agriculture right up to the channel banks in many reaches. Channel straightening and bank armoring in this area may have been limited by the ongoing presence of beavers and the wet meadows adjacent the channel that would have made these lands marginal for tilling and agriculture. Areas of the channel below Shelburne Pond where channel straightening was clearly associated with agriculture include Reach M07 and M10 (Figure 9).

Figure 9. Historical channel straightening north of I-89 (left) and south of Van Sicklen Road (right) as seen in aerial photography from 1962.

3.0 Data Collection

3.1 Data Collection Methods

The Vermont River Management Program (RMP) has invested many person-years of effort into developing a state-of-the-art system of Stream Geomorphic Assessment (SGA) protocols. The SGA protocols are intended to be used by resource managers, community watershed groups, municipalities and others to identify how changes to land use affect hydro-geomorphic processes at the landscape and reach scale, and how these changes alter the physical structure and biotic habitat of streams in Vermont. The SGA protocols have become a key tool in the prioritization of restoration projects that will 1) reduce sediment and nutrient loading to downstream receiving waters such as Lake Champlain and the Connecticut River, 2) reduce the risk of property damage from flooding and erosion, and 3) enhance the quality of instream biotic habitat. The protocols are based on defensible scientific principles and have been tested widely in many watersheds throughout the state. Data collected for the Muddy Brook watershed using the protocols will form the basis for preliminary project identification carried out during future River Corridor Planning efforts.

The SGA protocols include three phases (VTANR, 2007a):

- **Phase 1**: The Phase 1 SGA approach utilizes the Stream Geomorphic Assessment Tool (SGAT), a GIS extension developed by RMP for the collection of reach and watershed scale data. In addition to the GIS and remote sensing effort, a cursory field assessment (“windshield survey”) is included for the verification of stream and valley forms, significant channel features and the location of man-made infrastructure. The Phase 1 SGA approach results in watershed-scale data about the landscape (e.g., soils and land cover) and the stream channel (e.g., slope and form), providing a basis for understanding the natural and human-impacted conditions within the watershed. The SGA data also aids in the identification of specific stressors affecting the physical conditions of the stream channels and structures (e.g., bridges and culverts). Table 4 summarizes the parameters collected in Phase 1 using the Feature Indexing Tool (FIT), which include those utilized to develop the final impact ratings.

- **Phase 2**: The Phase 2 approach builds upon Phase 1 data through the collection of reach-specific data about the current physical conditions. Characterization of reach conditions utilizes a suite of quantitative (e.g., channel geometry, pebble counts) and qualitative (e.g., pool-riffle habitat) measurements to calculate two indices: Rapid Geomorphic Assessment (RGA) Score; Rapid Habitat Assessment (RHA) score. Using the RGA scores in conjunction with knowledge about the background or "reference" conditions, a sensitivity rating is developed to predict the degree to which the channel will adjust to human impacts in the future. Table 3 summarizes the parameters collected and verified in Phase 2 using the Feature Indexing Tool (FIT).

Table 3. Parameters Collected with FIT

Phase 1 Step	Phase 2 Step	Data Type	Impact	Sub-Impact
3.1	**1.2**	Point	Alluvial Fan	NA
3.2	**1.6**	Point	Grade Control	Dam Ledge Waterfall Weir
NA	**3.3**	Point	Mass Failure	NA
5.5	**5.5**	Point	Dredging	Dredging Gravel Mining Commercial Mining
NA	**4.4**	Point	Debris Jam	NA
NA	**4.6**	Point	Stormwater Input	NA
NA	**4.9**	Point	Beaver Dam	NA
NA	**5.2**	Point	Migration	Neck Cut Off Flood chute Avulsion Braiding
NA	**5.3**	Point	Steep Riffle or Head Cut	Head Cut Steep Riffle
NA	**5.4**	Point	Stream Crossing	Stream Ford Animal Crossing
NA	**3.3**	Point	Gully	NA
6.2	**1.3**	Line	Development	NA
6.1	**1.3**	Line	Encroachment	Berm Improved Path Road Railroad
5.3	**3.1**	Line	Bank Armoring or Revetment	Rip-Rap Hard Bank Other
7.2	**3.1**	Line	Erosion	NA
5.4	**5.5**	Line	Straightening	Straightening With Windrowing

- **Phase 3**: Phase 3 surveys involve the collection of detailed, reach-scale survey data to verify or build upon Phase 2 data. These surveys are typically carried out prior to project development for an "active" channel management approach (e.g., floodplain restoration), or for long-term monitoring purposes.

FEA used SGAT to develop the baseline data layers for the watershed. The remaining Phase 1 data were collected remotely and with windshield surveys for the 32 reaches along 24.4 river miles. All major human impacts and natural features were indexed in a GIS using the Feature Indexing Tool (FIT).

3.2 Phase 1 & 2 Quality Assurance

The RMP Quality Assurance (QA) protocols outlined in the SGA protocols (VTANR, 2007) were followed in order to ensure a complete and accurate dataset. FEA and RMP shared responsibility for QA for the SGAT shapefiles and the finalized Phase 1dataset. All metadata describing the data sources were entered in the Data Management System (DMS), with extraordinary sources noted in the comments section in Step 7. Three separate QA reviews were completed by RMP staff following the completion of Steps 2 and 7 of Phase 1, and Steps 1 through 7 of Phase 2. A written record of the QA issues raised by RMP, and responses from FEA is included in Appendix C. The DMS database for all reaches was finalized in December, 2008.

4.0 Results

The following section presents the results of the Phase 1 and 2 SGA data for Muddy Brook. Section 4.1 summarizes watershed-scale stressors on the physical stability and habitat conditions of the brook. Section 4.2 summarizes reach-scale conditions, stressors and, for applicable reaches, project identification information specific to the reach. Reach-scale data from the Phase 2 observations are provided as summary sheets in Appendix B. Reaches for which no Phase 2 data were collected (not assessed in field) have no summary sheets included, however data collected for banks and buffers (Step 3) are found in the DMS. Bed substrate histograms, plots of channel cross sections, and photographs are provided in Appendices E, F, and G respectively on a separate CD.

4.1 Watershed-Scale Stressors

The following is a discussion of stressors on the hydrologic and sediment regimes of the Muddy Brook watershed. The mapping of physical stressors and natural or human constraints for both regimes allows for 1) a process-based approach to understanding stream conditions at different scales, and 2) an evaluation of the connectivity of stressors along the channel network.

4.1.1 Hydrologic Regime Impacts

The following description of the hydrologic regime of a watershed, and the general response to watershed-scale land use changes and stressors is included from the most recent version of the VTANR River Corridor Planning Guide (VTANR, 2007b).

> The hydrologic regime may be defined as the timing, volume, and duration of flow events throughout the year and over time. The hydrologic regime may be influenced by climate, soils, geology, groundwater, watershed land cover, connectivity of the stream, riparian, and floodplain network, and valley and stream morphology. The hydrologic regime, as addressed in this section, is characterized by the input and manipulation of water at the watershed scale and should not be confused with channel and floodplain "hydraulics," which describes how the energy of flowing water affects reach-scale physical forms and is affected by reach-scale physical modifications (e.g., bridges modify channel and floodplain hydraulics).
>
> When the hydrologic regime has been significantly changed, stream channels will respond by undergoing a series of channel adjustments. Where hydrologic modifications are persistent, the impacted stream will adjust morphologically (e.g., enlarging when stormwater peaks are consistently higher) and often result in significant changes in sediment loading and channel adjustments in downstream reaches.

The Muddy Brook watershed contains a mixture of land cover types (Table 1), including significant amounts of agricultural land cover (mostly in the upper watershed). The watershed has a low to moderate degree of impervious cover (6.7%), below levels typically associated with degraded stream conditions at the national level (CWP, 2003), but above the 5% impact threshold noted in urbanizing watersheds in Chittenden County (Fitzgerald, 2007). Vertical and lateral channel adjustments caused by upslope urbanization have been shown to be a significant source of fine sediment loading in watersheds around the world (Trimble, 1997; Simon and Rinaldi, 2006), and are known to have a deleterious effect on aquatic biota in Vermont (Fitzgerald, 2007). Due to ongoing channel adjustments in Chittenden County watersheds in response to urbanization, VTANR asserts that endogenous sources of sediment (e.g., channel bed and banks) far outweigh the exogenous sources (e.g., colluvial and runoff-generated) in the stormwater-impaired watersheds of Vermont (VTDEC, 2006). Although the Muddy Brook watershed is not listed as stormwater-impaired on the 303(d) list, it has a level of impervious cover consistent with other small watersheds in the county that are impaired by stormwater, and it does not meet the aquatic life use standards for Class B waters. With these impacts in mind, total impervious area (TIA) values, a surrogate metric for

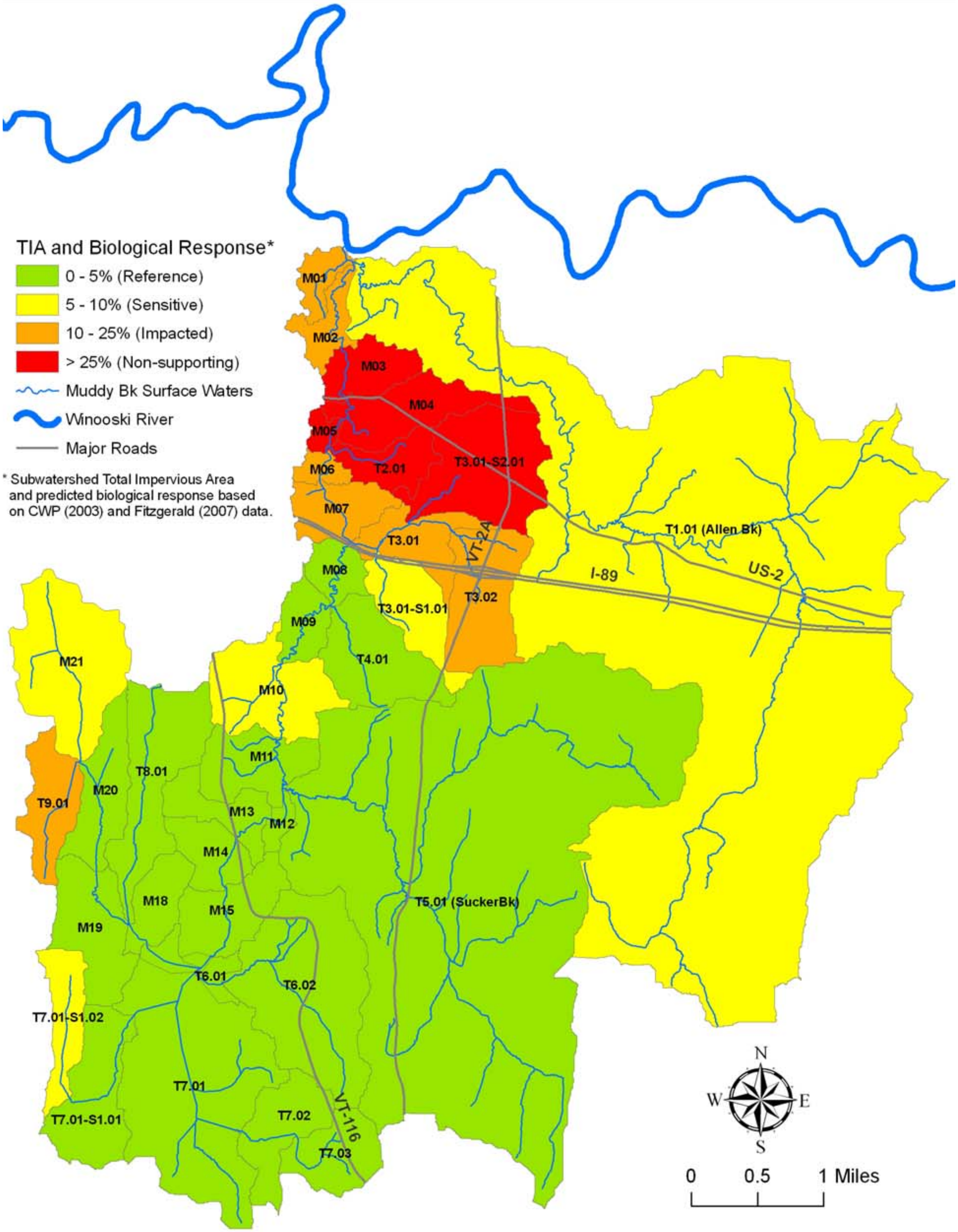


Figure 10. TIA values for Muddy Brook subwatersheds.

urbanization that has implications for biological integrity, have been summarized for the Muddy Brook study subwatersheds (Figure 10).

With the exception of T9.01, none of the subwatersheds in the upper watershed have TIA values greater than 10%. Subwatershed T9.01 drains a residential neighborhood but the channel was not assessed for Phase 2 data. The remaining reaches of the upper watershed are characterized by agricultural land uses with limited residential development and large tracts of conserved lands around Shelburne Pond. The lower watershed is highly urbanized, with all subwatershed TIA values exceeding 10% and 5 out of 11 subwatersheds having TIA values exceeding 25%. In addition, there are greater stormwater input densities in the lower watershed. Table 4 summarizes ranked stormwater input densities for all reaches with values exceeding 5 inputs per stream mile, all of which were found in the lower watershed.

Table 4. Stormwater input densities for reaches with values exceeding 5 inputs per stream mile.

Segment	Length	Stormwater Inputs (SI)	SI per mile
M03	2,400	9	20
T3.01-A	1,147	4	18
T3.01-D	902	2	12
M04	1,434	3	11
M05	1,478	3	11
M07	3,300	6	10
T3.01-C	1,223	2	9
T3.01-F	642	1	8
T3.02-A	1,372	2	8
T3.01-B	773	1	7
T2.01-A	1,712	2	6
M01	883	1	6
T3.02-B	2,763	3	6

The combination of increased runoff volumes from impervious cover and more efficient conveyance of this runoff via man-made drainage infrastructure results in an increase in frequency of channel forming flow events. These conditions typically result in channel processes that upset the fluvial geomorphic equilibrium of alluvial streams, causing channel incision and decreased floodplain access. Channel incision ratios of greater than 1.4 were observed in multiple reaches in the lower watershed, and are indicative of stage II of channel evolution where floodplain access is severely reduced.

4.1.2 Sediment Regime Impacts

The following description of the sediment regime of a watershed, and the general response to watershed-scale land use changes and stressors is included from the most recent version of the VTANR River Corridor Planning Guide (VTANR, 2007).

> The sediment regime may be defined as the quantity, size, transport, sorting, and distribution of sediments. The sediment regime may be influenced by the proximity of sediment sources, the hydrologic regime, and valley, floodplain and stream morphology. Understanding changes in sediment regime at the reach and watershed scales is critical to the evaluation of stream adjustments and sensitivity. The sediment erosion and deposition patterns, unique to the equilibrium conditions of a stream reach, create habitat. In all but the most dynamic areas (e.g., alluvial fans), they provide for relatively stable bed forms and bank conditions.

The current day stressors to the Muddy Brook sediment regime have been mapped using the variables extracted from the Phase 2 field dataset, and the percent of agricultural cropland within each subwatershed (Figure 11). Four classes of percent cropland were mapped to depict the relative impact of sediment delivery from agricultural lands at the reach and watershed scales. In addition, depositional and migration features mapped during the Phase 2 assessments are included to depict areas of increased vertical and lateral channel adjustments due to aggradation. Mass failures and bank erosion (as a percentage of the total reach length) depict where sediment delivery is occurring from the channel boundaries.

In the upper watershed there are sources of sediment from overland flow due to extensive croplands, especially in the subwatersheds draining to Shelburne Pond. Further evidence of the long term effect of fine sediments high in phosphorus impacting the trophic state Shelburne Pond is provided in Appendix D. Despite the high degree of sediment delivery to the channel and the Pond in the upper watershed, very few areas of increased deposition and channel migration were noted above the Van Sicklen Road crossing. Below this crossing, migration features were present in Reaches M09 and M08; however these were associated with beaver activity.

In the lower watershed below the I-89 crossing, the number of depositional features and the degree of instability in the channel boundaries increases in a downstream direction. This is evident in Figure 11 for all mainstem reaches downstream of M07. Despite the relatively low degree of cropland in the lower watershed, vertical and lateral channel adjustments resulting from aggradation of sediment are occurring due largely to three

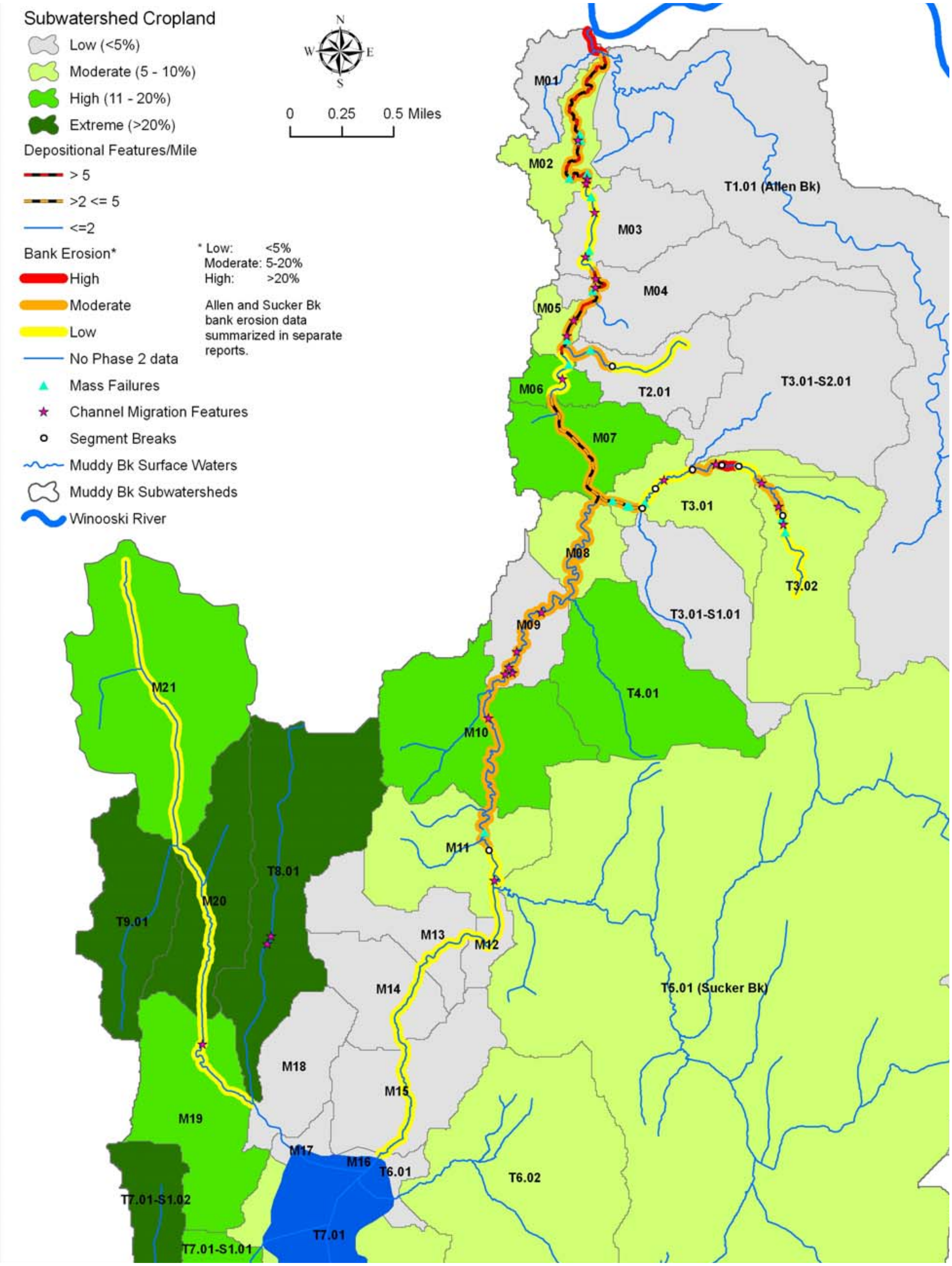


Figure 11. Muddy Brook watershed sediment load indicators.

key processes: 1) increased sediment delivery to the mainstem from the highly urbanized tributaries draining the Tafts Corners area (T2 and T3) from headcutting and gullying. Note, that the depositional features per mile on the mainstem are high downstream of both tributary confluences; 2) increased incision within the lower mainstem reaches, likely due to increased runoff from impervious surfaces, is resulting in unstable channel banks and multiple mass failures; 3) reaches M03 through M06 are currently in advanced stages of channel evolution (stages III and IV), resulting in lateral migration and further instability in the channel boundaries.

4.2 Reach-Scale Data

4.2.1 Phase 1 Reference Stream Types

Thirty-two (32) reaches were identified for assessment during the Phase 1 analysis. Remotely collected data of valley confinement, channel slope, and sinuosity were used to develop reference stream types for the assessed reaches according to the Rosgen (1994) and Montgomery and Buffington (1997) classification systems. Characterization of reference stream types is based on the channel forms and processes we would expect in a particular geologic and geomorphic setting without human influences. Windshield surveys were conducted in May of 2008 to confirm, where possible, the initial classifications. Table 7 presents the results of the Phase 1 stream classifications.

Table 5. Reference Stream Type Characteristics for Muddy Brook Watershed

Stream Type	Valley Confinement	Channel Slope	Sinuosity	Bedform	Number of Study Reaches*
A	Confined	> 4%	Low	Cascade or Step-pool	0 (0%)
B	Confined	2 – 4%	Low	Step-pool or Plane bed	3 (9%)
C	Unconfined	< 2%	Moderate	Riffle Pool	6 (19%)
E	Unconfined	< 2%	High	Riffle Pool or Dune-Ripple	23 (72%)

Note: Does not include data for Allen and Sucker Brooks collected as part of separate studies.
* Percentage of total in parentheses.

As previously noted, most of the reaches in the middle and upper watershed are very low gradient, sinuous streams with fine bed substrate. These stream types, classified as E under the Rosgen system, represent 72% of the total reaches assessed during Phase 1. Six

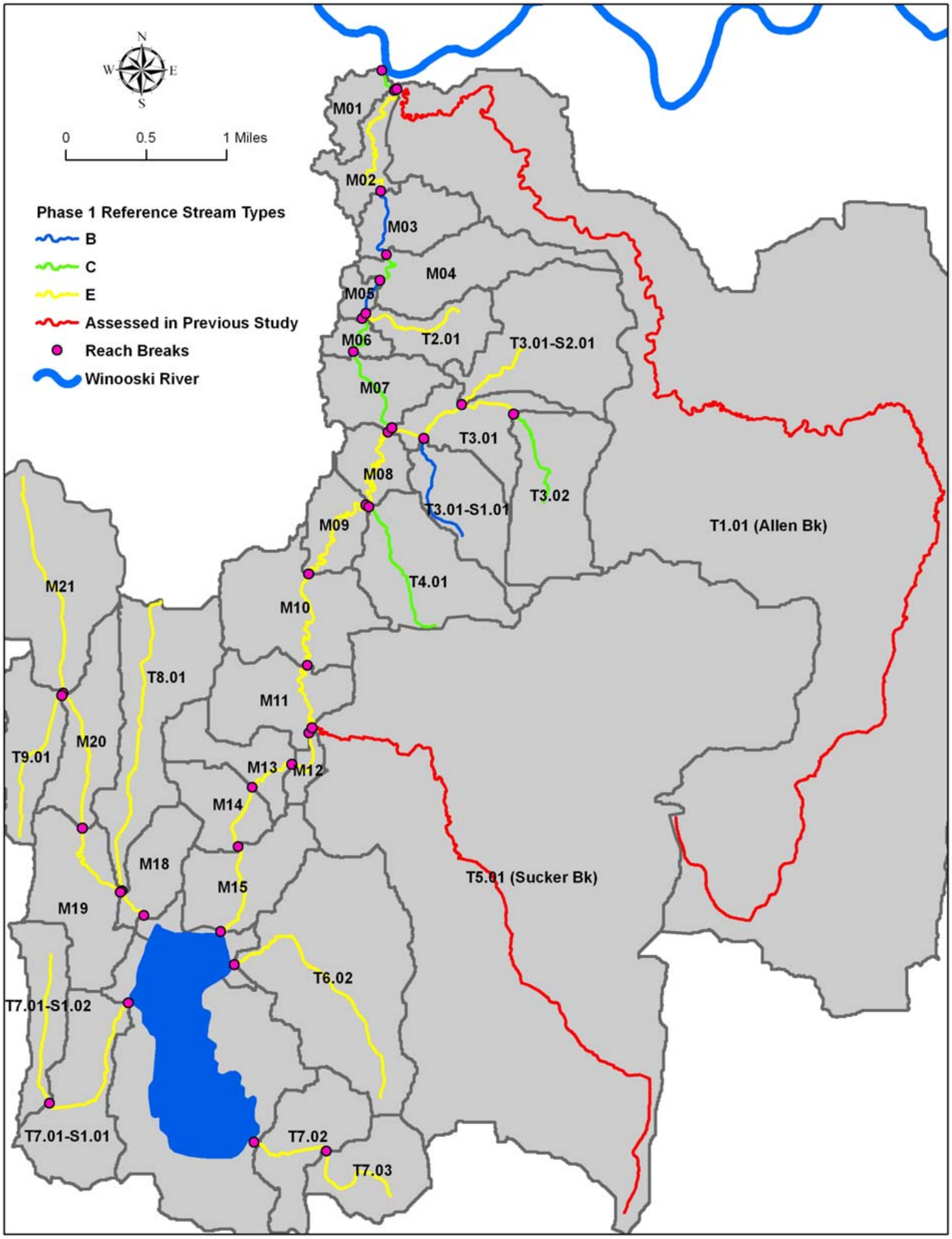


Figure 12. Phase 1 Reference Stream Types.

reaches in the watershed are C-type under reference conditions. This stream type is typically characterized by a moderately sinuous channel found in a broad, unconfined valley setting with a balance between the upslope sediment supply and the transport capacity. Only three of the reaches are characterized by steep channels in confined valley settings (B-type) that are dominated by sediment transport processes. Figure 12 depicts the spatial distribution of the stream types across the watershed.

4.2.2 Phase 2 Reach Summaries

From the Phase 1 assessments 23 reaches were chosen for further Phase 2 data collection. This included 20 reaches on the mainstem, two on T3, and one on T2. Table 6 presents data specific to all areas in the watershed assessed for Phase 2 data as part of this or previous projects.

Table 6. Mainstem and Major Tributary Summary Data

DMS ID	Name	Watershed Area (square miles)	Assessed River Length (mi)*	Number of Phase 2 Assessed Reaches*
M	Muddy Mainstem	31.9	11.6	19
T1	Allen Brook	11.2	12.4	12
T2	Unnamed Tributary	0.2	0.7	1
T3	Taft Corners Tributary	1.9	1.7	2
T5	Sucker Brook	7.4	6.4	11

* Allen and Sucker Brook data previously collected in past studies.

The following is a technical summary of the Phase 2 observations used to document key geomorphic processes and adjustments occurring in the Muddy Brook watershed at the reach scale.

Mainstem Reaches

M01

Reach M01 is found from the confluence with the Winooski River up to the confluence with Allen Brook (Figure 13). The reach is 883 feet long and has an overall channel slope of approximately 0.2%. The broad valley setting, moderate entrenchment ratio (ER = 3.7), and moderate width-to-depth ratio (WDR = 15.2) indicated C-type channel geometry (Rosgen, 1994), with dune-ripple bed morphology (Montgomery and Buffington, 1997). The backwater from the Winooski in high flow events has caused a substantial amount of fine sand and silt deposition throughout the reach. Bank erosion spanning 30% of the right bank and 10% of the left has had a significant impact on the sediment load, because the banks are largely non-cohesive (Figure 14). The low slope of the reach and high sediment load has helped form several prominent point bars with elevations about one-half of the bankfull height. Allen Brook (T1.01) drains an area of over 10 sq. miles and contributes greatly to the observed discharge and width of the first reach.


Figure 13. The confluence of Muddy Bk. with the Winooski


Figure 14. Bank erosion on the right bank 10'h x 150' l

The substrate distribution reflects the high degree of sedimentation observed in this reach. The bed was dominated by sand (53%), with fines and silts (35%) also present. Down-cutting and the resulting incision ratio on the reach (IR = 1.9), has shifted the sediment balance and initiated vertical channel evolution processes (CEM stage II). The continued degradation and incision due to historic channel straightening is responsible for the channel's unstable state (RGA condition "fair"). It is likely that the channel will continue to incise and form new bar features on a lower terrace as it regains its stability. The combined effect of the sand substrate and limited supply of large woody debris (LWD = 30 pieces / mile) has greatly reduced the available habitat diversity (RHA condition "fair"). The degradation of the channel has eliminated almost all of the pools that would normally complement the point bars.

M02

From the confluence with Allen Brook (T1.01), reach M02 extends upstream 5,570 feet until the valley becomes confined just southeast of the Burlington Airport. The channel is set in a very broad valley, which has been subject to current and historic agricultural activities. The channel slope is very low (0.2%), and the entrenchment (ER = 13.1) and width-to-depth ratios (WDR = 7.7) are both indicative of E-type channel geometry. Throughout the reach the bedform was predominantly dune-ripple, although some riffle-pool formations were observed. Bank erosion was abundant along the boundaries, with 21% and 15% of the channel eroded on the left and right banks, respectively. Moderately high incision (IR = 1.6) was noted at the cross section. The extent of the channel erosion was not limited to the banks; a head cut was observed several hundred feet upstream of the National Guard Avenue channel crossing. There, a more cohesive clay conglomerate provides temporary vertical stability, halting the migration of the 0.5-foot head cut (Figure 15). Three mass failures were also observed on the right banks of the upper-reach where the channel was continuous with valley wall. The soft sand texture of the exposed slope provides little resistance to the power of the channel (Figure 16).


Figure 15. 0.5-foot head cut (picture taken upstream)


Figure 16. Mass failure on the right bank 40'h x 70'

Historically this reach has been straightened, encompassing about 20% of the channel's length. The recent incision and down-cutting have resulted from the increased runoff from upslope urban land use, resulting in increased channel slope. The bank instability observed throughout the channel may also be attributed to beaver activity. Many mature silver maples (*Acer saccharinum)* that were once rooted on the near-channel banks were felled by beavers, and only the stumps remain today. Historically aerial photos from 1937 and 1962 show dense tree cover (albeit limited in width) along the lower part of the reach. Changes in planform from degradation processes and some widening in the upper portion of the reach make this channel unstable and actively incising (CEM stage II; RGA condition "fair"). Given recent and historical changes in morphology the channel is largely disconnected from its floodplain. The channel bed is primarily composed of sand (57%) and silt (21%) substrate. The down-cutting and excess sediment loading has filled deep pools and limited the availability of epifaunal substrate cover. With these features lacking the overall integrity of fish and bethic invertebrate habitat is limited (RHA condition "fair"). The woody debris density is higher than in M01 (62 piece/mile) and many of the downed silver maple trees remain in the channel.

Project Identification
The corridor of this reach is currently undeveloped. Given the channel adjustment processes in response to historic straightening, protection of the stream corridor should be high priority. In addition, the lack of woody debris (due to adjacent agricultural land use and nearby beaver activity) in the channel has likely contributed to additional vertical instability. In the lower areas of the reach where the headcut was observed, the reintroduction of LWD downstream of the area with straightening could be an effective intervention strategy.

M03
M03 begins at a sharp change in confinement southeast of the Burlington Airport and extends upstream until the reach break at the Williston Road culvert. The channel is 2,578 feet in length and it has the highest slope of all the mainstem reaches on Muddy Brook (3.0%). Given the high slope the geomorphic processes are largely transport-based. The entrenchment (ER = 2.1) and width-to-depth ratios (WDR = 20.5) indicate B-type channel geometry with step-pool bedform features. The reach is set in a semi-confined valley, well buffered on both sides by mixed forests. However, the texture of the steep banks is mostly sand in the lower reach, making erosion risks high. Two large bedrock cascades are found mid-reach one after the other (Figure 17). Each grade control rise approximately 8 feet above the height of water. These grade controls, along with the coarse substrate make this channel stable with limited vertical channel adjustments (Figure 18).


Figure 17. Step-pool bedform with grade control


Figure 18. The first of two bedrock grade controls

The substrate composition is mostly cobble (45%) and boulder (29%). The higher slope of this reach prevents the aggradation of fine sediment, transporting it down to reaches M02 and into the Winooski River. Several springs percolate into the channel from the adjacent karst side slopes of this reach, providing a thermal buffer for aquatic invertebrates. Many Plecopteran exoskeletons (Family *Perlidae*) were observed on the cobble substrate. Having more cover and overall habitat types this reach appeared relatively healthy (RHA condition "good"). In the lower reach the increase in runoff and power due to upslope urbanization has resulted in the erosion of some of the step-pool bed features. Similarly, the increase in upslope runoff has caused some minor widening in the upper reach. The changes in morphology on the lower and upper ends of the reach have resulted in an unstable geomorphic stability rating for the reach, but the grade controls limit further vertical adjustment (RGA condition "fair;" CEM stage I).

M04

M04 is a short reach, 1,434 in length, extending from Williston Road up to a change in confinement east of Gregory Drive. As a result of the low channel slope (0.2%), the reach is dominated by depositional processes. The channel is set in a broad valley and has typical C-type channel geometry (ER = 11.6; WDR = 17.5; Figure 19). The floodplain connectivity is good throughout this reach, but the deposition of coarse and fine sediment has begun to shift the channel's planform. A high density of large depositional features was observed on this channel (22 features/mile), along with a two migration features. The larger of the two features is a flood chute that receives about of one-third of the channel's bankfull flow and diverts it into the left corridor before reentering downstream of the first large channel bend (Figure 20). The right side of the channel had approximately 15% of its bank eroded and the left had a mass failure, adding significantly to the amount of sediment loading to the channel.


Figure 19. Cross section with typical C-type geometry


Figure 20. The upstream end of the large floodchute

The substrate composition of the stream channel was distributed normally with a slight skew to the coarser-sized material. The bed was predominately cobble substrate (46%), with slightly less coarse gravel (22%). There was a large extent of sedimentation of fine material that was not accurately depicted in the sediment distribution. Throughout the reach large cobble substrate was embedded by fines, inhibiting the viable habitat of the channel's interstitial pore space in the hyporheic zone. The frequency of riffles and pools, and velocity and depth patterns were reference giving the reach relatively healthy habitat structure for aquatic organisms (RHA condition "good"). The erosion and sediment deposition associated with the abundance of point, side, and mid-channel bars indicates the channel is changing its planform and widening in response to increase sediment load and stream power (RGA condition "fair"). The widening processes appear to be decreasing due to changes in planform, indicating stage IV channel evolution.

M05

M05 has an unusual combination of low slope (0.5%) and confined valley setting. The channel exhibits B-type geometry (ER = 2.1; WDR = 21.1) despite the low slope, and channel extends 1,478 miles from the change in confinement along Gregory Drive to approximately 400 ft. upstream of the Marshall Avenue crossing. The channel has plane bed morphology, with little variation in cross section (Figure 21). The corridor is well buffered along both sides with dense mixed tree and herbaceous cover. The reach has one culvert crossing where the channel passes under Marshall Ave (Figure 22). This structure is at grade and is amply sized

Figure 21. Plane bed channel bedform

Figure 22. Culvert crossing at Marshall Ave.

to accommodate large storm events. The input of Tributary 2 is directly upstream of the culvert. The tributary's down-cutting and incision supply fine sediments to the upper reach. Several bar features were observed (15 features/mile), including a large island bar. The confined setting and low slope has made aggradation the primary geomorphic process in this reach. The substrate depositing on side and mid-channel bars was large in size, 5.0 and 9.0 inches respectively. This suggests that the channel still generates enough stream power to transport coarser substrate in high flow events. The pebble count histogram shows cobble to be the dominant substrate, with 53% of the distribution within that size class. Woody debris was common through the reach, often getting snagged on boulders protruding from the channel (LWD = 50 pieces/mile). The channel's potential to form large bar features, aggrade substrate, and change its planform without any areas of incision suggests stage IV of the CEM (RGA condition "fair"). The plane bed morphology has limited the velocity and depth patterns in the reach, greatly reducing the habitat (RHA condition "fair").

M06

Reach M06 begins upstream of Marshall Avenue and extends up until the confinement changes slightly east of Community Drive. The channel is 1,701 feet in length and has a slope of 0.2%. The entrenchment (ER = 2.8) and width-to-depth ratios (WDR = 14.9) are indicative of C-type channel geometry with riffle-pool bedform. The bedform and channel morphology are consistent with the measurements on the upper and lower ends of the reach, but mid-reach the channel changed slightly. The channel in this section became widened, deep, and slow-moving. No segmentation was done for this reach because the slow-moving area was only small a fraction of the entire channel, and it has remained in this state since the early 1960's. A large pool was noted at the upstream end

Figure 23. Ponding observed mid-reach

Figure 24. High embeddedness and filamentous algae

of the slow-moving area. This pool was approximately 80 feet wide and its bottom was comprised of silt and sand deposits (Figure 23). It is likely that this section of the reach is a result of a slight change in slope too small to be observed on the topographic maps. The deposition of fine sediment was not limited to the ponded region; upstream, high amounts of fine particles of silt were completely covering green filamentous algae (Figure 24). This greatly reduced the habitat condition of the reach (RHA condition "fair"). The coarse bed substrate supports some macroinvertebrate life, but the conditions were only suitable for net-spinning trichopterans who utilize the suspended fine sediment for nutrition. Given the noted morphology of the system the stream channel remains stable (RGA condition "good"). From historical photos it appears that the channel has changed very little over the last 45 years. The channel has been kept in stage III of channel evolution and does not have enough upslope stream power to transition to a later stage. The coarse substrate in the reach has also helped stabilize this reach. The upper and lower portions are dominantly cobble substrate (50%) and fine gravel (12%). The adjacent corridor has changed little in terms of vegetative composition. The channel has been starved of debris (LWD = 12 pieces/mile), limiting the channel from advancing in the channel evolution process.

M07

M07 extends from the reach break to just upstream of the Interstate-89 crossing at the confluence with Tributary 3. The channel is 3,300 feet in length and "gentle gradient," meaning the slope value could not be accurately discerned from the topographic maps. A wide range of features were observed in the field, making this reach interesting with respect to its history. Much of this reach has been historically straightened, resulting in plane bed morphology and a higher diameter substrate due to increased stream power (Figure 25). The reach is currently aggrading fine sediment, but still can be characterized by E-type channel geometry with plane bed bedform (ER = 6.5; WDR = 9.4). Many areas of the middle section of the reach are wide and deep, and appeared canal-like with little flow (Figure 26). On the upstream end near I-89 the riparian buffer width is less than 25 feet and over 500 feet of the corridor have been encroached upon by the roadway. This could be helping the channel remain stable in this very unusual state. Under reference conditions we would expect an E-type channel with gravel substrate and riffle-pool morphology.


Figure 25. Plane morphology with coarse substrate


Figure 26. Stream channel that is deep and canal-like

Cobble comprised 52% of the total substrate composition, despite the channel's E-type geometry. Similar to M06, the slow conditions of the reach caused algal growths on rocks that inevitably became covered with brown silt and detritus. The habitat condition was highly reduced because the limited channel sinuosity (1.0), pool variability, and pool substrate all received low scores (RHA condition "fair"). There was limited woody debris (LWD =17 pieces/mile) on this reach because the near banks are dominated by shrubs and sapling species. The historical straightening has left this channel in stage III of the CEM and its extremely low slope will make it difficult for the channel to further adjust to develop a healthy floodplain. The channel is stable but has departed from its reference state, resulting in a reduced score for the geomorphic assessment condition (RGA condition "fair").

M08

From the lower reach break, M08 extends 4,712 feet upstream to a change in confinement in a densely wooded area. The channel is set in a very broad valley and has characteristic E-type geometry with dune-ripple bedform. The reach slope is "gentle gradient" and the channel is highly sinuous (sinuosity = 1.8). The entrenchment ratio (ER = 12.0) is consistent with the assigned channel type. There is an undersized culvert on downstream end of this reach where the access road to a large quarry crosses the channel. The bottom of the culvert has been scoured out by the channel, which could lead to failure of the structure in the future. It also has a debris jam on the upstream end which may lead to road damage and channel instability (Figure 27). Immediately downstream of the culvert the maximum pool depth is 6.0 feet and the right stream bank is extremely eroded where the channel bends sharply to the left. The upstream end of the reach is slightly ponded from a beaver dam built on a bedrock grade control (Figure 28). This impoundment backs up water into reach M09 but it has not significantly altered the channel dynamics.

Figure 27. Debris jam inside the undersized culvert

Figure 28. Beaver pond on the upstream end of the reach

The corridor is well-buffered and mostly forested, except on the left bank in the lower reach where it is impacted from the quarry. Because of the highly wooded corridor, debris jams (3 total) and LWD (40 pieces/mile) are found throughout the reach. This has created good habitat for fish and other aquatic fauna (RHA condition "good"). Like M03, this reach has several cold spring inputs entering from the adjacent slopes, which lower the stream temperature significantly and help to maintain baseflows in summer months. The substrate is predominantly silt (73%) and sand (18%), making excellent dune-ripple formations in areas behind woody debris. The reach is quite stable, exhibiting reference planform and geometry, with some minor incision in the upper and lower reach (RGA condition "good").

Project Identification

The channel is largely stable throughout this reach with the exception of the area around the Quarry Road culvert. This culvert is severely undersized (25% of bankfull channel width) and is causing severe scour and bank erosion downstream. In addition, the debris jam in the culvert and rusting throughout threaten its integrity in the near future. This structure should be considered high priority for replacement.

M09

M09 extends for 5,197 feet starting at the slight change in valley confinement to just downstream of Van Sicklen Rd. The reach has a gentle gradient; it is highly sinuous, and well connected to its floodplain throughout. Channel geometry data, such as the width-to-depth ratio (WDR = 5.8), are indicative of a reference E-type channel with dune-ripple bedform. The sand upper banks were non-cohesive and easily erodible, providing the channel with a moderate sediment load and frequently undercut banks. A total of 7.0% of the left bank and 4.0% of the right banks were eroded, mostly on the outside of meander bends. Several point, side and island bars were observed, consistent with the planform and morphology of this stream type. An old bridge abutment found mid-reach was causing erosion and channel migration (Figure 30). Other areas had minor channel migration that was caused by old beaver dams that have since failed.

Figure 29. Old bridge abutment that has failed.

Figure 30. A native mussel *Elliptio complanata*

The corridor of this well-buffered reach is vegetated by small shrubs, saplings, and herbaceous plants. These species lack the rooting strength necessary to prevent changes in planform and widening, which were the two major geomorphic adjustments taking place on this reach. Lack of terracing and incision suggests that this channel is in stage I of the CEM (RGA condition "good"). The undercut banks and abundance of LWD (59 pieces/mile) also make the habitat condition "good". The bed is comprised mostly of silt substrate (82%), with some sand (10%). The habitat conditions present in this reach were ideal for a freshwater mussel known as the eastern elliptio (*Elliptio complanata*; Figure 29). This species had a wide range of habitats including river, stream, and lake systems. Recently, the *E. complanata* has been increasingly impacted by competition from the invasive zebra mussel (*Dreissena polymopha)*. Zebra mussel's will foul the native mussel's habitat and greatly increase the risk of mortality (Hallac and Marsden, 2001). This reach and others in Muddy Brook act as an important refuge for these native mussels.

Project Identification

The channel is stable with good floodplain connectivity, with the exception of the area around two old bridge abutments mid-reach. The abutments are causing erosion and bifurcation of the channel. Given that the stream crossing is no longer in use, removal of the abutments should be a medium-to-high priority project.

M10

Reach M10 is found from the confluence of a small tributary just below the Van Sicklen Road crossing up to a slight change in confinement where a small tributary enters from the west. The reach has a length of 4,338 feet and has a "gentle gradient" slope classification. The channel has moderately-high sinuosity (1.4), and the entrenchment ratio (ER = 8.7) is consistent with an E-type channel classification. Many areas of reach are incised from past straightening and removal of riparian vegetation (i.e. lack of LWD inputs). Bank erosion was observed throughout the lower reach (Figure 31) and many areas of failing rip-rap indicate that adjacent agriculture fields were protected in the past from lateral migration.

Figure 31. Bank erosion in lower reach.

Figure 32. Cross-section in M10

Channel incision was noted in the cross-section (IR = 1.4; Figure 32) and the bankfull indicators at this level were very consistent throughout the reach. Incision is likely a result of the combined impacts of channel straightening and removal of riparian vegetation. Limited large woody debris observed in the channel (LWD = 45 pieces/mile) is leading to decreased fine sediment attenuation (e.g., bar formation), leading to further incision. However, the cohesive lower clay banks and bed limit the rate of further channel incision, causing the channel to be held in stage II of CEM. Due to the reduced floodplain access and moderate degree of bank erosion, the reach received an RGA rating of "Fair". Quality habitat in the reach is limited by the lack of a healthy riparian buffer, the areas of straightened channel which lack pool formation, and increased sedimentation from bank erosion. The reach received an RHA score of "Fair".

Project Identification

With the exception of the downstream end of this reach, the stream corridor is currently undeveloped. Given the channel adjustment processes in response to historic straightening, protection of the stream corridor should be high priority. In addition, the lack of woody debris (due to adjacent agricultural land) in the channel has likely contributed to additional vertical instability. In the lower areas of the reach where a residential property has encroached upon the channel, the riparian buffer has been reduced to lawn, and there are numerous areas of unstable channel boundaries. Riparian plantings in these areas would aid in restoration of physical and ecological conditions.

M11-A

Reach M11 was segmented due to ponding from a beaver dam mid-reach at a change in channel confinement. Segment M11-A is found from the reach break with M10 up to a change in confinement where a beaver dam is currently found. Segment M11-B was only assessed for Step 3 data (banks and buffers). M11-A has a length of 1,885 feet and has a "gentle gradient" slope classification. M11 also has moderately high sinuosity (1.4), and the high entrenchment ratio (ER = 24.7) is consistent with an E-type channel classification. Unlike downstream reach M10, there is no evidence of past straightening; however, channel incision was evident throughout. Greater amounts of wood are present in channel (LWD = 103 pieces/mile) because some larger trees and saplings are found along the banks (more than in M10).

Figure 33. Cross-section in M11-A.

Figure 34 Failed old farm crossing in lower M11-A.

A level of channel incision consistent with that observed in M10 was noted in the cross-section (IR = 1.4; Figure 33). As in M10, incision may have resulted from the removal of riparian vegetation, among other impacts when the adjacent floodplain was used for agriculture. The cohesive lower clay banks and bed limit the rate of further channel incision; however a high degree of slumping on the outer bends was noted on the upper banks which are composed of non-cohesive sands. Due to the reduced floodplain access and moderate degree of bank erosion and widening, the reach received an RGA rating of "Fair". Biological habitat in M11-A is reduced due to the lack of a healthy riparian buffer and increased sedimentation from bank erosion (RHA = "Fair").

**M11B, M12, M13, M14,
M15, M16, M17 & M18**

These reaches were not assessed following the complete SGA Phase 2 protocol because they were extensively impounded by beaver activity. The "gentle gradient" conditions extend from the segment break at M11B upstream until M18 the first reach above Shelburne Pond (Figure 35). However, the riparian banks, buffers, and corridor analyses were conducted for these reaches using a combination of field observations (entire corridor walked or canoed where possible) and the 2004 high resolution aerial photographs. M16 and M17 were not assessed because they are found within Shelburne Pond and are not part of the fluvial system.

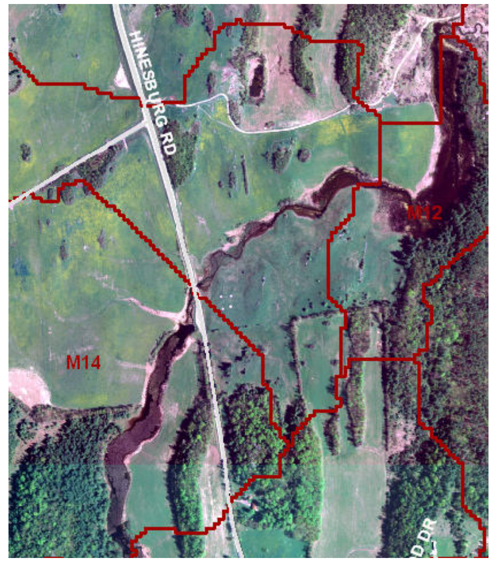


Figure 35. Extent of ponding on M12-M14

M19

Reach M19 was not assessed because of property restrictions, but observations made from the downstream end of reach M20 (Figure 36) and using the high resolution aerial photos revealed several areas of concern. The reach extends a length of 3,294 feet from the downstream ponded area on M18 to the ecotone between forest patch and field south of Cheese Factory Road. The entire reach has experienced extensive historical channel straightening for agricultural purposes. Currently, at a mild bend two thirds of the way up the reach the channel flows both into the straightened portion of the channel and into the historic channel to the west (Figure 37). The majority of the land within the corridor is currently used as grazing land for a dairy herd, and it is likely that the cows graze in the channel. This was not confirmed in the field because of property access was not granted.

Figure 36. The straightened channel along the fence row

Figure 37. Straightening in M19

M20

M20 is 4,962 feet in length and extends from the pasture clearing about 400 feet south of Cheese factory Road up to the reach break at the confluence with Tributary 9. The channel exhibits E-type channel morphology with dune-ripple bedform. The channel slope (0.3%) and sinuosity are low. Downstream of the Cheese Factory Road culvert the channel has been straightened with windrowing which limits its floodplain access (Figure 38). The bermed feature on the left bank is approximately 1-foot above the normal bankfull height. Upstream of the crossing the channel has good access to its floodplain and exhibits excellent E-type channel geometry. The riparian zone throughout the reach is buffered by herbaceous grasses and incoming successional seres. Upstream of the Dorset St. crossing the channel is slightly incised and entrenched in what appears to be a historic farming ditch (Figure 39). This portion of the reach was not worthy of segmentation because of the low stream power and short length.

Figure 38. Straightened channel with windrowing

Figure 39. Channel downstream of confluence with T9

The channel is largely stable in between Cheese Factory Road and Dorset Street and the dominant processes at work in the reach are natural changes in planform (CEM stage I; RGA condition “good”). The habitat condition in this reach is “good”. There is a wide variety of pool sizes, steep banks that have overhanging vegetation, and ample baseflow. However, woody debris (20 pieces/ mile) is not regularly abundant in this channel because the surrounding corridor is mostly herbaceous vegetation or a mixture of shrubs and samplings. Most of the debris was noted in the small stretch of the channel that goes through a more developed forest.

Project Identification

The straightening in the lower reach (~400 feet) and into M19 has likely led to increased sediment and nutrient transport to Shelburne Pond. A berm adjacent the channel has disconnected the floodplain and inhibited the channel from regaining sinuosity. Removal of the berm and reintroduction of LWD could encourage the redevelopment of sinuosity and planform. In order to assess the viability of this active restoration option more information about the condition of the downstream reach (M19) would be needed. Additionally, the limited stream power of this reach due to the small drainage area combined with the cohesive clay soils may be a limitation to natural redevelopment of channel sinuosity.

M21

The final reach of the mainstem reaches extends 7,589 feet from the reach break at the confluence with T9 to the ending point upstream of the Vermont National Country Club golf course. The channel exhibits E-type channel geometry, but the low slope (0.3%) in this headwater reach has led to ponding in several areas (Figure 40). Given the small drainage area of the reach and low slope there are little geomorphic processes at work, and the floodplain remains connected and swampy. Downstream of the first driveway there are two relic culverts (Figure 41). The culverts seem to be made from old steel farm equipment tires and long timbers, presumably put in place by farmers to gain access to their fields. The upslope golf course might be a source for both nutrients and sediment to the channel. Accounts from nearby residents recall the channel responding quickly during and after the construction of the course. Dense algae blooms and the sedimentation of ponded areas are now common in the headwaters of this brook.

Figure 40. Ponded area downstream of a driveway

Figure 41. Culvert channel crossing clogged with debris

The substrate is predominately sand (80%) with some fines and silt (20%). The low slope and small drainage area (0.21 sq. mi) makes this reach inactive from a geomorphic standpoint. However, a slight degree of degradation was observed in areas downstream of culverts as well as some fining in ponded areas. The entire reach was most likely a farm ditch, trenched to concentrate the diffuse flow across what was once land used for agriculture. The overall geomorphic state is stable, but in "fair" condition because of this historical change in planform. The channel seems to lack the power needed for it to continue through the channel evolution process (CEM stage II).

Tributary Reaches

T2.01-A

Reach T2.01 drains a highly urbanized subwatershed from the commercial-industrial district along Shunpike Road. The reach was segmented approximately 850 feet upstream of the Marshall Avenue crossing due to a large beaver pond (Figure 42). Segment T2.01-A is found from the confluence with the mainstem at the Kimball Avenue crossing up to the beaver pond. The segment has a length of 1,712 feet and a channel slope of 0.6%. With the exception of an extensively armored area in the lower segment along Kimball Avenue, the reach has a sinuous planform with sand substrate. The width-to-depth ration (WDR = 5.9) and entrenchment ratio (ER = 7.3) support an E-type classification.


Figure 42. Ponding behind beaver dam at segment break.


Figure 43 Bank erosion above Marshall Ave. crossing.

Severe incision was noted in the lower reach where armoring is not present. A headcut (1.9 feet) is located approximately 30 feet below the Marshall Avenue crossing and has led to a large debris jam. Some bank erosion immediately below the culvert outfall may be resulting from the undersized culvert and the limited sediment continuity through the structure (see further discussion in section 4.3 and Table 7). Channel incision and bank erosion upstream of Marshall Avenue (Figure 43) may be related to past beaver ponding and deposition of sediment behind the dams. Due to the vertical channel instability and limited habitat due to sedimentation of the pools and reduced channel sinuosity, the RGA and RHA scores were “Fair”.

Project Identification

The headcut found downstream of the Marshall Avenue crossing has the potential to migrate upslope and endanger the 30 inch culvert. A debris jam has formed downstream, and the limited bank armoring protecting some bank failure downstream of the crossing has eroded into the channel. Given the limited stream power for this reach due to the small drainage area, the headcut does not appear to be migrating rapidly upslope. However the increased urbanization in the upslope watershed makes the stabilization of this feature a high priority.

T2.01-B

T2.01-B was not completely assessed because of beaver activity impounding the entire segment. Only the corridor characteristics were noted because the segment lacks any geomorphic processes typical of a fluvial system.

T3.01-A

T3.01-A begins at the confluence with M07 just downstream of the Interstate-89 crossing and extends 1,147 feet upstream ending due east of the Brownell Road. The reach was segmented because the bed substrate and channel dimensions change upslope of the road crossing. The segment has a broad valley type, which is partially encroached upon by I-89. The channel geometry is indicative of an E-type channel (ER = 7.6 & WDR = 7.0), but scour (IR = 1.25) associated with the encroachment and straightening along I-89 has led to plane bed channel morphology (Figure 44). The incision of the channel has been slowed by the presence of clay that is not easily eroded. The segment has experienced some bank erosion on both the left and right banks, and there are two mass failures on the right bank where the channel has slumped material off from the adjacent side slope. Along I-89 a drainage culvert has been scoured out by overland flow coming off the highway (Figure 45). The culvert is held in place by a slab of concrete that has been undermined and the gully has the potential to recede towards the highway in the near future.

Figure 44. E-type channel with plane bed morphology

Figure 45. Interstate drainage eroding around a culvert

The substrate found in this segment is predominately fine, with silt and clay comprising 76% of the pebble count. The encroachment and straightening associated with the interstate has caused the channel to be in stage II of the CEM. The geomorphic condition rating is “fair,” because large storm events are able to push aggraded sediment through the channel, readily shifting the thalweg. Only in areas where woody debris has been lodged are changes in planform occurring. As more debris gets lodged securely in the channel, the planform could begin to shift and the channel could move through the evolution process. There were few viable habitat features observed in this reach. The “fair” habitat is indicative of the plane bed morphology and lack of riffle-pool features expected in a channel in this setting.

Project Identification

The stormwater outfall from I-89 highlighted in Figure 45 is a moderate sediment source, with potential to worsen if not addressed in the near future. A small gully beneath the pipe is receding upslope towards the northbound lane, and road fill is being eroded into the channel.

T3.01-B

T3.01-B extends 773 feet from the segment break east of Brownell Rd. up to a large active beaver dam near the industrial building. This segment was delineated due to changes in planform to highlight differences in floodplain connectivity between it and the downstream segment. T3.01-B is set in a very broad valley and it has good access to its floodplain throughout. Following its reference stream type, the channel has E-type geometry and dune-ripple bed form. The right corridor has been encroached upon heavily in the lower segment by the fill associated with Brownell Road, however a wide floodplain is found along the left banks in this area. One large mass failure was present on the left bank mid-segment (Figure 46). This feature was the result of a historic beaver dam that diverted water into the adjacent side slope. Several other partially intact beaver dams were observed in this segment, providing great catch points for debris accruement (11 debris jams/mile).

Figure 46. Mass failure on left bank (mid-segment)

Figure 47. E-type channel with lots of woody debris

The reach was composed mostly of silt (60%) and sand (35%), forming excellent dune-ripple features spaced approximately every 90 feet. The abundance of large woody debris (107 pieces/mile), undercut banks, and refuge areas made habitat readily available (Figure 47; RHA condition "good"). The channel is greatly stabilized by the abundance of woody debris and does not have any signs of incision, indicating stage I of the CEM. The channel has some alterations in planform (i.e. an active flood chute off the left bank resulting from past beaver activity) but its geomorphic state is stable (RGA condition "good"). However, it is likely that this channel may be occupied by beavers in the future since the low gradient segment upstream has been dammed recently.

T3.01-C

T3.01-C was not completely assessed because of beaver activity impounding the entire segment. Only the corridor characteristics were noted because the segment lacks any geomorphic activity typical of a fluvial system.

T3.01-D

From just downstream of the entrance driveway to an industrial park off Marshall Ave., this segment extends upstream 1,223 feet to the next break. This segment has been greatly influenced by sediment transported downstream from a large headcut in T3.01-E. The channel geometry is indicative of E-type geometry with dune-ripple morphology. The lower section of the channel near the road crossing has some channel stability with limited floodplain access. Mid-segment there is a high degree of overbank deposition of sands and silts and many depositional features exceeding one-half of bankfull elevation (Figure 48). The upper end of the segment becomes incised (IR = 1.7) approaching the gully created by the headcut (Figure 49). In addition to the aggradation of sediment from the segment above there is an input from within T3.01-D. One meander bend was highly eroded on the outer bank as the increase stream power from the upslope drainage area's impervious surfaces cut through the lacustrine sediments.

Figure 48. Aggradation of sediment mid-segment

Figure 49. Incised channel on upper end of the segment

The segment is unstable due to increased sedimentation from upslope. The sediment that has been deposited in the channel feels soft underfoot, with saltation observed during low flows. The channel may be stabilized as woody debris attenuates in the margins and traps sediment (LWD = 52 pieces/mile). This is already happening in the lower reach, creating channel sinuosity. Because of this the channel was assessed as stage IV of the channel evolution model, and likely to become more stable as time goes on. The high degree of fine sediment traveling through the system has greatly reduced the available habitat in pools or coarser substrate (RHA condition “fair”). The geomorphic condition of this segment is “fair” as well, but with a total score of 28 it is very close to a poor rating.

T3.01-E

This segment was delineated to characterize a series of headcuts that have created a large gully through a field west of Harvest Lane (Figure 50). The segment is 445 feet long, with the gully encompassing about 30% of the segment’s total length. The segment extends upstream of the headcut location to account for the total length that would be at risk as the cut migrates towards the road. There were three definitive head cuts on this segment: 1) the primary headcut (furthest upstream) had a total height of 2.8’ (Figure 51); 2) the secondary cut (downstream) had a height of 0.7’; 3) the tertiary headcut (furthest downstream) had a height of 1.1’. Together, these features are active in cutting down through the lacustrine surficial materials to re-equilibrate the slope. The stressor that has most likely been responsible for this unstable state is the increase in stream power from the upslope urbanized drainage area (Taft’s Corners). The change in stream power has caused the channel to become deeply entrenched (ER = 1.6) and incised (IR = 2.5), representing G-type channel geometry.

Figure 50. The gully created by the three headcuts

Figure 51. The primary headcut

Using high resolution color aerial photographs and LiDAR-derived contours, we were able to discern the location of the head cut in 2004 when the imagery was flown. This means that the channel has migrated approximately 30 feet a year since 2004, and, if it continues at that rate, could endanger the culvert crossing at Harvest Lane in 5 to 8 years (Figure 52).

This segment is actively adjusting to accommodate increased runoff draining from the urban land use upslope. There is no viable habitat in this reach downstream of the primary headcut and limited channelized flow above (RHA condition "poor"). The gully is an excellent example of stage II of the channel evolution process. Degradation, aggradation, widening, and planform changes are all occurring on this segment simultaneously resulting in a "poor" geomorphic condition rating.

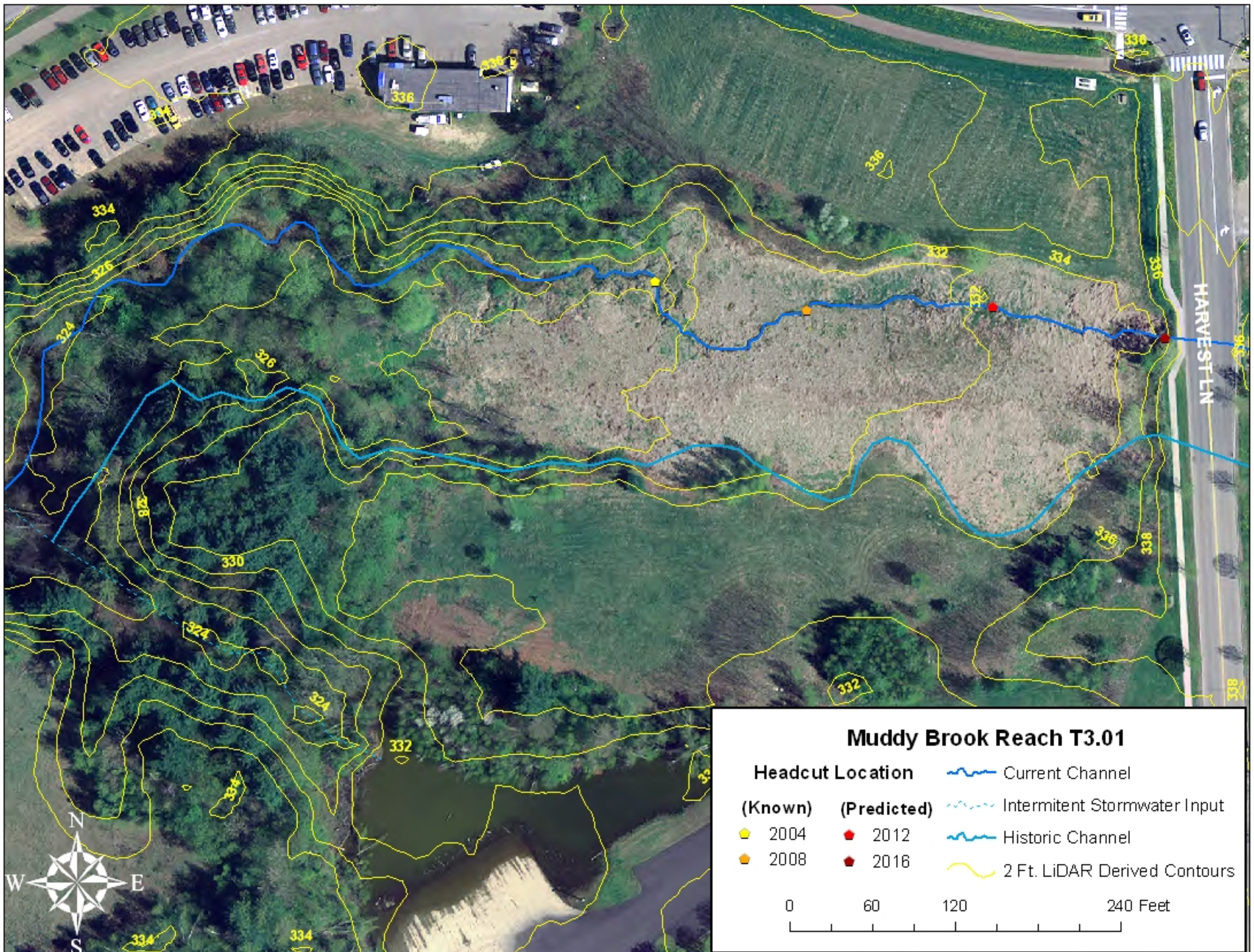


Figure 52. Head cut location

Project Identification

The channel will need to be stabilized in the near future (within 5 to 10 years) in order to avoid a conflict at the Harvest Lane crossing. In addition, large amounts of fine sediment are being exported from the channel and delivered to downstream reaches. A Phase 3 survey and alternatives analysis will likely be required to develop an appropriate restoration approach for this reach.

T3.01-F

T3.01-F begins just downstream of the Harvest Lane crossing and extends upstream 642 feet until the reach break at the change in substrate type and slope. The segment was delineated to distinguish between the area in immediate danger of the migrating head cut and areas upslope of the culvert. The channel has E-type geometry with dune-ripple bedform. In many places the channel appears braided and diffuse as it winds through the wetland. The segment is well vegetated on both banks with wetland species of sedges and cattails.

There are few features present in this segment to quantify. The channel's floodplain (wetland) is accessed easily, making this channel quite stable geomorphically (CEM stage I; RGA condition "good"). However, the variable flow conditions and the absence of pools limit the available habitat in this segment (RHA condition "fair").

T3.02-A

This segment begins at the reach break downstream of Harvest Lane and stops 0.25 miles upstream approximately 100 ft east of the northeast corner of the Home Depot Building. The reach was segmented because the valley confinement changes from very broad to semi-confined and the upslope segment becomes entrenched (Figure 53). The channel geometry is indicative of a C_b-type stream with riffle-pool bedform (Figure 54). T3.03-A has moderate sinuosity and is not entrenched (ER = 12.9). However, the width-to-depth ratio is lower than expected for this stream type, possibly resulting from the excess stream power associated with the flashy hydrologic regime of this subwatershed. The impact associated with land use changes becomes very evident in this segment. The sub-dominant buffer width is less than 25 feet on both the right and left bank. Also, erosion was common on the slight meander bends mid-reach with 10% of both the left and right banks eroded.

Figure 53. Wide unconfined valley type

Figure 54. Cross-section showing C_b-type geometry

This segment has a much higher slope than any of the segments in T3.01 and the coarser substrate size directly reflects that change. The bed substrate was comprised of coarse gravel (33%) and cobble (31%). The potential for woody debris to accumulate is low (LWD = 8 pieces/mile) because the surrounding vegetation is mostly shrubs, saplings, and herbaceous material. No major adjustment process stands out in this reach and its “fair” condition rating can be attributed to some degradation, aggradation, and changes in planform. The channel has a stage I evolution state because evolution processes have not fully developed. There was a good variety of epifaunal substrate small pools making the habitat condition “good”.

T3.02.B

This segment starts at a change in confinement to the east of Home Depot and extends 2,763 feet upstream to the terminal end of the reach. The flow path of this segment has been dramatically altered by the construction of the I-89 and surrounding developments. A culvert diverts the channel under I-89, emerging upstream along Route 2A where it is rip-rapped and forced to the side of the road. By reference this channel should exhibit B-type channel geometry with riffle-pool features, but the channel departed and currently exhibits G-type geometry. This departure is the result of a headcut that is working its way up the middle portion of the segment (Figure 55). The headcut has a total height of 2.8 feet and is the primary source of sediment aggrading in the downstream segment. Large amounts of fill from the construction of the highway and the berm along side of the Home Depot building greatly alter the valley’s confinement. Several mass failures were observed as a direct response to these impacts to the stream corridor (Figure 56). The eroding banks, and sediment derived from the down-cutting of the headcut will continue to increase the overall sediment load to the channel, decreasing viable habitat and geomorphic stability.

The higher slope observed in this segment combined with the influences from the surrounding development has greatly reduced the stability of the channel (RGA condition "fair"). As the headcut migrates upstream to the crossing of I-89, it is unlikely that the structure or the road would be jeopardized because of the extensive rip-rap protecting the downstream end of the culvert. Currently, the culvert is perched, with about 40 feet of large boulder-sized rocks within the channel and on both banks. The down-cutting of the migrating headcut and the export of sediment is typical of a channel found in stage II of the CEM.

Figure 55. The headcut found mid-segment

Figure 56. A mass failure observed on the left bank

The complete absence of wood in the riparian corridor and in the channel could be one factor in the reaches instability. An increase in wood could help hold back some of the sediment washing downstream. The lack of connectivity to the upper reach, epifaunal substrate cover and channel alteration has had a deleterious affect on the available habitat in this segment (RHA condition "fair"). With continued development and urbanization in this watershed, it is likely that the habitat condition will worsen.

Project Identification

As noted above, the heacut will not likely jeopardize the I-89 crossing due to extensive armoring. However, the extensive bank erosion and mass failures in highly unstable fill soils is severely increasing sediment (and likely phosphorus) loading to downstream reaches. Active stabilization measures may be warranted at this site, especially if adjacent properties are endangered by ongoing erosion. Resloping the steep banks and reintroducing LWD and engineered debris jams in some locations around the headcut could help stabilize the channel's lateral stability. However, this would need to be done secondarily after addressing the slope change at the headcut using an active restoration approach.

4.3 Structures Summary

The VTDEC Bridge and Culvert Assessment Protocol (VTDEC, 2007) was utilized to collect data for structures found on the selected Phase 2 reaches. The data was entered into the DMS, and summarized below in Table 7. Of the 16 structures assessed, only 7 accommodate 75% of the bankfull channel width. This width is typically cited in transportation design standards (MMI, 2008), and while it is not the 100% value recommended by VTANR, it represents a point of comparison for assessing compatibility of the structure with channel equilibrium conditions.

Structures that are incompatible from a bankfull width approach *and* causing significant upstream or downstream erosion include the following: M02, River Cove Road bridge; M08, Quarry Road culvert; M13, Route 116 bridge; T2.01-A, Marshall Avenue. Structures that have moderate to severe aggradation above or below that is threatening the long-term integrity of the structure include the following: M02, River Cove Road Bridge; T3.02-A, Harvest Lane (upstream crossing). These structures should be considered high-priority for replacement by town and state agencies.

Table 7. Summary of Stream Crossings.

Reach or Segment (Type)	Town	Road Name	Road Type	Stream Approach	Struct. Height (ft)	Struct. Width (ft)	Channel Width (ft)	Struct/Chan Width*	COMMENTS
M02 (Bridge)	South Burlington	River Cove Rd.	Gravel	Sharp Bend	10.5	26.0	50.0	**52%**	Bank erosion high in lower reaches due to deposition and migration associated with the proximity to the confluence with the Winooski River. Upstream bank armoring diameter too small and it is failing.
M03 (Culvert)	South Burlington	Williston Rd.	Paved	Naturally Straight	14.0	11.0	45.1	**24%**	Culvert has good structural integrity, and despite its small width it can handle large flood flows due to clearance. No major problems above or below.
M05 (Culvert)	South Burlington	Kimball Ave.	Paved	Mild Bend	16.0	16.0	40.0	**40%**	Very stable structure. Undersized compared to channel width, but adequate to accommodate high flows. No major problems above or below.
M07 (Bridge)	South Burlington	I-89 North Lane	Paved	Mild Bend	10.0	61.0	27.7	220%	No problems noted, the structure has adequate width and armoring upslope and down.
M07 (Bridge)	South Burlington	I-89 South Lane	Paved	Mild Bend	10.0	61.0	27.7	220%	No problems noted; adequate width and armoring upslope and down.
M08 (Culvert)	South Burlington	Quarry Rd. (just south of I-89 southbound lane)	Gravel	Sharp Bend	7.0	7.0	27.7	**25%**	Underside of the entire culvert is rusted and deteriorated. Debris jam forming inside upper end with potential to become much worse. Grossly undersized and causing scour and erosion below.
M10 (Bridge)	South Burlington	Van Sicklen Rd.	Paved	Mild Bend	5.1	31.5	17.5	180%	Bridge is fairly recent and has no noteworthy problems.
M13 (Bridge)	South Burlington	Route 116	Paved	Sharp Bend	5.1	12.0	33.2	**36%**	Structure appears to be undersized and causing minor scour on the upstream end from high flow events. Some erosion originates from road runoff.
M20 (Culvert)	Shelburne	Cheese Factory Rd.	Paved	Channelized Straight	7.3	5.5	6.0	92%	Culvert looks recently replaced and stable.

Reach or Segment (Type)	Town	Road Name	Road Type	Stream Approach	Struct. Height (ft)	Struct. Width (ft)	Channel Width (ft)	Struct/Chan Width*	COMMENTS
M20 (Culvert)	South Burlington	Dorset St.	Paved	Channelized Straight	6.0	6.0	6.0	100%	Culvert appears to be new, well armored around road bed, and stable.
T2.01-A (Culvert)	Williston	Private Driveway off Kimball Ave.	Gravel	Mild Bend	2.5	2.5	5.5	**45%**	Culvert is undersized but not causing significant deposition upstream or erosion downstream.
T2.01-A (Culvert)	Williston	Marshall Ave.	Paved	Naturally Straight	3.5	3.5	5.5	**64%**	Culvert as been obstructed in past by beaver dams but now has an aluminum collar on upstream end. High degree of bank erosion upstream and downstream, with a headcut (1.9 ft) located immediately downstream.
T3.01-A (Culvert)	Williston	S. Brownell Rd.	Paved	Sharp Bend	8.5	8.5	19.8	**43%**	Upstream end of culvert is at the confluence of the main tributary channel (T3.01-B) and T3.01-S1 which could pose a problem in the future due to sediment and debris deposition from backwater conditions.
T3.01-D (Culvert)	Williston	Private Driveway off Marshall Ave.	Paved	Sharp Bend	6.0	9.0	11.0	82%	Recently installed culvert (<5 years old) associated with commercial driveway off Marshall Ave. Channel and structure are stable with no major problems.
T3.01-F (Culvert)	Williston	Harvest Ln. (downstream crossing)	Paved	Mild Bend	3.0	4.0	4.0	100%	Just upstream (250') of headcut in downstream segment. Headcut migrating at ~35 feet per year.
T3.02-A (Culvert)	Williston	Harvest Ln. (upstream crossing)	Paved	Channelized Straight	5.0	5.0	11.8	**42%**	Low slope of the culvert has cause sediment to aggrade on the upstream end near the outfall of the Home Depot retention basin

***** Bolded values are structure widths less than 75% of the bankfull channel width

4.4 Fluvial Erosion Hazard Zones

For study reaches where Phase 2 data was collected, FEA developed the Fluvial Erosion Hazard (FEH) zone of the Muddy Brook and selected tributary reaches. The FEH corridor and reach-specific ratings were developed using the Stream Geomorphic Assessment Tool (SGAT) and the DEC FEH approach (VTANR, 2008). The FEH corridor width is determined by the inherent sensitivity of the reach to adjustments (i.e., lateral migration) and the current condition of reach stability as determined through the Phase 2 field surveys. The reach-specific ratings, as outlined in Table 8, determine the corridor width needed to accommodate fluvial geomorphic equilibrium conditions. The corridor may then be used by municipalities to develop strategies that will reduce property loss and infrastructure damage from flooding and erosion. Further background information about the FEH approach is provided the DEC publication "Municipal Guide to Fluvial Erosion Hazard Mitigation" (VTDEC, 2007).

Table 8. FEH Ratings and Corridor Widths Based on Typical Setting and Impact

Sensitivity Rating	Corridor Width in Relation to Reference Channel Width	Typical Setting & Impact
Very Low	Equal	Steep, bedrock or boulder-bottomed stream with no impacts
Low	Two (2) channel widths	Steep, bedrock or boulder-bottomed stream with limited human impacts
Moderate	Four (4) channel widths	Moderate gradient stream with limited human impacts
High	Six (6) channel widths Eight (8) channel widths for E-type streams	Low to moderate gradient stream with limited to moderate human impacts
Very High	Six (6) channel widths Eight (8) channel widths for E-type streams	Low to moderate gradient stream with high human impacts
Extreme	Six (6) channel widths Eight (8) channel widths for D and E-type streams	Severe departure from reference conditions; Stream types with high natural sensitivity

Figures 57 and 58 depict the draft FEH zone for selected reaches in the watershed.

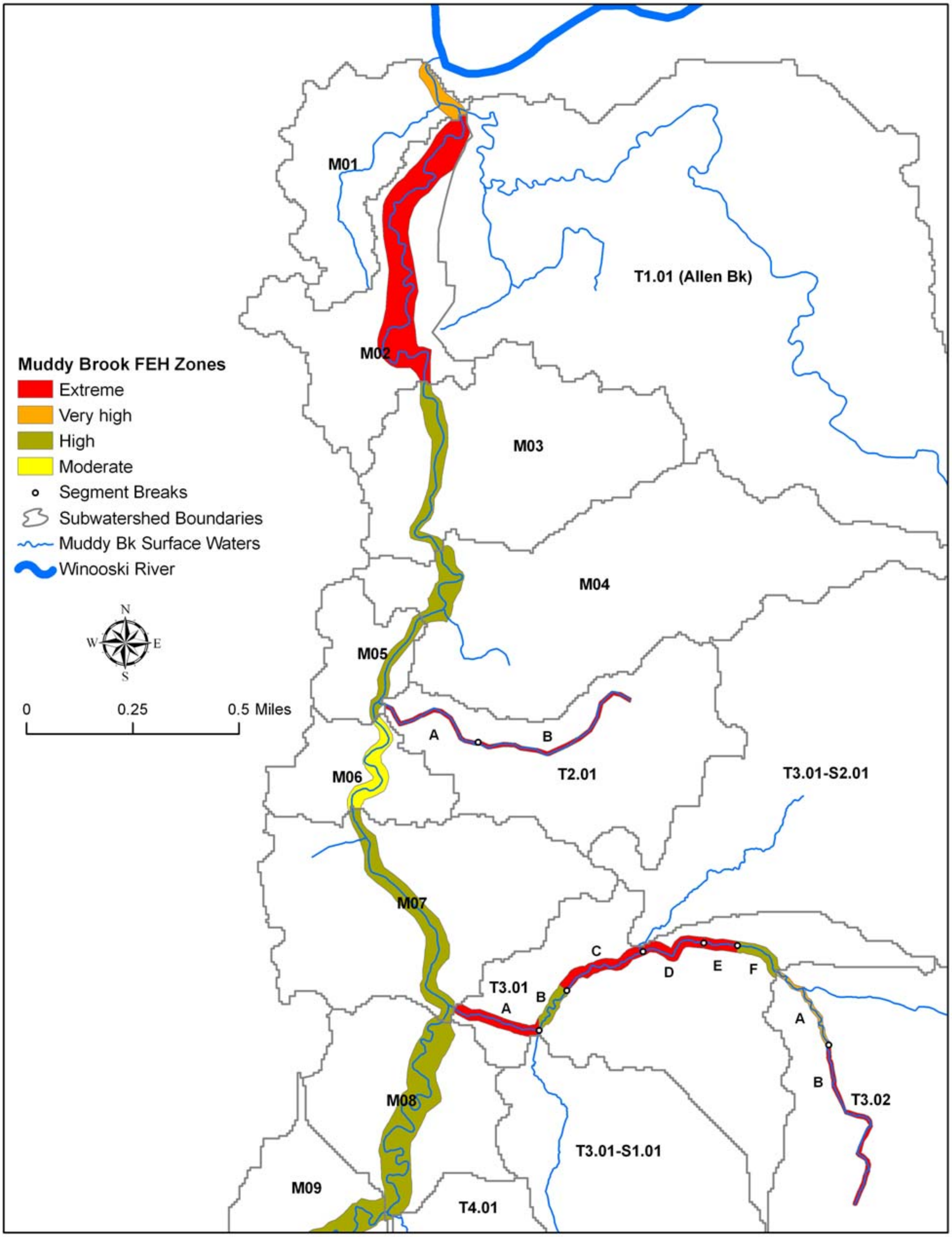


Figure 57. Draft FEH Zones for Lower Muddy Brook Watershed

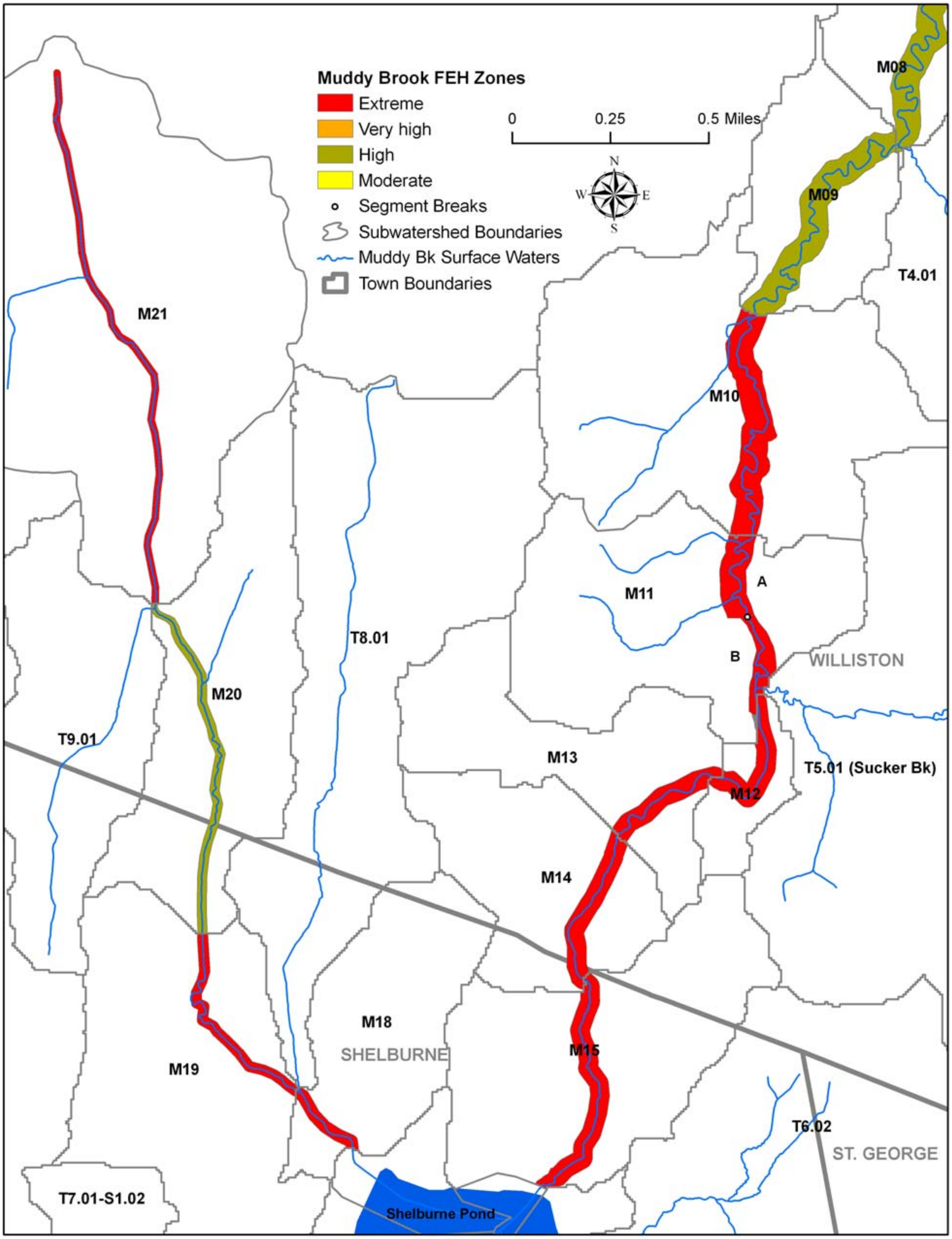


Figure 58. Draft FEH Zones for Upper Muddy Brook Watershed

5.0 Conclusions & Recommendations

The physical condition of Muddy Brook varies tremendously from headwaters to mouth. Some of this variability is attributable to the change in surficial geologic materials from north to south, which has in turn led to different land development patterns. The parent material generally changes from lactustrine dominated in the upper reaches to alluvial and outwash dominated near the mouth. Differences in parent material and valley slope has generally led to the formation of coarse-bottomed, B and C-type stream channels in the lower watershed, and highly-sinuous sand-bottomed channels with E-type geometry in the upper watershed.

These key differences in land slopes and soils have also led to distinct patterns of historical and present day land development in the watershed. In the lower watershed closer to the Winooski River and the main transportation networks (e.g., US Route 2), residential, commercial and industrial land uses are concentrated. Given the very low slope of the land and the agriculturally productive, fine grained soils in the upper watershed, urban land use is less common and extensively farmed tracks remain today.

The watershed stressors described in Section 4.1 indicate that the lower zone of the watershed is experiencing the greatest degree of channel adjustment and decline in physical habitat due to increased urbanization. Vertical channel adjustments, in conjunction with historical riparian buffer loss (from adjacent agriculture) and increased stormwater runoff are causing a decline in biotic integrity. Without steps to address the watershed and reach-scale level stressors affecting the channel conditions, habitat conditions will continue to decline and will be less likely to support a reference biotic community in the future. In contrast, the upper reaches of the watershed are largely unaffected by this stressor, and instead are still recovering from past impacts such as channel straightening and bank armoring. Overall, floodplain connectivity is greater in the upper watershed in the absence of modern day impacts to the hydrologic regime.

General Recommendations

The Muddy Brook study of geomorphic and habitat conditions would benefit from a more detailed review of the watershed and reach-scale stressors. This effort would involve the following components that would aid in the identification of projects that could protect, sustain, or restore fluvial geomorphic equilibrium conditions, through the implementation of either passive or active stream corridor management strategies:

- Development of stressor identification and departure analysis maps.
- Complete summary of potential projects to address stressors causing channel instability and degraded physical habitat.
- Prioritized "active" and "passive" restoration projects, and further development of identified projects, including landowner outreach and conceptual designs.

Together with the development of FEH zones for all reaches assessed for Phase 2 data, stream corridor planning activities would augment the baseline data needed to address high-priority areas for corridor protection. This effort will become increasingly important as residential land use pressures extend from the northern watershed towards the south.

Reach-Specific Recommendations
Based on the reach-specific summaries of potential restoration projects found in Sections 4.2 and 4.3, the following restoration activities are recommended:

- **Arrest Headcuts:** The two headcuts noted on Tributary 3 are causing the export of large amounts of sediment to the downstream reaches. The headcut located downstream of Harvest Lane on T3.01-E has the potential to impact the road crossing in the near future (5-10 years), and will need to be addressed with an active channel management approach. A Phase 3 level survey was completed by Sam Parker in December 2008 as part of his UVM EpSCOR-funded studies. Continuous monitoring of both headcut sites is recommended to determine the rates of migration and the immediacy of restoration needs.
- **Corridor Protection:** Protecting the stream corridor through conservation easements is recommended along reaches of the lower and middle watershed that are susceptible to future development. This approach is especially important in reaches or segments that are in vertical adjustment: M02, M10, T3.01-E.
- **Undersized Stream Crossings:** Severely undersized culverts are causing channel adjustments in the following reaches: M02, M08, M13, T2.01-A, T3.02-A. As noted in the structures summary, these structures should be considered high-priority for replacement by town and state agencies.
- **Derelict Stream Crossing:** There is an inactive stream crossing in Reach M09. The abutments act as a channel constriction and are causing erosion and bifurcation of the channel. Given that the stream crossing is no longer in use, removal of the abutments is recommended.

6.0 References

Albers, J., 2000, Hands on the Land: A History of the Vermont Landscape, MIT Press, Cambridge, MA.

CWP (Center for Watershed Protection), 2003, Impacts of Impervious Cover on Aquatic Systems. Watershed Protection Research Monograph: 39-49.

Fitzgerald, E. P., 2007, Linking urbanization to stream geomorphology and biotic integrity in the Lake Champlain Basin, Vermont [M.S. Thesis]: Burlington, Vermont, University of Vermont, 121 p.

Fitzgerald Environmental Associates, LLC. (FEA), 2007, Sucker Brook Watershed: Phase 1 and 2 Stream Geomorphic Assessment Summary.

Fitzgerald Environmental Associates, LLC. (FEA), 2008, Allen Brook Watershed Departure Analysis and Project Identification Summary.

Hallac, D.E. and J.E. Marsden, 2001, Comparison of conservation strategies for unionids threatened by zebra mussels (Dreissena polymorpha): periodic cleaning vs quarantine and translocation, *Journal of the North American Benthological Society*, 20(2), 200-210.

Montgomery, D. R., & Buffington, J. M., 1997, Channel-reach morphology in mountain drainage basins, *Geological Society of America Bulletin*, 109(5), 596-611.

NOAA (National Oceanic and Atmospheric Administration), 2008a, Land Cover Analysis Data for New England – Coastal Change Analysis Program. Accessed May, 2008 and available at: http://www.csc.noaa.gov/crs/lca/ccap.html

NOAA (National Oceanic and Atmospheric Administration), 2008b, Burlington Vermont Climatology. Accessed July, 2008 and available at: http://www.erh.noaa.gov/btv/climo/stations/burlington.shtml

NWI (National Wetlands Inventory), 2003, US Fish and Wildlife Service Digital Publication of the National Wetlands Inventory Data from 1983. Available at: www.vcgi.org. Accessed April, 2007

Paul, M. J., and J. L. Meyer, 2001, Streams in the urban landscape. Annual Review of Ecology and Systematics 32:333-365.

Pease, J., 2008, Personal Communication with Jim Pease, Vermont Water Quality Division.

Rosgen, D. L., 1994, A classification of natural rivers, Catena, 22(3), 169 - 199.

Simon, A. and Rinaldi, M., 2006, Disturbance, stream incision, and channel evolution: The roles of excess transport capacity and boundary materials in controlling channel response, *Geomorphology*, 79, 361-383

Thompson, E.H., and E.R. Sorenson, 2000, Wetland, Woodland, Wildland: A Guide to the Natural Communities of Vermont, Vermont Department of Fish and Wildlife and The Nature Conservancy.

Trimble, S. W. 1997, Contribution of stream channel erosion to sediment yield from an urbanizing watershed, *Science* 278:1442-1444.

USGS (Untied States Geological Survey), 2008, Real-time Flow Monitoring Data for Vermont Rivers, available at: http://waterdata.usgs.gov/nwis

UVM (University of Vermont), 2008, Landscape Change Program –Historical Photographs, Accessed June, 2008 at: http://www.uvm.edu/landscape//

VTANR (Vermont Agency of Natural Resources), 2007a, Stream Geomorphic Assessment Handbook - Phase 1 & 2 Protocols. Vermont Agency of Natural Resources Publication. Available at: http://www.anr.state.vt.us/dec/waterq/rivers/htm/rv_geoassesspro.htm.

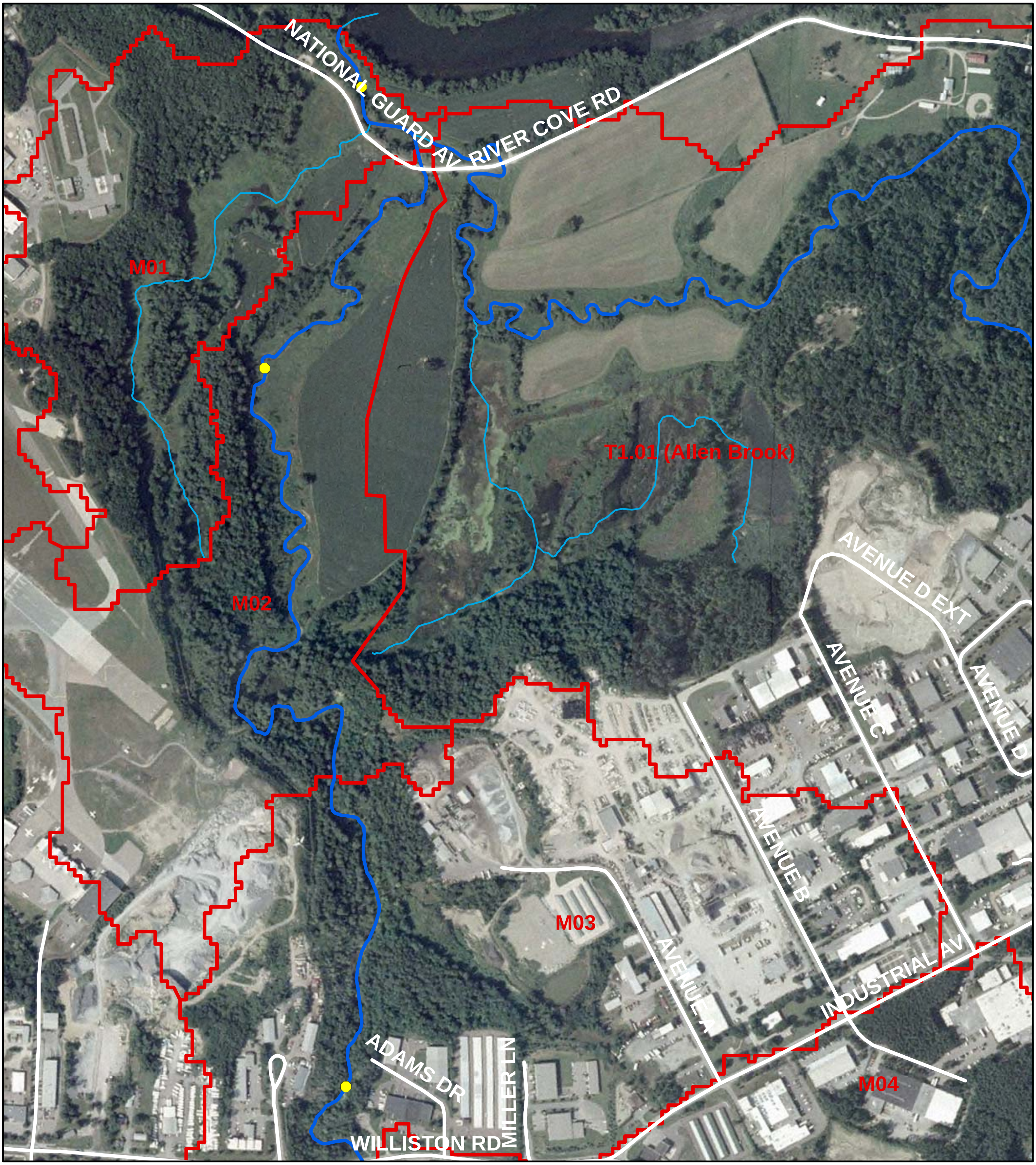
VTANR (Vermont Agency of Natural Resources), 2007b, Vermont Agency of Natural Resources River Corridor Planning Guide, Draft dated July 11, 2007. Accessed in August, 2007 at: http://www.anr.state.vt.us/dec/waterq/rivers/htm/rv_restoration.htm

VTANR (Vermont Agency of Natural Resources), 2008, Municipal Guide to Fluvial Erosion Hazard Mitigation, dated November 12, 2008. Accessed at: http://www.anr.state.vt.us/dec/waterq/rivers.htm

VTDEC (Vermont Department of Environmental Conservation), 2005, Biological and Aquatic Life Use Attainment Assessment of Tributary Four to Muddy Brook.

Appendix A

Reach Mapping



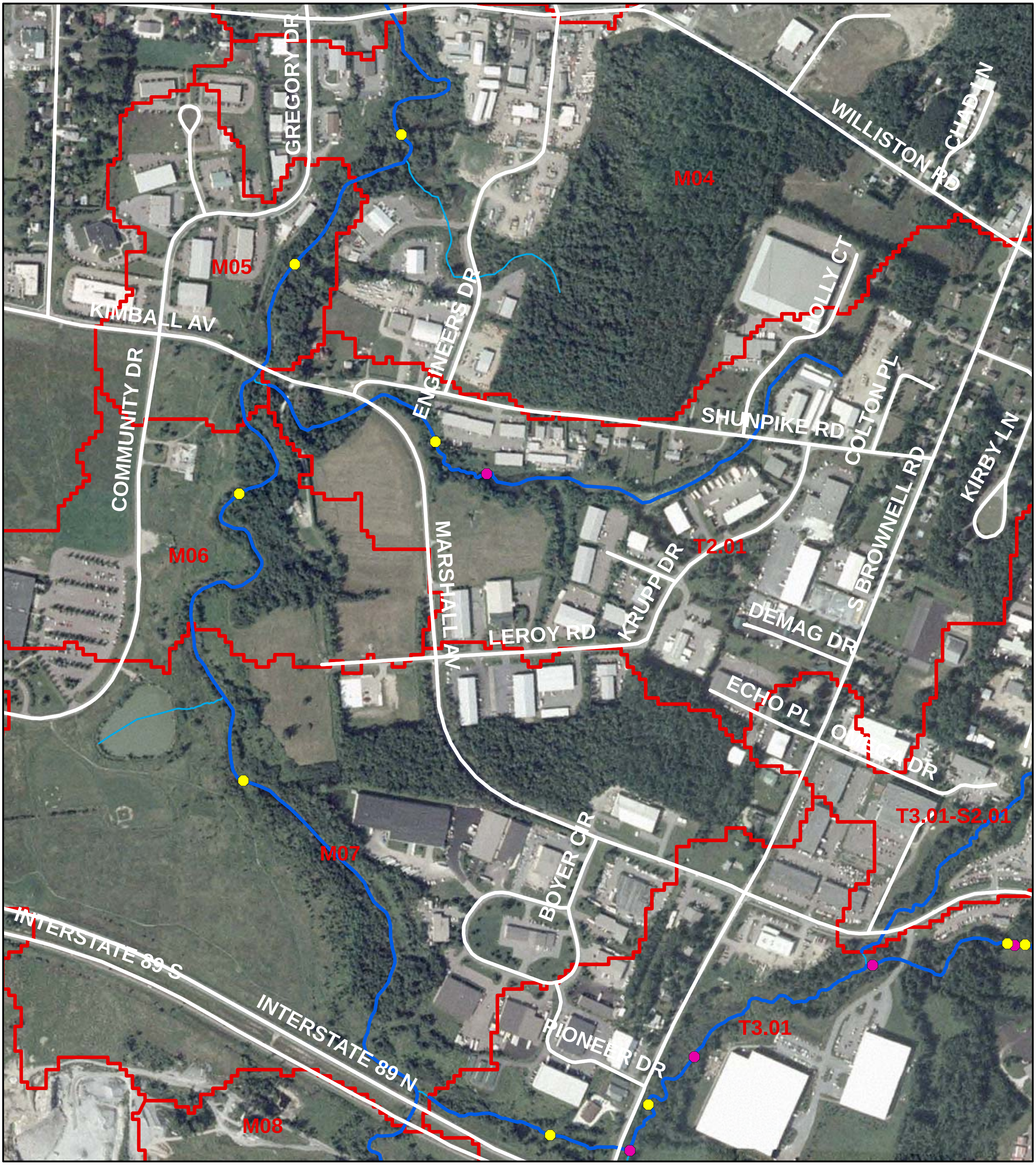
Cross-Section Locations
Segment Breaks
Subwatershed Boundaries
Muddy Bk Surface Waters
Minor Tributaries

Muddy Brook Phase 2 Mapping Reaches M01, M02, M03 & T1.01 (Allen Brook)

0 600 1,200 Feet

N E S W

Fitzgerald Environmental Associates, LLC.
www.fitzgeraldenvironmental.com



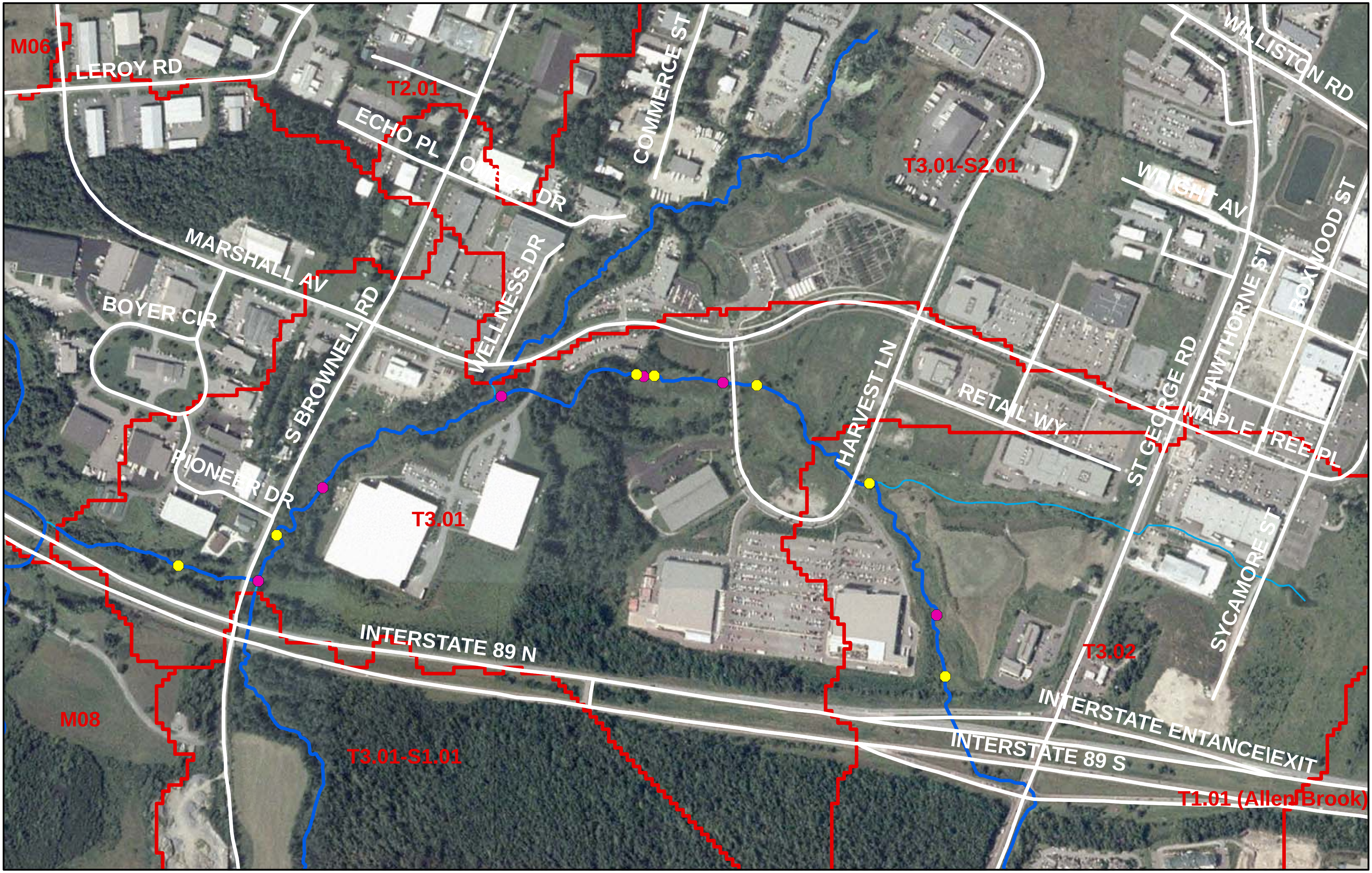
Cross-Section Locations
Segment Breaks
Subwatershed Boundaries
Muddy Bk Surface Waters
Minor Tributaries

Muddy Brook Phase 2 Mapping
Reaches M04, M05, M06,
M07 & T2.01

0 600 1,200 Feet

N S E W

Fitzgerald Environmental Associates, LLC.
www.fitzgeraldenvironmental.com



Cross-Section Locations

Segment Breaks

Subwatershed Boundaries

Muddy Bk Surface Waters

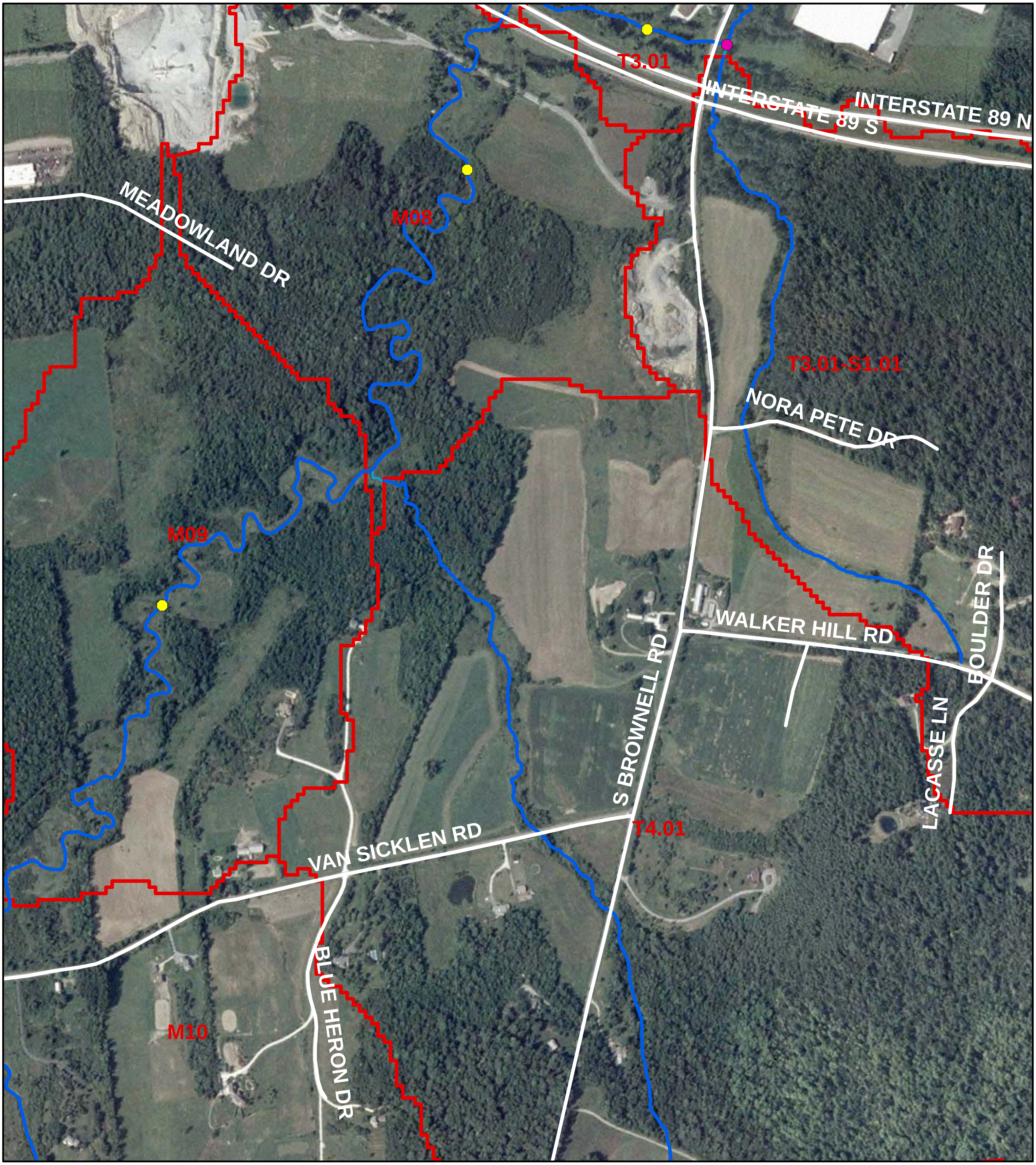
Minor Tributaries

Muddy Brook Phase 2 Mapping
Reaches T3.01, T3.02,
T3.01-S1.01 & T3.01-S1.01

0 600 1,200 Feet

N
W E
S

Fitzgerald Environmental Associates, LLC.
www.fitzgeraldenvironmental.com



Cross-Section Locations

Segment Breaks

Subwatershed Boundaries

Muddy Bk Surface Waters

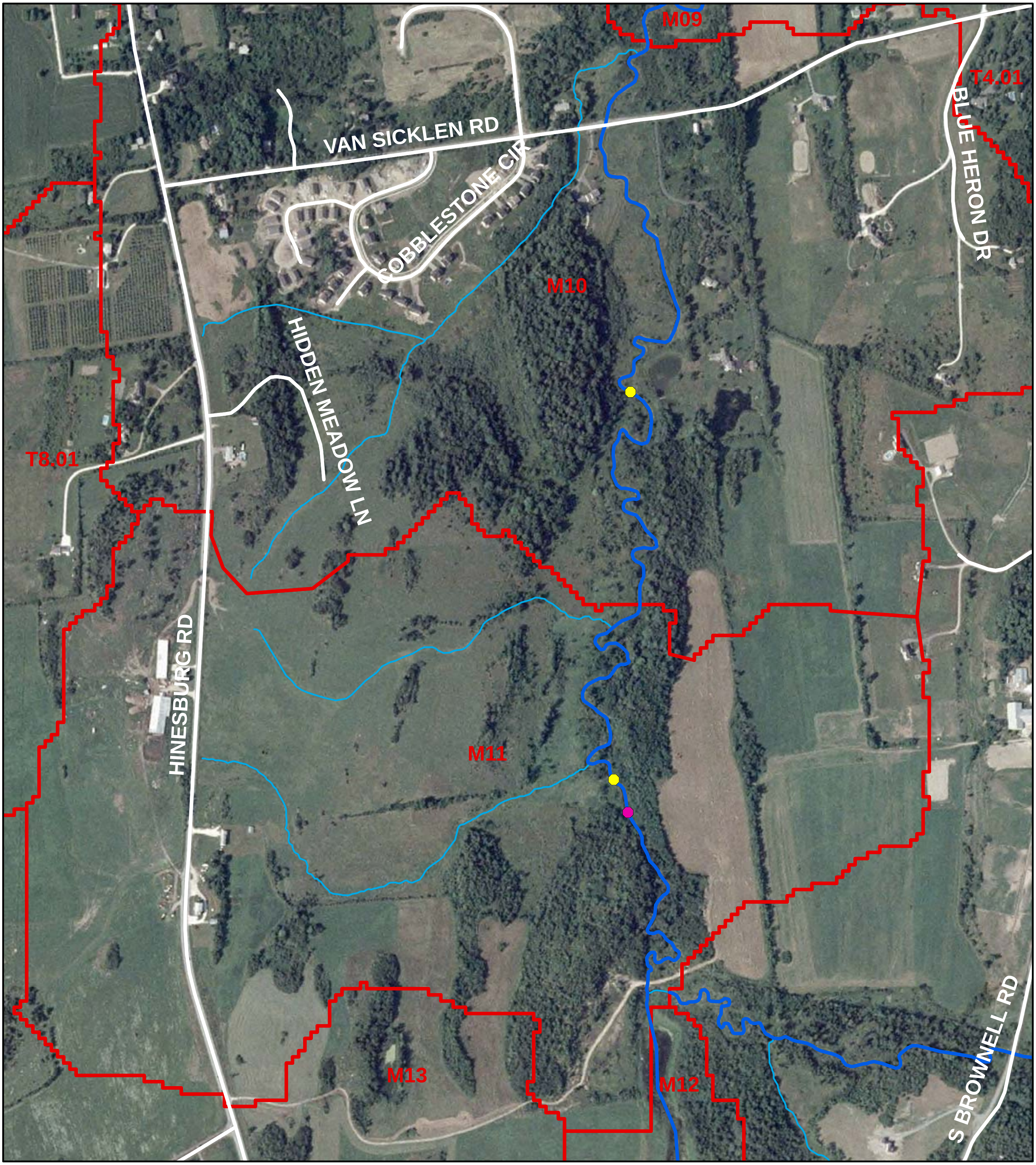
Minor Tributaries

Muddy Brook Phase 2 Mapping
Reaches M08, M09,
T3.01-S1.01 & T4.01

0 600 1,200 Feet

N W E S

Fitzgerald Environmental Associates, LLC.
www.fitzgeraldenvironmental.com



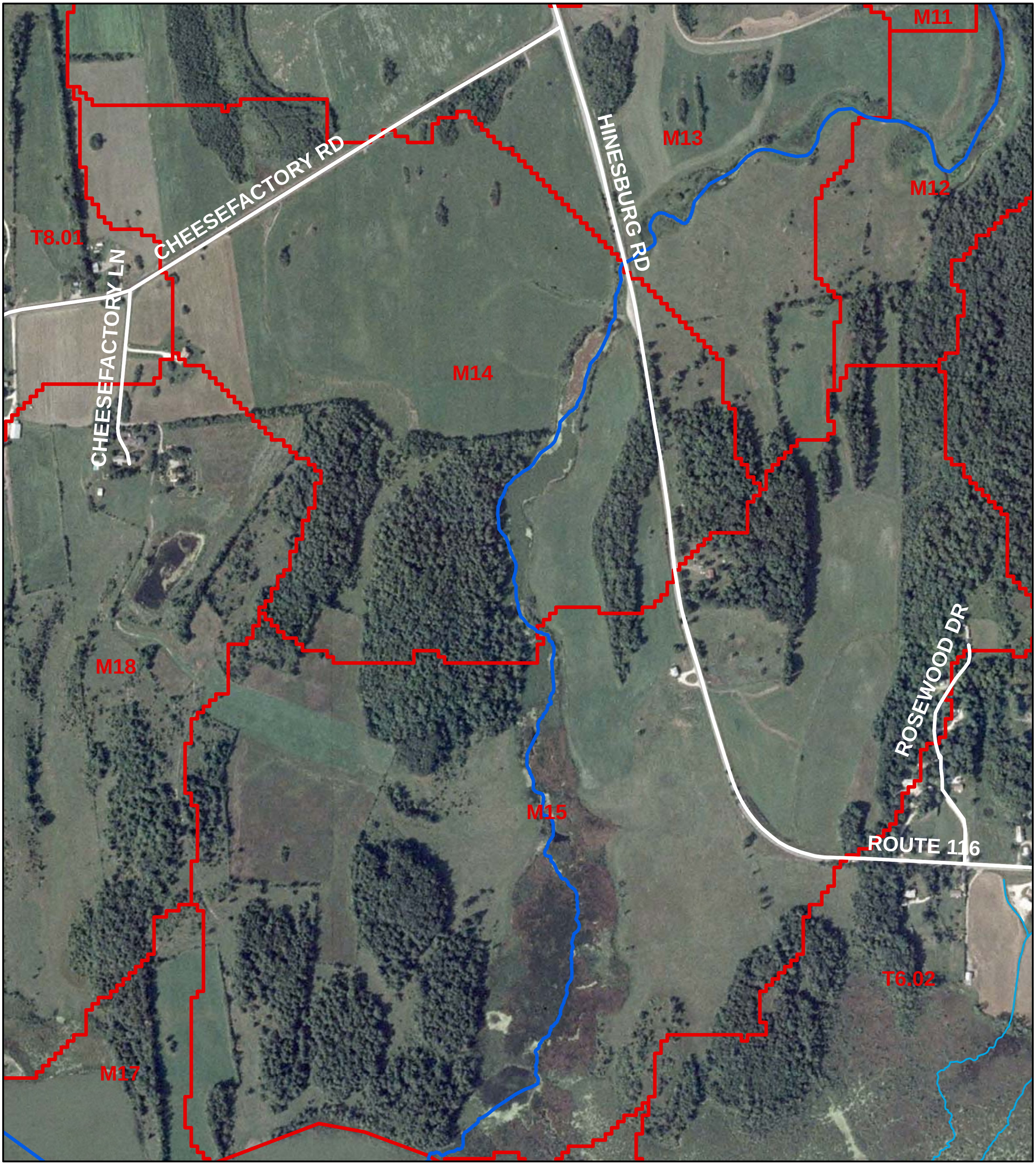
Muddy Brook Phase 2 Mapping
Reaches M10 & M11

- Cross-Section Locations
- Segment Breaks
- Subwatershed Boundaries
- Muddy Bk Surface Waters
- Minor Tributaries

0 600 1,200 Feet

N W E S

Fitzgerald Environmental Associates, LLC.
www.fitzgeraldenvironmental.com



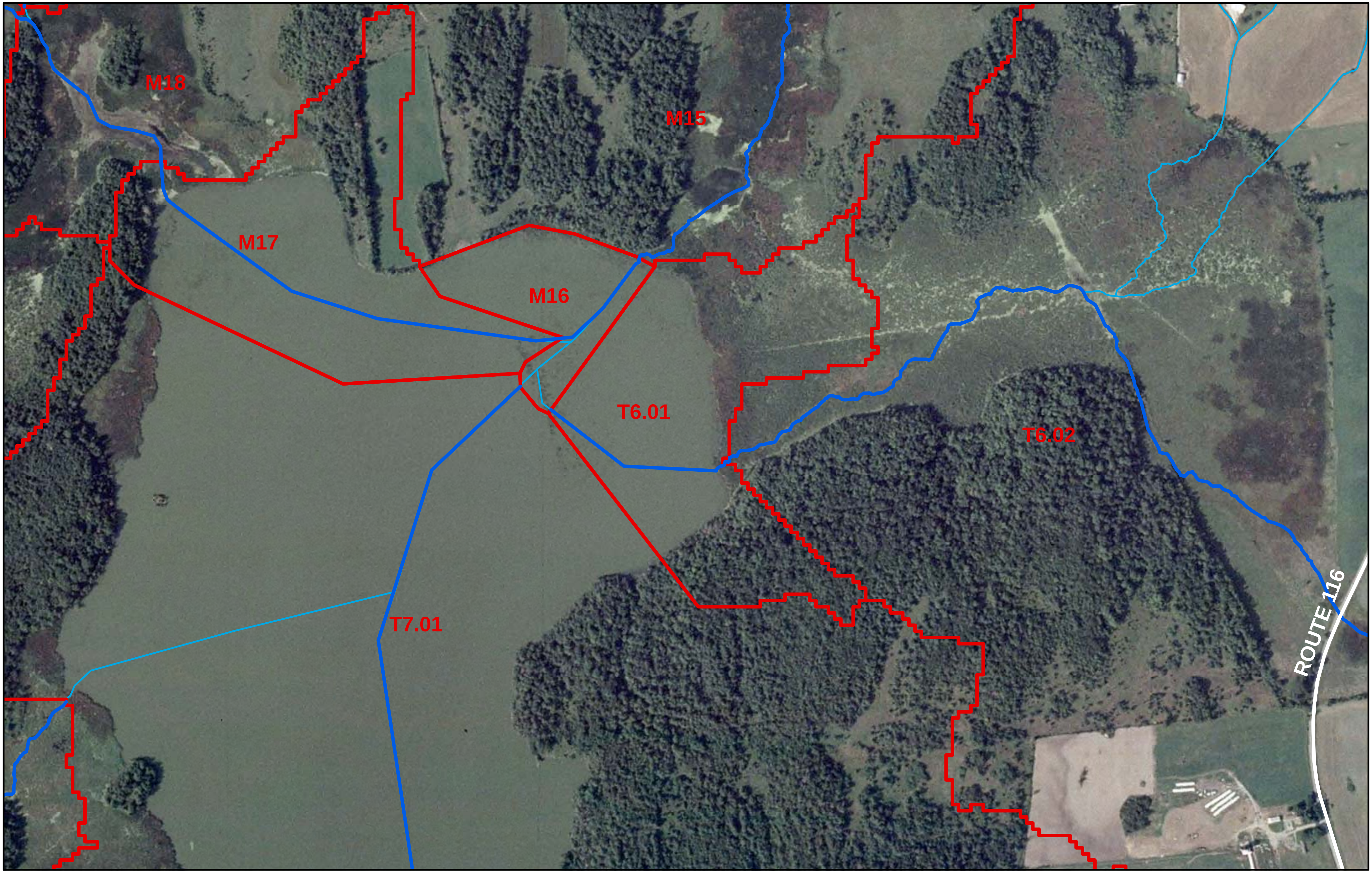
Cross-Section Locations
Segment Breaks
Subwatershed Boundaries
Muddy Bk Surface Waters
Minor Tributaries

Muddy Brook Phase 2 Mapping
Reaches M12, M13, M14 & M15

0 600 1,200 Feet

N S E W

Fitzgerald Environmental Associates, LLC.
www.fitzgeraldenvironmental.com



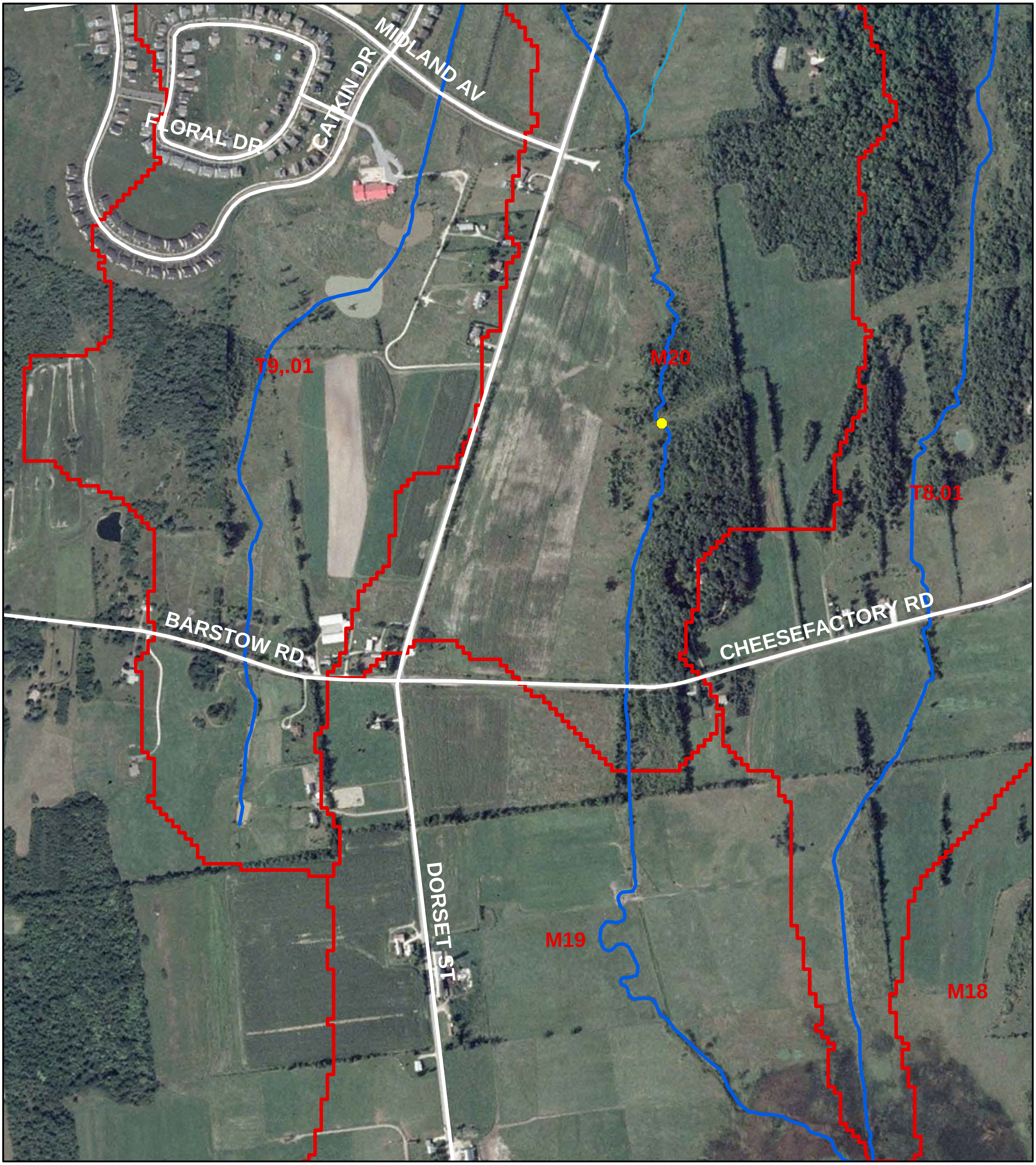
Cross-Section Locations
Segment Breaks
Subwatershed Boundaries
Muddy Bk Surface Waters
Minor Tributaries

Muddy Brook Phase 2 Mapping
Reaches M16, M17, M18,
T6.01, T6.02 & T7.01

0 600 1,200 Feet

N W E S

Fitzgerald Environmental Associates, LLC.
www.fitzgeraldenvironmental.com



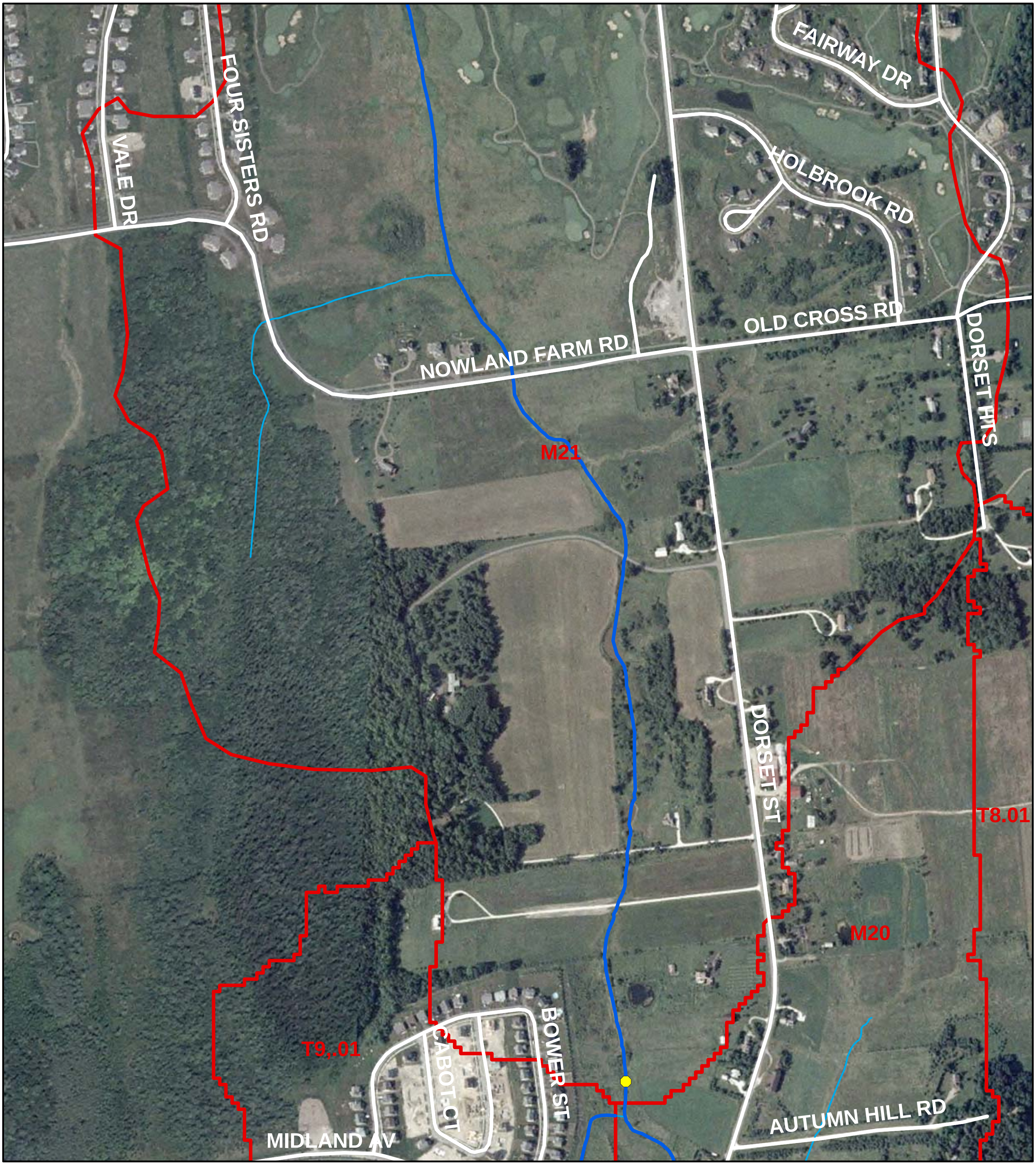
- Cross-Section Locations
- Segment Breaks
- Subwatershed Boundaries
- Muddy Bk Surface Waters
- Minor Tributaries

Muddy Brook Phase 2 Mapping
Reaches M19, M20,
T8.01 & T9.01

0 600 1,200 Feet

N W E S

Fitzgerald Environmental Associates, LLC.
www.fitzgeraldenvironmental.com



Cross-Section Locations
Segment Breaks
Subwatershed Boundaries
Muddy Bk Surface Waters
Minor Tributaries

Muddy Brook Phase 2 Mapping
Reaches M20 & M21

0 600 1,200 Feet

N W E S

Fitzgerald Environmental Associates, LLC.
www.fitzgeraldenvironmental.com

Appendix B

Reach Summary Data

Stream Geometry Data

Muddy Brook

		Phase 2 Stream Type					Phase 1 Data		Phase 2 Channel Data													
Reach	Seg-ment	Stream Type	Bed Material	Bedform	Subcl. Slope	Sub Rch?	Channel Slope	Channel width	Bankfull width	Max. depth	Mean depth	Floodpr. width	Abandn FldPln	W/D Ratio	Entrench-ment	Incision Ratio	Stage Evol.	Evol. Model	RGA Cond.	RHA Cond.	QC Stf	Aut
M01	0	C	Sand	Dune-Ripple	None	No	0.23	60.08	57.0	4.75	3.66	210.0	9.1	15.57	3.68	1.92	II	F	Fair	Fair	P	P
M02	0	E	Sand	Dune-Ripple	None	No	0.20	25.00	24.9	4.6	3.31	325.0	7.3	7.52	13.05	1.59	II	F	Fair	Fair	P	P
M03	0	B	Cobble	Step-Pool	None	No	3.06	49.74	45.1	3.3	2.31	93.0	4.1	19.52	2.06	1.24	III	F	Fair	Good	P	P
M04	0	C	Cobble	Riffle-Pool	None	No	0.21	49.48	35.0	2.5	1.91	407.0	3.4	18.32	11.63	1.36	IV	F	Fair	Good	P	P
M05	0	B	Cobble	Plane Bed	c	No	0.47	49.02	40.0	2.9	1.91	84.0	2.9	20.94	2.10	1.00	IIc	D	Fair	Fair	P	P
M06	0	C	Cobble	Riffle-Pool	None	No	0.18	32.70	32.7	3.3	2.29	90.0	4.0	14.28	2.75	1.21	III	F	Good	Fair	P	P
M07	0	E	Cobble	Plane Bed	None	No	0.00	24.30	24.3	3.6	2.57	157.0	4.8	9.46	6.46	1.33	II	F	Fair	Fair	P	P
M08	0	E	Silt	Dune-Ripple	None	No	0.00	27.70	27.7	4.2	2.4	331.0	5.1	11.54	11.95	1.21	I	F	Good	Good	P	P
M09	0	E	Silt	Dune-Ripple	None	No	0.00	20.00	20.0	4.7	3.45	400.0	6.2	5.80	20.00	1.32	I	F	Good	Good	P	P
M10	0	E	Sand	Dune-Ripple	None	No	0.00	18.00	18.0	4.2	3.13	156.0	5.9	5.75	8.67	1.40	II	F	Fair	Fair	P	P
M11	A	E	Gravel	Dune-Ripple	None	No	0.00	15.00	15.0	3.45	2.48	370.0	4.95	6.05	24.67	1.43	II	F	Fair	Fair	P	P
M11	B	E	Sand	Dune-Ripple	None	No	0.00	15.00											Fair		P	F
M12	0	E	Sand	Dune-Ripple	None	No	0.00	33.35											Fair		P	F
M13	0	E	Sand	Dune-Ripple	None	No	0.00	33.23											Fair		P	F
M14	0	E	Sand	Dune-Ripple	None	No	0.00	32.78											Fair		P	F
M15	0	E	Sand	Dune-Ripple	None	No	0.00	32.34											Fair		P	F
M18	0	E	Sand	Dune-Ripple	None	No	0.00	21.12											Fair		P	F
M19	0	E	Sand	Dune-Ripple	None	No	0.00	17.92											Fair		P	F
M20	0	E	Sand	Dune-Ripple	None	No	0.28	6.00	6.0	1.6	0.94	130.0	1.6	6.38	21.67	1.00	I	F	Good	Fair	P	P
M21	0	E	Sand	Dune-Ripple	None	No	0.32	4.00	3.5	1.7	0.79	58.5	2.2	4.43	16.71	1.29	II	F	Fair	Fair	P	P
T2.01	A	E	Sand	Dune-Ripple	None	No	0.64	6.93	5.5	1.5	0.94	40.0	2.3	5.85	7.27	1.53	II	F	Fair	Fair	P	P
T2.01	B	E	Sand	Dune-Ripple	None	No	0.64	6.93											Fair		P	F
T3.01	A	E	Silt	Plane Bed	None	No	0.60	17.55	19.8	5.2	2.84	151.0	6.5	6.97	7.63	1.25	II	F	Fair	Fair	P	P
T3.01	B	E	Silt	Dune-Ripple	None	No	0.60	17.55	10.7	3.2	2.05	182.0	3.7	5.22	17.01	1.16	I	F	Good	Good	P	P
T3.01	C	E	Sand	Dune-Ripple	None	No	0.60	17.55											Fair		P	F
T3.01	D	E	Sand	Dune-Ripple	None	No	0.60	17.55	11.0	2.5	1.55	160.0	4.3	7.10	14.55	1.72	IV	F	Fair	Fair	P	P
T3.01	E	G	Silt	Plane Bed	None	No	0.60	17.55	5.3	2.5	1.65	8.5	6.3	3.21	1.60	2.52	II	F	Poor	Poor	P	P
T3.01	F	E	Silt	Dune-Ripple	None	No	0.60	17.55	4.0	1.2	0.56	144.0	1.2	7.14	36.00	1.00	I	F	Good	Fair	P	P
T3.02	A	C	Gravel	Riffle-Pool	b	No	2.10	10.01	11.8	2.3	1.49	152.0	2.3	7.92	12.88	1.00	I	F	Fair	Good	P	P
T3.02	B	G	Cobble	Step-Pool	None	Yes	2.10	10.01	7.0	1.8	1.15	10.9	4.0	6.09	1.56	2.22	II	F	Fair	Fair	P	P

Rapid Geomorphic Assessment

Muddy Brook

Reach	Seg-ment	Sub-Rch?	Degradation			Aggradation			Widening		Planform		Geo. Score	Geo. Condition	Evol. Stage	Confin-ement Type	Sens-itivity	QC	
			Score	STD	Historic	Score	STD	Historic	Score	Historic	Score	Historic						Stf	Aut
M01	0	No	10	None	Yes	11	None	No	10	No	11	No	0.53	Fair	II	BD	Very	P	P
M02	0	No	6	None	Yes	12	None	No	5	No	5	No	0.35	Fair	II	VB	Extreme	P	P
M03	0	No	13	None	No	14	None	No	11	No	13	No	0.64	Fair	III	SC	High	P	P
M04	0	No	11	None	Yes	12	None	No	9	No	10	No	0.53	Fair	IV	BD	High	P	P
M05	0	No	14	None	No	10	None	No	14	No	13	No	0.64	Fair	IIc	SC	High	P	P
M06	0	No	14	None	No	11	None	No	13	No	15	No	0.66	Good	III	NW	Moderat	P	P
M07	0	No	9	None	Yes	9	None	No	11	No	12	Yes	0.51	Fair	II	BD	High	P	P
M08	0	No	15	None	No	14	None	No	15	No	16	No	0.75	Good	I	VB	High	P	P
M09	0	No	15	None	No	15	None	No	13	No	12	No	0.69	Good	I	VB	High	P	P
M10	0	No	9	None	No	14	None	No	10	No	12	No	0.56	Fair	II	VB	Extreme	P	P
M11	A	No	10	None	No	14	None	No	11	No	13	No	0.60	Fair	II	VB	Extreme	P	P
M11	B	No											0.00	Fair				P	F
M12	0	No											0.00	Fair				P	F
M13	0	No											0.00	Fair				P	F
M14	0	No											0.00	Fair				P	F
M15	0	No											0.00	Fair				P	F
M18	0	No											0.00	Fair				P	F
M19	0	No											0.00	Fair				P	F
M20	0	No	13	None	No	16	None	No	17	No	14	No	0.75	Good	I	VB	High	P	P
M21	0	No	10	None	No	12	None	No	14	No	11	Yes	0.59	Fair	II	VB	Extreme	P	P
T2.01	A	No	7	None	No	8	None	No	10	No	11	No	0.45	Fair	II	VB	Extreme	P	P
T2.01	B	No											0.00	Fair				P	F
T3.01	A	No	9	None	No	12	None	No	12	No	13	Yes	0.58	Fair	II	BD	Extreme	P	P
T3.01	B	No	15	None	No	16	None	No	17	No	14	No	0.78	Good	I	VB	High	P	P
T3.01	C	No											0.00	Fair				P	F
T3.01	D	No	12	None	No	3	None	Yes	5	No	8	No	0.35	Fair	IV	VB	Extreme	P	P
T3.01	E	No	2	E to G	Yes	3	None	No	4	Yes	7	Yes	0.20	Poor	II	VB	Extreme	P	P
T3.01	F	No	14	None	No	13	None	No	15	No	14	No	0.70	Good	I	VB	Very	P	P
T3.02	A	No	11	None	No	11	None	No	14	No	12	No	0.60	Fair	I	VB	Very	P	P
T3.02	B	Yes	3	Other	Yes	11	None	No	12	No	11	No	0.46	Fair	II	SC	Extreme	P	P

Project: **Muddy Brook** | **Phase 2 Segment Summary** | | February 2, 2009 | SGAT Version: 4.56

Stream: **Muddy Brook** | Reach # **M01** | Segment: **0** | Completion Date: **May 27, 2008**

Organization: **Agency of Natural Resources** | Observers: **EPF, SPP** | Why Not assessed: | Rain: **Yes**

Segment Length (ft): **883** | Segment Location: **From confluence with the Winooski River up to reach break where Tributary 1 (Allen Brook)**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **None**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	**0**	**0**
height	**0**	**0**
Roads	**71**	**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	**Always**	**Never**
Texture	**Sand**	**Sand**

1.5 Valley Features

- Valley Width (ft) **400**
- Width Determination **Estimated**
- Confinement Type **Broad**
- Rock Gorge? **No**
- Human-caused Change? **No**

Step 2. Stream Channel

- 2.1 Bankfull Width **57**
- 2.2 Max Depth (ft) **4.75**
- 2.3 Mean Depth (ft) **3.66**
- 2.4 Floodprone Width (ft) **210**

Notes:

Aggradation of fine sediments due to backwater at confluence with the Winooski River. Limited habitat variability due to aggradation and lack of woody debris in channel--only one significant pool with cover.

Step 2. (Contued)

- 2.5 Aband. Floodpln **9.10** ft.
- Human Elev Floodpln **0.00** ft.
- 2.6 Width/Depth Ratio **15.57**
- 2.7 Entrenchment Ratio **3.68**
- 2.8 Incision Ratio **1.92**
- Human Elevated Inc Rat **0.00**
- 2.9 Sinuosity **Moderate**
- 2.10 Riffles Type **Not Applicable**
- 2.11 Riffle/Step Spacing (ft) **200**

2.12 Substrate Composition

Bedrock	**0**%
Boulder	**0**%
Cobble	**0**%
Coarse Gravel	**2**%
Fine Gravel	**10**%
Sand	**53**%
Silt and smaller	**35**%

- Silt/Clay Present? **Yes**
- Detritus **10** %
- # Large Woody **5**

2.13 Average Largest Particle on

- Bed **N/A**
- Bar **N/A**

2.14 Stream Type

- Stream Type: **C**
- Bed Material: **Sand**
- Subclass Slope: **None**
- Bed Form: **Dune-Ripple**
- 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	**Sand**	**Sand**
Consistency	**Non-cohesive**	**Non-cohesive**
Lower		
Material Type	**Mix**	**Mix**
Consistency	**Cohesive**	**Cohesive**

Bank Erosion	Left	Right
Erosion Length (ft)	**95**	**290**
Erosion Height (ft)	**4.00**	**7.25**
Revetmt. Type	**None**	**None**
Revetmt. Length (ft)	**0**	**0**

Near Bank Veg. Type	Left	Right
Dominant	**Shrubs/Saplin**	**Herbaceous**
Sub-dominant	**Herbaceous**	**Shrubs/Saplin**

Bank Canopy	Left	Right
Canopy %	**1-25**	**26-50**
Mid-Channel Canopy	**Open**	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	**26-50**	**26-50**
Sub-dominant	**0-25**	**0-25**
W less than 25	**283**	**258**

Buffer Veg. Type	Left	Right
Dominant	**Shrubs/Saplin**	**Herbaceous**
Sub-dominant	**Herbaceous**	**Mixed Trees**

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	**Shrubs/Saplin**	**Crop**
Sub-dominant	**Residential**	**Forest**
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 **Abundant**
- 4.3 Flow Status **Moderate**
- 4.4 # of Debris Jams **0**
- 4.5 Flow Regulation Type **None**
  - Flow Regulation Use
  - Impoundments
  - Impoundmt. Location
- 4.6 Up/Down strm flow reg **None**
  - (old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	**0**	Road Ditch	**0**
Other	**1**	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	**3**	**0**
Diagonal	Delta	Island
0	**0**	**0**

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	**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 **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.

Stream: **Muddy Brook** Reach # **M01** Segment: **0** Completion Date: **May 27, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Rain: **Yes**

Segment Length (ft): **883** Segment Location: **From confluence with the Winooski River up to reach break where Tributary 1 (Allen**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions **None**

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

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**10**	**None**	**Yes**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**10**		**No**
7.4 Change in Planform	**11**		**No**
Total Score	**42**		
Geomorphic Rating	**0.525**		

Channel Evolution Model **F**

Channel Evolution Stage **II**

Geomorphic Condition **Fair**

Stream Sensitivity **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	7
6.2 Pool Substrate	6
6.3 Pool Variability	5
6.4 Sediment Deposition	7
6.5 Channel Flow Status	13
6.6 Channel Alteration	9
6.7 Channel Sinuosity	7
6.8 Bank Stability	Left: 3 Right: 3
6.9 Bank Vegetation Protection	Left: 6 Right: 4
6.10 Riparian Vegetation Zone Width	Left: 5 Right: 3
Total Score	78
Habitat Rating	0.39

Habitat Stream Condition **Fair**

Narrative:

Historic and current agricultural activities and the presence of the road bed has limited the channel's ability to meander, causing degradation and incision . Additional deposition of fines and erosion is caused by the backwater of the Winooski.

Project: Muddy Brook

Phase 2 Segment Summary

February 2, 2009 SGAT Version: 4.56

Stream: Muddy Brook | Reach # M02 | Segment: 0 | Completion Date: May 27, 2008

Organization: Agency of Natural Resources | Observers: EPF, SPP | Why Not assessed: | Rain: Yes

Segment Length (ft): 5,570 | Segment Location: From National Guard Ave. at the confluence with Allen Brook up to change in confinement

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation None

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	Steep	Hilly
Continuous w/	Never	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Sand

1.5 Valley Features

- Valley Width (ft) 350
- Width Determination Estimated
- Confinement Type Very Broad
- Rock Gorge? No
- Human-caused Change? No

Step 2. Stream Channel

- 2.1 Bankfull Width 25
- 2.2 Max Depth (ft) 4.60
- 2.3 Mean Depth (ft) 3.31
- 2.4 Floodprone Width (ft) 325

Notes:

Extreme incision (Avg. ~ 1.6) throughout the lower-to-middle reach. This incision was brought about by a combination of historic straightening, loss of LWD inputs, and the fine non-cohesive substrate.

Step 2. (Contued)

- 2.5 Aband. Floodpln 7.30 ft.
- Human Elev Floodpln 0.00 ft.
- 2.6 Width/Depth Ratio 7.52
- 2.7 Entrenchment Ratio 13.05
- 2.8 Incision Ratio 1.59
- Human Elevated Inc Rat 0.00
- 2.9 Sinuosity Moderate
- 2.10 Riffles Type Eroded
- 2.11 Riffle/Step Spacing (ft) 190

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	6 %
Fine Gravel	15 %
Sand	57 %
Silt and smaller	21 %

- Silt/Clay Present? Yes
- Detritus 10 %
- # Large Woody 62

2.13 Average Largest Particle on

- Bed N/A
- Bar N/A

2.14 Stream Type

- Stream Type: E
- Bed Material: Sand
- Subclass Slope: None
- Bed Form: Dune-Ripple
- Field Measured Slope:

2.15 Reference Stream Type (if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	Multiple	24.25
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope Undercut

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

Bank Erosion	Left	Right
Erosion Length (ft)	1,154	837
Erosion Height (ft)	4.53	5.37
Revetmt. Type	Hard Bank	Rip-Rap
Revetmt. Length (ft)	37	143

Near Bank Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	1-25	1-25

Mid-Channel Canopy Open

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	51-100
Sub-dominant	51-100	26-50
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Forest	Hay
Mass Failures	51	342
Height	20	28
Gullies	0	0
Height	0	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 3
- 4.5 Flow Regulation Type None
  - Flow Regulation Use
  - Impoundments
  - Impoundmt. Location
- 4.6 Up/Down strm flow reg None
  - (old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	1	Urb Strm Wtr Pipe	0

- 4.9 # of Beaver Dams 0
  - Affected Length (ft) 0

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
8	7	7
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
2	1	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	1	No

- 5.4 Stream Ford or Animal No
- 5.5 Straightening Straightening
  - Straightening Length: 1,022
- 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.

Stream: **Muddy Brook** Reach # **M02** Segment: **0** Completion Date: **May 27, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Rain: **Yes**

Segment Length (ft): **5,570** Segment Location: **From National Guard Ave. at the confluence with Allen Brook up to change in**

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	26.0	Yes	Yes	No	Yes

Problem Alignment

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**6**	**None**	**Yes**
7.2 Channel Aggradation	**12**	**None**	**No**
7.3 Widening Channel	**5**		**No**
7.4 Change in Planform	**5**		**No**
Total Score	**28**		
Geomorphic Rating	**0.35**		

Channel Evolution Model **F**

Channel Evolution Stage **II**

Geomorphic Condition **Fair**

Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	8
6.2 Pool Substrate	6
6.3 Pool Variability	10
6.4 Sediment Deposition	6
6.5 Channel Flow Status	15
6.6 Channel Alteration	8
6.7 Channel Sinuosity	12
6.8 Bank Stability	Left: 2 Right: 2
6.9 Bank Vegetation Protection	Left: 5 Right: 5
6.10 Riparian Vegetation Zone Width	Left: 7 Right: 4
Total Score	90
Habitat Rating	0.45

Habitat Stream Condition **Fair**

Narrative:

Incision and severe bank erosion throughout the lower-to-mid reach.

Project: Muddy Brook

Phase 2 Segment Summary

February 2, 2009 SGAT Version: 4.56

Stream: Muddy Brook | Reach # M03 | Segment: 0 | Completion Date: May 27, 2008

Organization: Agency of Natural Resources | Observers: EPF, SPP | Why Not assessed: | Rain: Yes

Segment Length (ft): 2,400 | Segment Location: From reach break near the airport up to Williston Rd.

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation: None

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	Extremely	Extremely
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Always	Always
Texture	Sand	Sand

1.5 Valley Features

Valley Width (ft): 166

Width Determination: Estimated

Confinement Type: Semi-confined

Rock Gorge?: No

Human-caused Change?: No

Step 2. Stream Channel

2.1 Bankfull Width	45
2.2 Max Depth (ft)	3.30
2.3 Mean Depth (ft)	2.31
2.4 Floodprone Width (ft)	93

Notes:

A fairly stable reach with some aggradation and migration in the lower reach caused by sediments supplied from upslope mass failures. Many stoneflies and caddis in lower reach. Springs from eastern corridor provides cool water inputs.

Step 2. (Contued)

2.5 Aband. Floodpln	4.10 ft.
Human Elev Floodpln	0.00 ft.
2.6 Width/Depth Ratio	19.52
2.7 Entrenchment Ratio	2.06
2.8 Incision Ratio	1.24
Human Elevated Inc Rat	0.00
2.9 Sinuosity	Low
2.10 Riffles Type	Complete
2.11 Riffle/Step Spacing (ft)	250

2.12 Substrate Composition

Bedrock	0%
Boulder	29%
Cobble	45%
Coarse Gravel	9%
Fine Gravel	5%
Sand	6%
Silt and smaller	6%

Silt/Clay Present?: Yes

Detritus: 5 %

Large Woody: 34

2.13 Average Largest Particle on

Bed	13.0	inches
Bar	3.8	inches

2.14 Stream Type

Stream Type: B

Bed Material: Cobble

Subclass Slope: None

Bed Form: Step-Pool

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	Multiple	20.33
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope: Steep

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

Bank Erosion	Left	Right
Erosion Length (ft)	69	0
Erosion Height (ft)	5.00	0.00
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	87	90

Near Bank Veg. Type	Left	Right
Dominant	Coniferous	Coniferous
Sub-dominant	Herbaceous	Herbaceous

Bank Canopy	Left	Right
Canopy %	51-75	51-75

Mid-Channel Canopy: Closed

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	51-100	None
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Coniferous	Coniferous
Sub-dominant	Mixed Trees	Mixed Trees

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	None	None
Mass Failures	0	294
Height	0	19
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps	Abundant
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	
Impoundmt. Location	
4.6 Up/Down strm flow reg	None
(old) Upstrm Flow Reg	

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	4
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	5

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	2	1

Diagonal	Delta	Island
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
2	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: 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.

Stream: **Muddy Brook** Reach # **M03** Segment: **0** Completion Date: **May 27, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Rain: **Yes**

Segment Length (ft): **2,400** Segment Location: **From reach break near the airport up to Williston Rd.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Waterfall	Mid-segment	12.00	8.00	Yes	
Ledge	Mid-segment	8.00	8.00	Yes	

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Culvert	11.0	Yes	Yes	No	No

Problem None

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**

	Score	STD	Historic
7.1 Channel Degradation	**13**	**None**	**No**
7.2 Channel Aggradation	**14**	**None**	**No**
7.3 Widening Channel	**11**		**No**
7.4 Change in Planform	**13**		**No**
Total Score	**51**		
Geomorphic Rating	**0.6375**		

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	15
6.2 Embeddedness	13
6.3 Velocity/Depth Patterns	15
6.4 Sediment Deposition	15
6.5 Channel Flow Status	12
6.6 Channel Alteration	16
6.7 Frequency of Riffles/Steps	15
6.8 Bank Stability	Left: 8 Right: 8
6.9 Bank Vegetation Protection	Left: 9 Right: 9
6.10 Riparian Vegetation Zone Width	Left: 6 Right: 8
Total Score	149
Habitat Rating	0.745

Habitat Stream Condition **Good**

Narrative:

Some aggradation and migration in the lower reach.

Project: Muddy Brook

Phase 2 Segment Summary

February 2, 2009 SGAT Version: 4.56

Stream: **Muddy Brook** Reach # **M04** Segment: **0** Completion Date: **May 28, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Why Not assessed: Rain: **Yes**

Segment Length (ft): **1,434** Segment Location: **From reach break upstream of Williston Rd. to change in confinement along side of Gregory**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **None**

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/	Sometimes	Never
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Sand	Not Evalua

1.5 Valley Features

- Valley Width (ft) **303**
- Width Determination **Estimated**
- Confinement Type **Broad**
- Rock Gorge? **No**
- Human-caused Change? **No**

Step 2. Stream Channel

- 2.1 Bankfull Width **35**
- 2.2 Max Depth (ft) **2.50**
- 2.3 Mean Depth (ft) **1.91**
- 2.4 Floodprone Width (ft) **407**

Notes:

Flood chutes in lower reach indicate changes in planform from ongoing aggradation and beaver activity. This reach has high sinuosity and an active floodplain, however moderate erosion/incision (perhaps due to urban land use in the watershed) could disconnect

Step 2. (Contued)

- 2.5 Aband. Floodpln **3.40** ft.
- Human Elev Floodpln **0.00** ft.
- 2.6 Width/Depth Ratio **18.32**
- 2.7 Entrenchment Ratio **11.63**
- 2.8 Incision Ratio **1.36**
- Human Elevated Inc Rat **0.00**
- 2.9 Sinuosity **High**
- 2.10 Riffles Type **Complete**
- 2.11 Riffle/Step Spacing (ft) **200**

2.12 Substrate Composition

Bedrock	0 %
Boulder	7 %
Cobble	46 %
Coarse Gravel	22 %
Fine Gravel	15 %
Sand	7 %
Silt and smaller	2 %

- Silt/Clay Present? **Yes**
- Detritus **15** %
- # Large Woody **9**

2.13 Average Largest Particle on

- Bed **11.0** inches
- Bar **4.0** 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	One	20.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Undercut**

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive
Bank Erosion	**Left**	**Right**
Erosion Length (ft)	60	214
Erosion Height (ft)	3.00	3.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0
Near Bank Veg. Type	**Left**	**Right**
Dominant	Deciduous	Deciduous
Sub-dominant	Herbaceous	Herbaceous
Bank Canopy	**Left**	**Right**
Canopy %	51-75	26-50
Mid-Channel Canopy	Closed	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	None	51-100
W less than 25	0	0
Buffer Veg. Type	**Left**	**Right**
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Mixed Trees	Mixed Trees

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin
Mass Failures	72	0
Height	20	0
Gullies	0	0
Height	0	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 **1**
- 4.5 Flow Regulation Type **None**
- Flow Regulation Use
- Impoundments
- Impoundmt. Location
- 4.6 Up/Down strm flow reg **None**
- (old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	1	Road Ditch	0
Other	1	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
2	3	1
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
2	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 **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.

Stream: **Muddy Brook** Reach # **M04** Segment: **0** Completion Date: **May 28, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Rain: **Yes**

Segment Length (ft): **1,434** Segment Location: **From reach break upstream of Williston Rd. to change in confinement along side of**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions **None**

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

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**11**	**None**	**Yes**
7.2 Channel Aggradation	**12**	**None**	**No**
7.3 Widening Channel	**9**		**No**
7.4 Change in Planform	**10**		**No**
Total Score	**42**		
Geomorphic Rating	**0.525**		

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	11
6.2 Embeddedness	11
6.3 Velocity/Depth Patterns	13
6.4 Sediment Deposition	8
6.5 Channel Flow Status	11
6.6 Channel Alteration	16
6.7 Frequency of Riffles/Steps	18
6.8 Bank Stability	Left: 6 Right: 5
6.9 Bank Vegetation Protection	Left: 8 Right: 8
6.10 Riparian Vegetation Zone Width	Left: 9 Right: 7
Total Score	131
Habitat Rating	0.655

Habitat Stream Condition **Good**

Narrative:

Some evidence of floodplain redevelopment and stage IV of CEM due to moderate incision, changes in planform, and aggradation.

Phase 2 Segment Summary

Project: **Muddy Brook**
Stream: **Muddy Brook** Reach # **M05** Segment: **0** Completion Date: **May 28, 2008**
Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Why Not assessed: Rain: **Yes**
Segment Length (ft): **1,478** Segment Location: **From reach break near Gregory Dr. to upstream of Marshall Ave. ~400 feet.**

QC Status - Staff: **Provisional Cons Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **None**
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	138	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Extremely	Extremely
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Always	Always
Texture	Mixed	Mixed

1.5 Valley Features
- Valley Width (ft) **126**
- Width Determination **Estimated**
- Confinement Type **Semi-confined**
- Rock Gorge? **No**
- Human-caused Change? **No**

Step 2. Stream Channel

- 2.1 Bankfull Width **40**
- 2.2 Max Depth (ft) **2.90**
- 2.3 Mean Depth (ft) **1.91**
- 2.4 Floodprone Width (ft) **84**

Notes:
Unusual combination of low slope (0.5%) and confined valley setting. Under reference conditions there would likely be better development of a riffle-pool sequence, however some aggradation and planform changes have resulted in mostly plane bed

Step 2. (Contued)

- 2.5 Aband. Floodpln **2.90** ft.
- Human Elev Floodpln **0.00** ft.
- 2.6 Width/Depth Ratio **20.94**
- 2.7 Entrenchment Ratio **2.10**
- 2.8 Incision Ratio **1.00**
- 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	1%
Boulder	9%
Cobble	53%
Coarse Gravel	16%
Fine Gravel	8%
Sand	6%
Silt and smaller	7%

- Silt/Clay Present? **No**
- Detritus **10** %
- # Large Woody **14**

2.13 Average Largest Particle on
- Bed **9.0** inches
- Bar **5.0** 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	One	25.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks
Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive
Bank Erosion	**Left**	**Right**
Erosion Length (ft)	140	41
Erosion Height (ft)	2.69	4.00
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	56	27
Near Bank Veg. Type	**Left**	**Right**
Dominant	Deciduous	Coniferous
Sub-dominant	Herbaceous	Deciduous
Bank Canopy	**Left**	**Right**
Canopy %	76-100	76-100
Mid-Channel Canopy	Closed	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	>100
Sub-dominant	26-50	None
W less than 25	0	0
Buffer Veg. Type	**Left**	**Right**
Dominant	Deciduous	Herbaceous
Sub-dominant	Coniferous	Mixed Trees

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Commercial	None
Mass Failures	0	54
Height	0	25
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
  - Impoundmt. Location
- 4.6 Up/Down strm flow reg **None**
  - (old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	1
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	2

4.9 # of Beaver Dams **0**
Affected Length (ft) **0**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

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

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
2	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 **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.

Stream: **Muddy Brook** Reach # **M05** Segment: **0** Completion Date: **May 28, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Rain: **Yes**

Segment Length (ft): **1,478** Segment Location: **From reach break near Gregory Dr. to upstream of Marshall Ave. ~400 feet.**

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?
Culvert	16.0	Yes	Yes	Yes	Yes

Problem None

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**

	Score	STD	Historic
7.1 Channel Degradation	**14**	**None**	**No**
7.2 Channel Aggradation	**10**	**None**	**No**
7.3 Widening Channel	**14**		**No**
7.4 Change in Planform	**13**		**No**
Total Score	**51**		
Geomorphic Rating	**0.6375**		

Channel Evolution Model **D**

Channel Evolution Stage **IIc**

Geomorphic Condition **Fair**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	14
6.2 Embeddedness	10
6.3 Velocity/Depth Patterns	8
6.4 Sediment Deposition	11
6.5 Channel Flow Status	11
6.6 Channel Alteration	18
6.7 Frequency of Riffles/Steps	6
6.8 Bank Stability	Left: 8 Right: 6
6.9 Bank Vegetation Protection	Left: 7 Right: 9
6.10 Riparian Vegetation Zone Width	Left: 6 Right: 8
Total Score	122
Habitat Rating	0.61

Habitat Stream Condition **Fair**

Narrative:

Aggradation and planform adjustments without incision suggests stage IIIc of the D-model of channel evolution.

Stream: **Muddy Brook** Reach # **M06** Segment: **0** Completion Date: **May 28, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Why Not assessed: Rain: **Yes**

Segment Length (ft): **1,701** Segment Location: **From reach break to just upstream of ponded area by the commercial building.**

QC Status - Staff: **Provisional Cons Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **None**

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	Steep	Very Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Silt/Clay

1.5 Valley Features

- Valley Width (ft) **190**
- Width Determination **Measured**
- Confinement Type **Narrow**
- Rock Gorge? **No**
- Human-caused Change? **No**

Step 2. Stream Channel

- 2.1 Bankfull Width **33**
- 2.2 Max Depth (ft) **3.30**
- 2.3 Mean Depth (ft) **2.29**
- 2.4 Floodprone Width (ft) **90**

Notes:

Good riffle-pool formations. High richness of sensitive macroinvertebrate species (EPT orders) noted in riffle habitat. One area of ponding in upper reach where an old on-stream impoundment may have been located.

Step 2. (Contued)

- 2.5 Aband. Floodpln **4.00** ft.
- Human Elev Floodpln **0.00** ft.
- 2.6 Width/Depth Ratio **14.28**
- 2.7 Entrenchment Ratio **2.75**
- 2.8 Incision Ratio **1.21**
- Human Elevated Inc Rat **0.00**
- 2.9 Sinuosity **Moderate**
- 2.10 Riffles Type **Complete**
- 2.11 Riffle/Step Spacing (ft) **230**

2.12 Substrate Composition

Bedrock	0%
Boulder	13%
Cobble	50%
Coarse Gravel	9%
Fine Gravel	12%
Sand	8%
Silt and smaller	8%

- Silt/Clay Present? **No**
- Detritus **15** %
- # Large Woody **4**

2.13 Average Largest Particle on

- Bed **9.0** inches
- Bar **N/A** 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	One	10.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive
Bank Erosion	**Left**	**Right**
Erosion Length (ft)	71	75
Erosion Height (ft)	3.00	3.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0
Near Bank Veg. Type	**Left**	**Right**
Dominant	Shrubs/Saplin	Deciduous
Sub-dominant	Herbaceous	Shrubs/Saplin
Bank Canopy	**Left**	**Right**
Canopy %	26-50	51-75
Mid-Channel Canopy	Closed	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	>100
Sub-dominant	26-50	26-50
W less than 25	0	0
Buffer Veg. Type	**Left**	**Right**
Dominant	Shrubs/Saplin	Deciduous
Sub-dominant	Herbaceous	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Forest
Sub-dominant	Crop	Shrubs/Saplin
Mass Failures	0	24
Height	0	10
Gullies	0	0
Height	0	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
  - Impoundments
  - Impoundmt. Location
- 4.6 Up/Down strm flow reg **None**
  - (old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	1	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	1	1
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
1	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 **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.

Project: Muddy Brook		Phase 2 Reach Summary		February 2, 2009
Stream: Muddy Brook	Reach #	M06	Segment: 0	Completion Date: May 28, 2008
Organization: Agency of Natural Resources	Observers:	EPF, SPP		Rain: Yes
Segment Length (ft): 1,701	Segment Location:	From reach break to just upstream of ponded area by the commercial building.		

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions **None**

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

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**14**	**None**	**No**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**15**		**No**
Total Score	**53**		
Geomorphic Rating	**0.6625**		

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	11
6.2 Embeddedness	11
6.3 Velocity/Depth Patterns	10
6.4 Sediment Deposition	10
6.5 Channel Flow Status	13
6.6 Channel Alteration	16
6.7 Frequency of Riffles/Steps	15
6.8 Bank Stability	Left: 6 Right: 8
6.9 Bank Vegetation Protection	Left: 5 Right: 8
6.10 Riparian Vegetation Zone Width	Left: 4 Right: 7
Total Score	124
Habitat Rating	0.62

Habitat Stream Condition **Fair**

Narrative:

Some aggradation in pools and riffles with minor incision suggests stage III CEM. Note: the reference channel width used for phase I reflects field observations.

Project: Muddy Brook

Phase 2 Segment Summary

February 2, 2009 SGAT Version: 4.56

Stream: **Muddy Brook** Reach # **M07** Segment: **0** Completion Date: **May 29, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Why Not assessed: Rain: **Yes**

Segment Length (ft): **3,300** Segment Location: **From reach break by the Burton offices to the just upstream of the Interstate-89 crossing.**

QC Status - Staff: **Provisional** **Cons** **Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **None**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	537	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	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **204**

Width Determination **Estimated**

Confinement Type **Broad**

Rock Gorge? **No**

Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **24**

2.2 Max Depth (ft) **3.60**

2.3 Mean Depth (ft) **2.57**

2.4 Floodprone Width (ft) **157**

Notes:

Much of this reach has been historically straightened, resulting in plane bed morphology and higher diameter substrate due to increased stream power. Reach is currently aggrading fine sediment within some riffles, however deposition is not severe

Step 2. (Contued)

2.5 Aband. Floodpln **4.80** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **9.46**

2.7 Entrenchment Ratio **6.46**

2.8 Incision Ratio **1.33**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **Low**

2.10 Riffles Type **Eroded**

2.11 Riffle/Step Spacing (ft) **410**

2.12 Substrate Composition

Bedrock	0 %
Boulder	3 %
Cobble	52 %
Coarse Gravel	24 %
Fine Gravel	2 %
Sand	14 %
Silt and smaller	5 %

Silt/Clay Present? **No**

Detritus **60** %

Large Woody **11**

2.13 Average Largest Particle on

Bed **9.5** **inches**

Bar **N/A** **inches**

2.14 Stream Type

Stream Type: **E**

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	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Boulder/Cobbl	Boulder/Cobbl
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	389	307
Erosion Height (ft)	3.89	4.00
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	181	173

Near Bank Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Herbaceous	Deciduous

Bank Canopy	Left	Right
Canopy %	26-50	51-75

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	0-25	26-50
W less than 25	99	0

Buffer Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Herbaceous	Deciduous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
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 **Minimal**

4.3 Flow Status **Low**

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments

Impoundmt. Location

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

(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	1
Other	3	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	2

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
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
1	0	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **2,167**

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.

Stream: **Muddy Brook** Reach # **M07** Segment: **0** Completion Date: **May 29, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Rain: **Yes**

Segment Length (ft): **3,300** Segment Location: **From reach break by the Burton offices to the just upstream of the Interstate-89**

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	61.0	Yes	Yes	No	No
Problem	None				
Bridge	61.0	Yes	Yes	No	No
Problem	None				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**9**	**None**	**Yes**
7.2 Channel Aggradation	**9**	**None**	**No**
7.3 Widening Channel	**11**		**No**
7.4 Change in Planform	**12**		**Yes**
Total Score	**41**		
Geomorphic Rating	**0.5125**		

Channel Evolution Model **F**

Channel Evolution Stage **II**

Geomorphic Condition **Fair**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	6
6.2 Pool Substrate	3
6.3 Pool Variability	3
6.4 Sediment Deposition	5
6.5 Channel Flow Status	13
6.6 Channel Alteration	5
6.7 Channel Sinuosity	2
6.8 Bank Stability	Left: 5 Right: 5
6.9 Bank Vegetation Protection	Left: 6 Right: 8
6.10 Riparian Vegetation Zone Width	Left: 3 Right: 7
Total Score	71
Habitat Rating	0.355

Habitat Stream Condition **Fair**

Narrative:

Aggradation of fine sediments within riffles. Historical straightening has increased sed. transport and lowered WDR. Note: the reference condition for this reach is E-type and the reference channel width used for phase I reflects field observations.

Stream: **Muddy Brook** Reach # **M08** Segment: **0** Completion Date: **May 29, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Why Not assessed: Rain: **Yes**

Segment Length (ft): **4,712** Segment Location: **From just upstream of I-89 to change in confinement in the wooded area upstream.**

QC Status - Staff: **Provisional** Cons **Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **None**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	101	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	Hilly
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Silt/Clay	Bedrock

1.5 Valley Features

- Valley Width (ft) **402**
- Width Determination **Estimated**
- Confinement Type **Very Broad**
- Rock Gorge? **Yes**
- Human-caused Change? **No**

Step 2. Stream Channel

- 2.1 Bankfull Width **28**
- 2.2 Max Depth (ft) **4.20**
- 2.3 Mean Depth (ft) **2.40**
- 2.4 Floodprone Width (ft) **331**

Notes:

Stable channel geometry with high sinuosity characteristic of reference conditions for E type channels. Some minor incision in upper reach immediately downstream of the reach break/ grade control. Culvert beneath Quarry Access Rd. is extremely undersized and

Step 2. (Contued)

- 2.5 Aband. Floodpln **5.10** ft.
- Human Elev Floodpln **0.00** ft.
- 2.6 Width/Depth Ratio **11.54**
- 2.7 Entrenchment Ratio **11.95**
- 2.8 Incision Ratio **1.21**
- Human Elevated Inc Rat **0.00**
- 2.9 Sinuosity **High**
- 2.10 Riffles Type **Complete**
- 2.11 Riffle/Step Spacing (ft) **190**

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	2 %
Fine Gravel	7 %
Sand	18 %
Silt and smaller	73 %

- Silt/Clay Present? **Yes**
- Detritus **25** %
- # Large Woody **36**

2.13 Average Largest Particle on

- Bed **N/A**
- Bar **N/A**

2.14 Stream Type

- Stream Type: **E**
- Bed Material: **Silt**
- Subclass Slope: **None**
- Bed Form: **Dune-Ripple**
- 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 **Undercut**

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive
Bank Erosion	**Left**	**Right**
Erosion Length (ft)	322	168
Erosion Height (ft)	5.04	4.05
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	85	83
Near Bank Veg. Type	**Left**	**Right**
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Herbaceous
Bank Canopy	**Left**	**Right**
Canopy %	76-100	51-75
Mid-Channel Canopy	Closed	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	0-25	None
W less than 25	194	95
Buffer Veg. Type	**Left**	**Right**
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

- 4.1 Springs / Seeps **Abundant**
- 4.2 Adjacent Wetlands **Abundant**
- 4.3 Flow Status **Low**
- 4.4 # of Debris Jams **3**
- 4.5 Flow Regulation Type **None**
  - Flow Regulation Use
  - Impoundments
  - Impoundmt. Location
- 4.6 Up/Down strm flow reg **None**
  - (old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	1	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	0

4.9 # of Beaver Dams **1**

Affected Length (ft) **1,000**

Step 5. Channel Bed and Planform Changes

5.1 Bar Types

Mid	Point	Side
1	1	0
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	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 **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.

Stream: **Muddy Brook** Reach # **M08** Segment: **0** Completion Date: **May 29, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Rain: **Yes**

Segment Length (ft): **4,712** Segment Location: **From just upstream of I-89 to change in confinement in the wooded area upstream.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken
Ledge	Mid-segment	2.00	1.00	Yes	

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Culvert	7.00	Yes	Yes	Yes	Yes

Problem Scour Above,Scour Below,Alignment

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**15**	**None**	**No**
7.2 Channel Aggradation	**14**	**None**	**No**
7.3 Widening Channel	**15**		**No**
7.4 Change in Planform	**16**		**No**
Total Score	**60**		
Geomorphic Rating	**0.75**		

Channel Evolution Model **F**

Channel Evolution Stage **I**

Geomorphic Condition **Good**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	15
6.2 Pool Substrate	18
6.3 Pool Variability	12
6.4 Sediment Deposition	15
6.5 Channel Flow Status	18
6.6 Channel Alteration	19
6.7 Channel Sinuosity	15
6.8 Bank Stability	Left: 7 Right: 9
6.9 Bank Vegetation Protection	Left: 8 Right: 6
6.10 Riparian Vegetation Zone Width	Left: 8 Right: 6
Total Score	156
Habitat Rating	0.78

Habitat Stream Condition **Good**

Narrative:

Mostly stable channel with some incision in upper reach. Note: the reference channel width used for phase I reflects field observations.

Project: **Muddy Brook** | **Phase 2 Segment Summary** | February 2, 2009 SGAT Version: 4.56

Stream: **Muddy Brook** Reach # **M09** Segment: **0** Completion Date: **May 29, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Why Not assessed: Rain: **Yes**

Segment Length (ft): **5,197** Segment Location: **From reach break to just downstream of Van Sicklen Rd.**

QC Status - Staff: **Provisional** Cons **Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **None**

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	Hilly	Steep
Continuous w/	Never	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Bedrock

1.5 Valley Features

Valley Width (ft) **421**

Width Determination **Estimated**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width **20**

2.2 Max Depth (ft) **4.70**

2.3 Mean Depth (ft) **3.45**

2.4 Floodprone Width (ft) **400**

Notes:

Stable channel geometry with high sinuosity characteristic of reference conditions for E type channels. Many remnants of old beaver dams (now debris jams) throughout. Old abutments causing erosion and channel migration mid-reach.

Step 2. (Contued)

2.5 Aband. Floodpln **6.20** ft.

Human Elev Floodpln **0.00** ft.

2.6 Width/Depth Ratio **5.80**

2.7 Entrenchment Ratio **20.00**

2.8 Incision Ratio **1.32**

Human Elevated Inc Rat **0.00**

2.9 Sinuosity **High**

2.10 Riffles Type **Complete**

2.11 Riffle/Step Spacing (ft) **160**

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	0 %
Fine Gravel	8 %
Sand	10 %
Silt and smaller	82 %

Silt/Clay Present? **Yes**

Detritus **25** %

Large Woody **58**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

2.14 Stream Type

Stream Type: **E**

Bed Material: **Silt**

Subclass Slope: **None**

Bed Form: **Dune-Ripple**

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 **Undercut**

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Silt	Silt
Consistency	Cohesive	Cohesive
Bank Erosion	**Left**	**Right**
Erosion Length (ft)	374	188
Erosion Height (ft)	3.22	3.69
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0
Near Bank Veg. Type	**Left**	**Right**
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin
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	51-100
W less than 25	0	0
Buffer Veg. Type	**Left**	**Right**
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
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 **Abundant**

4.3 Flow Status **Low**

4.4 # of Debris Jams **8**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments

Impoundmt. Location

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

(old) Upstrm Flow Reg

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	2	2
Diagonal	**Delta**	**Island**
0	0	2

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
3	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.

Stream: **Muddy Brook** Reach # **M09** Segment: **0** Completion Date: **May 29, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Rain: **Yes**

Segment Length (ft): **5,197** Segment Location: **From reach break to just downstream of Van Sicklen Rd.**

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?
Old	12.5	Yes	Yes	Yes	Yes

Problem Deposition Above,Scour Below

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**15**	**None**	**No**
7.2 Channel Aggradation	**15**	**None**	**No**
7.3 Widening Channel	**13**		**No**
7.4 Change in Planform	**12**		**No**
Total Score	**55**		
Geomorphic Rating	**0.6875**		

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	18
6.2 Pool Substrate	16
6.3 Pool Variability	18
6.4 Sediment Deposition	15
6.5 Channel Flow Status	18
6.6 Channel Alteration	19
6.7 Channel Sinuosity	14
6.8 Bank Stability	Left: 7 Right: 7
6.9 Bank Vegetation Protection	Left: 7 Right: 7
6.10 Riparian Vegetation Zone Width	Left: 9 Right: 9
Total Score	164
Habitat Rating	0.82

Habitat Stream Condition **Good**

Narrative:

Mostly stable channel. See step 5 for further narrative. Note: the reference channel width used for phase I reflects field observations.

Stream: **Muddy Brook** Reach # **M10** Segment: **0** Completion Date: **June 2, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, CFF** Why Not assessed: Rain: **Yes**

Segment Length (ft): **4,338** Segment Location: **From approx. 400ft. downstream of Van Sichlen Rd. up to minor trib entering from west**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **None**

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	184	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Steep	Steep
Continuous w/	Sometimes	Never
W/in 1 Bankfill	Sometimes	Never
Texture	Bedrock	Not Evalua

1.5 Valley Features

- Valley Width (ft) **512**
- Width Determination **Measured**
- Confinement Type **Very Broad**
- Rock Gorge? **No**
- Human-caused Change? **No**

Step 2. Stream Channel

- 2.1 Bankfull Width **18**
- 2.2 Max Depth (ft) **4.20**
- 2.3 Mean Depth (ft) **3.13**
- 2.4 Floodprone Width (ft) **156**

Notes:

Many areas of reach are incised from past straightening and removal of riparian vegetation (i.e., lack of LWD inputs). Bank erosion extensive throughout and many area of failing rip-rap indicate that adjacent agriculture fields were protected in past from

Step 2. (Contued)

- 2.5 Aband. Floodpln **5.90** ft.
- Human Elev Floodpln **0.00** ft.
- 2.6 Width/Depth Ratio **5.75**
- 2.7 Entrenchment Ratio **8.67**
- 2.8 Incision Ratio **1.40**
- Human Elevated Inc Rat **0.00**
- 2.9 Sinuosity **Moderate**
- 2.10 Riffles Type **Not Applicable**
- 2.11 Riffle/Step Spacing (ft) **0**

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	1 %
Coarse Gravel	5 %
Fine Gravel	33 %
Sand	39 %
Silt and smaller	21 %

- Silt/Clay Present? **Yes**
- Detritus **20** %
- # Large Woody **36**

2.13 Average Largest Particle on

- Bed **N/A**
- Bar **N/A**

2.14 Stream Type

- Stream Type: **E**
- Bed Material: **Sand**
- Subclass Slope: **None**
- Bed Form: **Dune-Ripple**
- 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 **Undercut**

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Clay	Clay
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	796	626
Erosion Height (ft)	4.73	4.79
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	289	21

Near Bank Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	1-25	1-25

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	0-25	None
W less than 25	474	0

Buffer Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
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 **Abundant**
- 4.3 Flow Status **Low**
- 4.4 # of Debris Jams **2**
- 4.5 Flow Regulation Type **None**
  - Flow Regulation Use
  - Impoundments
  - Impoundmt. Location
- 4.6 Up/Down strm flow reg **None**
  - (old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	2	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
2	7	1
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	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 **No**
- 5.5 Straightening **Straightening**
  - Straightening Length: **467**
- 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:	Muddy Brook	Phase 2 Reach Summary	page 2 of 2		February 2, 2009
Stream:	Muddy Brook	Reach # M10	Segment: 0	Completion Date:	June 2, 2008
Organization:	Agency of Natural Resources	Observers: EPF, CFF		Rain:	Yes

Segment Length (ft): **4,338** Segment Location: **From approx. 400ft. downstream of Van Sichlen Rd. up to minor trib entering from**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Bridge	31.5	Yes	Yes	No	Yes

Problem None

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**9**	**None**	**No**
7.2 Channel Aggradation	**14**	**None**	**No**
7.3 Widening Channel	**10**		**No**
7.4 Change in Planform	**12**		**No**
Total Score	**45**		
Geomorphic Rating	**0.5625**		

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	11
6.2 Pool Substrate	10
6.3 Pool Variability	10
6.4 Sediment Deposition	12
6.5 Channel Flow Status	15
6.6 Channel Alteration	8
6.7 Channel Sinuosity	12
6.8 Bank Stability	Left: 4 Right: 4
6.9 Bank Vegetation Protection	Left: 5 Right: 7
6.10 Riparian Vegetation Zone Width	Left: 4 Right: 6
Total Score	108
Habitat Rating	0.54

Habitat Stream Condition **Fair**

Narrative:
Channel evolution is slow due to very low gradient channel with continued access to floodplain, and clay banks resistant to erosion. See step 5 for further narrative.
Note: the reference channel width used for phase I reflects field observations.

Stream: **Muddy Brook** Reach # **M11** Segment: **A** Completion Date: **June 2, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, CFF** Why Not assessed: Rain: **Yes**

Segment Length (ft): **1,885** Segment Location: **From where trib enters at reach break with M10 up to beaver dam where valley width**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Other Reason**

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
W/in 1 Bankfill	Never	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **335**

Width Determination **Measured**

Confinement Type **Very Broad**

Rock Gorge? **No**

Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width	15
2.2 Max Depth (ft)	3.45
2.3 Mean Depth (ft)	2.48
2.4 Floodprone Width (ft)	370

Notes:

No evidence of past straightening, but channel incision evident as in M10. Greater amounts of wood are present in channel b/c some larger trees and shrubs/saplings are found along the banks (more than in M10). High degree of bank erosion on outside

Step 2. (Contued)

2.5 Aband. Floodpln	4.95 ft.
Human Elev Floodpln	0.00 ft.
2.6 Width/Depth Ratio	6.05
2.7 Entrenchment Ratio	24.67
2.8 Incision Ratio	1.43
Human Elevated Inc Rat	0.00
2.9 Sinuosity	Moderate
2.10 Riffles Type	Not Applicable
2.11 Riffle/Step Spacing (ft)	0

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	4 %
Coarse Gravel	8 %
Fine Gravel	13 %
Sand	75 %
Silt and smaller	0 %

Silt/Clay Present? **Yes**

Detritus **20** %

Large Woody **36**

2.13 Average Largest Particle on

Bed **N/A**

Bar **N/A**

2.14 Stream Type

Stream Type: **E**

Bed Material: **Gravel**

Subclass Slope: **None**

Bed Form: **Dune-Ripple**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	One	11.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Undercut**

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Clay	Clay
Consistency	Cohesive	Cohesive
Bank Erosion	**Left**	**Right**
Erosion Length (ft)	413	54
Erosion Height (ft)	5.04	5.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0
Near Bank Veg. Type	**Left**	**Right**
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin
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	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Herbaceous	Herbaceous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	None	None
Mass Failures	0	21
Height	0	11
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps	Abundant
4.2 Adjacent Wetlands	Abundant
4.3 Flow Status	Low
4.4 # of Debris Jams	4
4.5 Flow Regulation Type	None
Flow Regulation Use	
Impoundments	
Impoundmt. Location	
4.6 Up/Down strm flow reg	None
(old) Upstrm Flow Reg	

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	0	1
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	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 **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.

Stream: **Muddy Brook** Reach # **M11** Segment: **A** Completion Date: **June 2, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, CFF** Rain: **Yes**

Segment Length (ft): **1,885** Segment Location: **From where trib enters at reach break with M10 up to beaver dam where valley width**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions **None**

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

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**10**	**None**	**No**
7.2 Channel Aggradation	**14**	**None**	**No**
7.3 Widening Channel	**11**		**No**
7.4 Change in Planform	**13**		**No**
Total Score	**48**		
Geomorphic Rating	**0.6**		

Channel Evolution Model **F**

Channel Evolution Stage **II**

Geomorphic Condition **Fair**

Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	11
6.2 Pool Substrate	10
6.3 Pool Variability	11
6.4 Sediment Deposition	13
6.5 Channel Flow Status	15
6.6 Channel Alteration	13
6.7 Channel Sinuosity	10
6.8 Bank Stability	Left: 4 Right: 4
6.9 Bank Vegetation Protection	Left: 6 Right: 6
6.10 Riparian Vegetation Zone Width	Left: 7 Right: 7
Total Score	117
Habitat Rating	0.585

Habitat Stream Condition **Fair**

Narrative:

Incision and some widening. See step 5 for further narrative. Note: the reference channel width used for phase I reflects field observations.

Project: **Muddy Brook**
Stream: **Muddy Brook** Reach # **M11** Segment: **B** Completion Date: **June 2, 2008**
Organization: **Agency of Natural Resources** Observers: **EPF, CFF** Why Not assessed: **beaver dam** Rain: **Yes**
Segment Length (ft): **1,542** Segment Location: **From start of impoundment at beaver dam, to reach break upstream of driveway. The reach**

QC Status - Staff: **Provisional Cons Passed**

Step 1. Valley and Floodplain

1.1 Segmentation
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		
Continuous w/		
W/in 1 Bankfill		
Texture		

1.5 Valley Features
Valley Width (ft) **0**
Width Determination
Confinement Type
Rock Gorge?
Human-caused Change?

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:
The reach has been impounded by beaver activity and extremely low slope of the valley. The reach was walked, despite the impoundments and valley and river corridor judgments were made.

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.
Human Elev Floodpln **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: **E**
Bed Material: **Sand**
Subclass Slope: **None**
Bed Form: **Dune-Ripple**
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

Bank Texture	Left	Right
Upper		
Material Type		
Consistency		
Lower		
Material Type		
Consistency		

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	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	1-25	1-25
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	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Forest	Forest
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

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

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 **3**
Affected Length (ft) **4,600**

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	1	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	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.

Project: **Muddy Brook** **Phase 2 Reach Summary** February 2, 2009

Stream: **Muddy Brook** Reach # **M11** Segment: **B** Completion Date: **June 2, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, CFF** Rain: **Yes**

Segment Length (ft): **1,542** Segment Location: **From start of impoundment at beaver dam, to reach break upstream of driveway. The**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions

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

Narrative:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Fair**

Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Project: **Muddy Brook** | **Phase 2 Segment Summary** | | February 2, 2009 | SGAT Version: 4.56

Stream: **Muddy Brook** | Reach # **M12** | Segment: **0** | Completion Date: **June 2, 2008**

Organization: **Agency of Natural Resources** | Observers: **FEA, CFF** | Why Not assessed: **beaver dam** | Rain: **Yes**

Segment Length (ft): **1,989** | Segment Location: **Ponded reach from old farming road to ~600 yards downstream of Rt. 116 crossing. Reach**

QC Status - Staff: Provisional Cons **Passed**

Step 1. Valley and Floodplain

1.1 Segmentation

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		
Continuous w/		
W/in 1 Bankfill		
Texture		

1.5 Valley Features

Valley Width (ft) **0**

Width Determination

Confinement Type

Rock Gorge?

Human-caused Change?

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:

Administrative judgment was used to enter stream type and condition in order to develop Fluvial Erosion Hazard (FEH) zones for reaches not completely assessed for Phase 2 data. The classification took into account the buffer and corridor conditions, past land use

Step 2. (Contued)

2.5 Aband. Floodpln	0.00 ft.
Human Elev Floodpln	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: **E**

Bed Material: **Sand**

Subclass Slope: **None**

Bed Form: **Dune-Ripple**

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

Bank Texture	Left	Right
Upper		
Material Type		
Consistency		
Lower		
Material Type		
Consistency		

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	Herbaceous	Deciduous
Sub-dominant	Pasture	Herbaceous

Bank Canopy	Left	Right
Canopy %	0	51-75
Mid-Channel Canopy	Open	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	>100
Sub-dominant	0-25	None
W less than 25	332	0

Buffer Veg. Type	Left	Right
Dominant	Herbaceous	Deciduous
Sub-dominant	Shrubs/Saplin	Herbaceous

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Hay	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

4.2 Adjacent Wetlands

4.3 Flow Status

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments

Impoundmt. Location

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

(old) Upstrm Flow Reg

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	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	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.

Stream: **Muddy Brook** Reach # **M12** Segment: **0** Completion Date: **June 2, 2008**

Organization: **Agency of Natural Resources** Observers: **FEA, CFF** Rain: **Yes**

Segment Length (ft): **1,989** Segment Location: **Ponded reach from old farming road to ~600 yards downstream of Rt. 116 crossing.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions

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

Narrative:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Fair**

Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Project: **Muddy Brook** | **Phase 2 Segment Summary** | | February 2, 2009 | SGAT Version: 4.56

Stream: **Muddy Brook** | Reach # **M13** | Segment: **0** | Completion Date: **June 2, 2008**

Organization: **Agency of Natural Resources** | Observers: **FEA, CFF** | Why Not assessed: **beaver dam** | Rain: **Yes**

Segment Length (ft): **1,861** | Segment Location: **From the reach break up to the Rt. 116 crossing. Reach was not completely assessed due**

QC Status - Staff: **Provisional** | Cons **Passed**

Step 1. Valley and Floodplain

1.1 Segmentation

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		
Continuous w/		
W/in 1 Bankfill		
Texture		

1.5 Valley Features

Valley Width (ft) **0**

Width Determination

Confinement Type

Rock Gorge?

Human-caused Change?

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:

Administrative judgment was used to enter stream type and condition in order to develop Fluvial Erosion Hazard (FEH) zones for reaches not completely assessed for Phase 2 data. The classification took into account the buffer and corridor conditions, past land use

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **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: **E**

Bed Material: **Sand**

Subclass Slope: **None**

Bed Form: **Dune-Ripple**

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

Bank Texture	Left	Right
Upper		
Material Type		
Consistency		
Lower		
Material Type		
Consistency		

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	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	0	0
Mid-Channel Canopy	Open	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	26-50	>100
Sub-dominant	51-100	None
W less than 25	214	0

Buffer Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Hay	Hay
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps

4.2 Adjacent Wetlands

4.3 Flow Status

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments

Impoundmt. Location

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

(old) Upstrm Flow Reg

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	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	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.

Stream: **Muddy Brook** Reach # **M13** Segment: **0** Completion Date: **June 2, 2008**

Organization: **Agency of Natural Resources** Observers: **FEA, CFF** Rain: **Yes**

Segment Length (ft): **1,861** Segment Location: **From the reach break up to the Rt. 116 crossing. Reach was not completely assessed**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions

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

Narrative:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Fair**

Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Project: Muddy Brook

Phase 2 Segment Summary

February 2, 2009 SGAT Version: 4.56

Stream: **Muddy Brook** Reach # **M14** Segment: **0** Completion Date: **June 2, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, CFF** Why Not assessed: **beaver dam** Rain: **No**

Segment Length (ft): **2,262** Segment Location: **From Rt. 116 crossing to reach break. Channel was not completely assessed due to**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation

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		
Continuous w/		
W/in 1 Bankfill		
Texture		

1.5 Valley Features

Valley Width (ft) **0**

Width Determination

Confinement Type

Rock Gorge?

Human-caused Change?

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:

Administrative judgment was used to enter stream type and condition in order to develop Fluvial Erosion Hazard (FEH) zones for reaches not completely assessed for Phase 2 data. The classification took into account the buffer and corridor conditions, past land use

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **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: **E**

Bed Material: **Sand**

Subclass Slope: **None**

Bed Form: **Dune-Ripple**

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

Bank Texture	Left	Right
Upper		
Material Type		
Consistency		
Lower		
Material Type		
Consistency		

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	Deciduous	Herbaceous
Sub-dominant	Herbaceous	None

Bank Canopy	Left	Right
Canopy %	51-75	0
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	272	1,620

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Herbaceous
Sub-dominant	Herbaceous	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Hay
Sub-dominant	Hay	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps

4.2 Adjacent Wetlands

4.3 Flow Status

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments

Impoundmt. Location

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

(old) Upstrm Flow Reg

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	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	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.

Stream: **Muddy Brook** Reach # **M14** Segment: **0** Completion Date: **June 2, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, CFF** Rain: **No**

Segment Length (ft): **2,262** Segment Location: **From Rt. 116 crossing to reach break. Channel was not completely assessed due to**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions

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

Narrative:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Fair**

Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Project: **Muddy Brook** | **Phase 2 Segment Summary** February 2, 2009 SGAT Version: 4.56

Stream: **Muddy Brook** Reach # **M15** Segment: **0** Completion Date: **June 3, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, CFF** Why Not assessed: **wetland** Rain: **Yes**

Segment Length (ft): **3,539** Segment Location: **From Reach break to Shelburne Pond. Reach was not completely assessed due to**

QC Status - Staff: **Provisional Cons** **Passed**

Step 1. Valley and Floodplain

1.1 Segmentation

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		
Continuous w/		
W/in 1 Bankfill		
Texture		

1.5 Valley Features

Valley Width (ft) **0**

Width Determination

Confinement Type

Rock Gorge?

Human-caused Change?

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:

Administrative judgment was used to enter stream type and condition in order to develop Fluvial Erosion Hazard (FEH) zones for reaches not completely assessed for Phase 2 data. The classification took into account the buffer and corridor conditions, past land use

Step 2. (Contued)

2.5 Aband. Floodpln	0.00 ft.
Human Elev Floodpln	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: **E**

Bed Material: **Sand**

Subclass Slope: **None**

Bed Form: **Dune-Ripple**

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

Bank Texture	Left	Right
Upper		
Material Type		
Consistency		
Lower		
Material Type		
Consistency		

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	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	1-25	0
Mid-Channel Canopy	Open	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	>100
Sub-dominant	0-25	0-25
W less than 25	751	604

Buffer Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Mixed Trees	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Hay	Hay
Sub-dominant	Forest	None
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps

4.2 Adjacent Wetlands

4.3 Flow Status

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments

Impoundmt. Location

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

(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	1	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	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	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.

Project: **Muddy Brook** | **Phase 2 Reach Summary** | page 2 of 2 | February 2, 2009

Stream: **Muddy Brook** | Reach # **M15** | Segment: **0** | Completion Date: **June 3, 2008**

Organization: **Agency of Natural Resources** | Observers: **EPF, CFF** | Rain: **Yes**

Segment Length (ft): **3,539** | Segment Location: **From Reach break to Shelburne Pond. Reach was not completely assessed due to**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken

4.8 Channel Constrictions

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

Narrative:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Fair**

Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Stream: **Muddy Brook** Reach # **M18** Segment: **0** Completion Date: **June 3, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, CFF** Why Not assessed: **wetland** Rain: **Yes**

Segment Length (ft): **1,189** Segment Location: **From Shelburne Pond to reach break in Ag field. Reach was not completely assessed due**

QC Status - Staff: **Provisional** Cons **Passed**

Step 1. Valley and Floodplain

1.1 Segmentation

1.2 Alluvial Fan

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		
Continuous w/		
W/in 1 Bankfill		
Texture		

1.5 Valley Features

Valley Width (ft) **0**

Width Determination

Confinement Type

Rock Gorge?

Human-caused Change?

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:

Administrative judgment was used to enter stream type and condition in order to develop Fluvial Erosion Hazard (FEH) zones for reaches not completely assessed for Phase 2 data. The classification took into account the buffer and corridor conditions, past land use

Step 2. (Contued)

2.5 Aband. Floodpln	0.00 ft.
Human Elev Floodpln	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: **E**

Bed Material: **Sand**

Subclass Slope: **None**

Bed Form: **Dune-Ripple**

Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures		0.00
Gullies		0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope

Bank Texture	Left	Right
Upper		
Material Type		
Consistency		
Lower		
Material Type		
Consistency		

Bank Erosion	Left	Right
Erosion Length (ft)	0	0
Erosion Height (ft)	0.00	0.00
Revetmt. Type		
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	None	None

Bank Canopy	Left	Right
Canopy %	0	0
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	Herbaceous	Herbaceous
Sub-dominant	None	None

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
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

4.2 Adjacent Wetlands

4.3 Flow Status

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type

Flow Regulation Use

Impoundments

Impoundmt. Location

4.6 Up/Down strm flow reg

(old) Upstrm Flow Reg

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	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	

5.4 Stream Ford or Animal

5.5 Straightening

Straightening Length: **0**

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.

Stream: **Muddy Brook** Reach # **M18** Segment: **0** Completion Date: **June 3, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, CFF** Rain: **Yes**

Segment Length (ft): **1,189** Segment Location: **From Shelburne Pond to reach break in Ag field. Reach was not completely assessed**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions

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

Narrative:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Fair**

Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Phase 2 Segment Summary

February 2, 2009 SGAT Version: 4.56

Project: Muddy Brook
Stream: **Muddy Brook** Reach # **M19** Segment: **0** Completion Date: **June 11, 2008**
Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Why Not assessed: **no property access** Rain: **Yes**
Segment Length (ft): **3,294** Segment Location: **Reach was in the pasture field downstream of Cheesefactory Rd. Access to the reach was**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation

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		
Continuous w/		
W/in 1 Bankfill		
Texture		

1.5 Valley Features

Valley Width (ft) **0**
Width Determination
Confinement Type
Rock Gorge?
Human-caused Change?

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:

Administrative judgment was used to enter stream type and condition in order to develop Fluvial Erosion Hazard (FEH) zones for reaches not completely assessed for Phase 2 data. The classification took into account the buffer and corridor conditions, past land use

Step 2. (Contued)

2.5 Aband. Floodpln	0.00 ft.
Human Elev Floodpln	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: **E**
Bed Material: **Sand**
Subclass Slope: **None**
Bed Form: **Dune-Ripple**
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

Bank Texture	Left	Right
Upper		
Material Type		
Consistency		
Lower		
Material Type		
Consistency		

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	Pasture	Pasture
Sub-dominant	Herbaceous	Herbaceous

Bank Canopy	Left	Right
Canopy %	0	0
Mid-Channel Canopy	Open	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	0-25	0-25
Sub-dominant	26-50	26-50
W less than 25	1,886	1,895

Buffer Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Pasture	Pasture
Sub-dominant	Hay	Hay
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

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

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	1	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	

5.4 Stream Ford or Animal **Yes**
5.5 Straightening **With Windrowing**
Straightening Length: **1,402**
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.

Stream: **Muddy Brook** Reach # **M19** Segment: **0** Completion Date: **June 11, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Rain: **Yes**

Segment Length (ft): **3,294** Segment Location: **Reach was in the pasture field downstream of Cheesefactory Rd. Access to the reach**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken

4.8 Channel Constrictions

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

Narrative:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Fair**

Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Stream: **Muddy Brook** Reach # **M20** Segment: **0** Completion Date: **June 11, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Why Not assessed: Rain: **Yes**

Segment Length (ft): **4,962** Segment Location: **From pasture clearing about 400 feet south of Cheesefactory Rd. to the confluence with Trib**

QC Status - Staff: **Provisional** Cons **Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **None**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	85	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	Hilly	Hilly
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Silt/Clay	Silt/Clay

1.5 Valley Features

- Valley Width (ft) **440**
- Width Determination **Estimated**
- Confinement Type **Very Broad**
- Rock Gorge? **No**
- Human-caused Change? **No**

Step 2. Stream Channel

- 2.1 Bankfull Width **6**
- 2.2 Max Depth (ft) **1.60**
- 2.3 Mean Depth (ft) **0.94**
- 2.4 Floodprone Width (ft) **130**

Notes:

Downstream of the Cheese Factory Rd. crossing the channel has been straightened with windrowing* which slightly limits its floodplain access - channel length was not long enough and floodplain disconnection not severe enough for this area to warrant

Step 2. (Contued)

- 2.5 Aband. Floodpln **1.60** ft.
- Human Elev Floodpln **0.00** ft.
- 2.6 Width/Depth Ratio **6.38**
- 2.7 Entrenchment Ratio **21.67**
- 2.8 Incision Ratio **1.00**
- 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	0%
Cobble	0%
Coarse Gravel	0%
Fine Gravel	5%
Sand	85%
Silt and smaller	10%

- Silt/Clay Present? **Yes**
- Detritus **5** %
- # Large Woody **19**

2.13 Average Largest Particle on

- Bed **N/A**
- Bar **N/A**

2.14 Stream Type

- Stream Type: **E**
- Bed Material: **Sand**
- Subclass Slope: **None**
- Bed Form: **Dune-Ripple**
- 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	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Clay	Clay
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	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	1-25	1-25
Mid-Channel Canopy	Open	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	51-100
Sub-dominant	>100	26-50
W less than 25	524	623

Buffer Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Forest	Forest
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 **Abundant**
- 4.3 Flow Status **Low**
- 4.4 # of Debris Jams **3**
- 4.5 Flow Regulation Type **None**
- Flow Regulation Use
- Impoundments
- Impoundmt. Location
- 4.6 Up/Down strm flow reg **None**
- (old) Upstrm Flow Reg

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	0	1
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	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 **Yes**
- 5.5 Straightening **With Windrowing**
- Straightening Length: **2,725**
- 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:	**Muddy Brook**	**Phase 2 Reach Summary**	page 2 of 2		February 2, 2009
Stream:	**Muddy Brook**	Reach # **M20**	Segment: **0**	Completion Date:	**June 11, 2008**
Organization:	**Agency of Natural Resources**	Observers: **EPF, SPP**		Rain:	**Yes**
Segment Length (ft):	**4,962**	Segment Location: **From pasture clearing about 400 feet south of Cheesefactory Rd. to the confluence**			

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?
Culvert	4.00	Yes	No	Yes	Yes
Problem	Scour Above,Scour Below				
Culvert	6.00	Yes	Yes	No	No
Problem	None				
Culvert	5.50	Yes	Yes	No	No
Problem	None				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**13**	**None**	**No**
7.2 Channel Aggradation	**16**	**None**	**No**
7.3 Widening Channel	**17**		**No**
7.4 Change in Planform	**14**		**No**
Total Score	**60**		
Geomorphic Rating	**0.75**		

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	7
6.2 Pool Substrate	12
6.3 Pool Variability	6
6.4 Sediment Deposition	16
6.5 Channel Flow Status	16
6.6 Channel Alteration	8
6.7 Channel Sinuosity	7
6.8 Bank Stability	Left: 9 Right: 9
6.9 Bank Vegetation Protection	Left: 7 Right: 7
6.10 Riparian Vegetation Zone Width	Left: 7 Right: 7
Total Score	118
Habitat Rating	0.59

Habitat Stream Condition **Fair**

Narrative:

Channel seems very stable and well buffered by the near bank vegetation. See step 5 for further narrative. Note: the reference channel width used for phase I reflects field observations.

Project: **Muddy Brook** | **Phase 2 Segment Summary** | February 2, 2009 | SGAT Version: 4.56

Stream: **Muddy Brook** | Reach # **M21** | Segment: **0** | Completion Date: **June 12, 2008**

Organization: **Agency of Natural Resources** | Observers: **EPF, SPP** | Why Not assessed: | Rain: **Yes**

Segment Length (ft): **7,589** | Segment Location: **From reach break at Tributary 9 to farm ditch near golf course.**

QC Status - Staff: **Provisional** Cons **Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **None**

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	949

1.4 Adjacent Side	Left	Right
Hillside Slope	Flat	Flat
Continuous w/	Never	Never
W/in 1 Bankfill	Never	Never
Texture	Not Evalua	Not Evalua

1.5 Valley Features

- Valley Width (ft) **394**
- Width Determination **Estimated**
- Confinement Type **Very Broad**
- Rock Gorge? **No**
- Human-caused Change? **No**

Step 2. Stream Channel

- 2.1 Bankfull Width **4**
- 2.2 Max Depth (ft) **1.70**
- 2.3 Mean Depth (ft) **0.79**
- 2.4 Floodprone Width (ft) **59**

Notes:

The channel largely exhibits E-type geometry, but the low slope in this headwater reach has led to ponding in several areas. Given the small drainage area of the reach and low slope there are little geomorphic processes at work, and the floodplain remains connected

Step 2. (Contued)

- 2.5 Aband. Floodpln **2.20** ft.
- Human Elev Floodpln **0.00** ft.
- 2.6 Width/Depth Ratio **4.43**
- 2.7 Entrenchment Ratio **16.71**
- 2.8 Incision Ratio **1.29**
- 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	0 %
Cobble	0 %
Coarse Gravel	0 %
Fine Gravel	0 %
Sand	80 %
Silt and smaller	20 %

- Silt/Clay Present? **Yes**
- Detritus **5** %
- # Large Woody **0**

2.13 Average Largest Particle on

- Bed **N/A**
- Bar **N/A**

2.14 Stream Type

- Stream Type: **E**
- Bed Material: **Sand**
- Subclass Slope: **None**
- Bed Form: **Dune-Ripple**
- 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	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Sand	Clay
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	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	1-25	1-25

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	51-100
Sub-dominant	0-25	0-25
W less than 25	1,833	1,690

Buffer Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Other	Other
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

- 4.1 Springs / Seeps **Abundant**
- 4.2 Adjacent Wetlands **Abundant**
- 4.3 Flow Status **Low**
- 4.4 # of Debris Jams **0**
- 4.5 Flow Regulation Type **Large Run of**
- Flow Regulation Use **Other**
- Impoundments
- Impoundmt. Location
- 4.6 Up/Down strm flow reg **None**
- (old) Upstrm Flow Reg

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

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	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 **Yes**
- 5.5 Straightening **Straightening**
- Straightening Length: **7,496**
- 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.

Stream: **Muddy Brook** Reach # **M21** Segment: **0** Completion Date: **June 12, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Rain: **Yes**

Segment Length (ft): **7,589** Segment Location: **From reach break at Tributary 9 to farm ditch near golf course.**

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?
Culvert	3.00	Yes	No	Yes	No
Problem	Scour Above,Scour Below				
Culvert	3.50	Yes	No	Yes	No
Problem	Scour Above,Scour Below				
Culvert	3.00	Yes	No	Yes	No
Problem	Deposition Above,Scour Below				
Culvert	3.00	Yes	No	Yes	No
Problem	None				
Culvert	3.50	Yes	No	Yes	No
Problem	None				
Culvert	3.50	Yes	No	Yes	No
Problem	None				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**10**	**None**	**No**
7.2 Channel Aggradation	**12**	**None**	**No**
7.3 Widening Channel	**14**		**No**
7.4 Change in Planform	**11**		**Yes**
Total Score	**47**		
Geomorphic Rating	**0.5875**		

Channel Evolution Model **F**

Channel Evolution Stage **II**

Geomorphic Condition **Fair**

Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	5
6.2 Pool Substrate	6
6.3 Pool Variability	8
6.4 Sediment Deposition	10
6.5 Channel Flow Status	14
6.6 Channel Alteration	7
6.7 Channel Sinuosity	5
6.8 Bank Stability	Left: 8 Right: 8
6.9 Bank Vegetation Protection	Left: 5 Right: 5
6.10 Riparian Vegetation Zone Width	Left: 5 Right: 6
Total Score	92
Habitat Rating	0.46

Habitat Stream Condition **Fair**

Narrative:

See step 5 for narrative. Note: the reference channel width used for phase I reflects field observations.

Project: **Muddy Brook** | **Phase 2 Segment Summary** page 1 of 2 | February 2, 2009 SGAT Version: 4.56

Stream: **Unnamed Tributary** Reach # **T2.01** Segment: **A** Completion Date: **June 5, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, CFF** Why Not assessed: Rain: **Yes**

Segment Length (ft): **1,712** Segment Location: **From confluence with mainstem upstream of Kimball Ave. up to beaver dams south of**

QC Status - Staff: **Provisional Cons Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **Other Reason**

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/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Sand

1.5 Valley Features

- Valley Width (ft) **99**
- Width Determination **Measured**
- Confinement Type **Very Broad**
- Rock Gorge? **No**
- Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width	6
2.2 Max Depth (ft)	1.50
2.3 Mean Depth (ft)	0.94
2.4 Floodprone Width (ft)	40

Notes:

Severe incision in lower reach where armoring is not present. Headcut noted immediately below Marshall Ave. crossing. Incision upstream of Marshall Ave. may be related to past beaver ponding and deposition of sediment behind the dams.

Step 2. (Contued)

2.5 Aband. Floodpln	2.30 ft.
Human Elev Floodpln	0.00 ft.
2.6 Width/Depth Ratio	5.85
2.7 Entrenchment Ratio	7.27
2.8 Incision Ratio	1.53
Human Elevated Inc Rat	0.00
2.9 Sinuosity	Moderate
2.10 Riffles Type	Not Applicable
2.11 Riffle/Step Spacing (ft)	0

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	0 %
Fine Gravel	0 %
Sand	90 %
Silt and smaller	10 %

- Silt/Clay Present? **Yes**
- Detritus **40** %
- # Large Woody **67**

2.13 Average Largest Particle on

- Bed **N/A**
- Bar **N/A**

2.14 Stream Type

- Stream Type: **E**
- Bed Material: **Sand**
- Subclass Slope: **None**
- Bed Form: **Dune-Ripple**
- Field Measured Slope:

2.15 Reference Stream Type

(if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	One	5.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Undercut**

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	117	175
Erosion Height (ft)	2.22	1.55
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	112	115

Near Bank Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Herbaceous	Herbaceous

Bank Canopy	Left	Right
Canopy %	51-75	51-75
Mid-Channel Canopy	Closed	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	51-100
Sub-dominant	26-50	26-50
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Mixed Trees	Mixed Trees

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Forest	Forest
Mass Failures	0	26
Height	0	5
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps	Abundant
4.2 Adjacent Wetlands	Abundant
4.3 Flow Status	Low
4.4 # of Debris Jams	3
4.5 Flow Regulation Type	None
Flow Regulation Use	
Impoundments	
Impoundmt. Location	
4.6 Up/Down strm flow reg	None
(old) Upstrm Flow Reg	

4.7 StormwaterInputs

Field Ditch	1	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	3	1
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	1	No

- 5.4 Stream Ford or Animal **No**
- 5.5 Straightening **Straightening**
- Straightening Length: **193**
- 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.

Stream: **Unnamed Tributary** Reach # **T2.01** Segment: **A** Completion Date: **June 5, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, CFF** Rain: **Yes**

Segment Length (ft): **1,712** Segment Location: **From confluence with mainstem upstream of Kimball Ave. up to beaver dams south of**

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?
Culvert	2.50	Yes	Yes	Yes	Yes
Problem	Deposition Above,Scour Below				
Culvert	3.50	Yes	Yes	Yes	Yes
Problem	Scour Below				

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**7**	**None**	**No**
7.2 Channel Aggradation	**8**	**None**	**No**
7.3 Widening Channel	**10**		**No**
7.4 Change in Planform	**11**		**No**
Total Score	**36**		
Geomorphic Rating	**0.45**		

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	13
6.2 Pool Substrate	7
6.3 Pool Variability	6
6.4 Sediment Deposition	6
6.5 Channel Flow Status	13
6.6 Channel Alteration	10
6.7 Channel Sinuosity	6
6.8 Bank Stability	Left: 4 Right: 4
6.9 Bank Vegetation Protection	Left: 6 Right: 6
6.10 Riparian Vegetation Zone Width	Left: 5 Right: 5
Total Score	91
Habitat Rating	0.455

Habitat Stream Condition **Fair**

Narrative:

Incision and beginning stages of bank erosion and widening. See step 5 for further narrative.

Project: **Muddy Brook** — **Phase 2 Segment Summary** — February 2, 2009 SGAT Version: 4.56

Stream: **Unnamed Tributary** Reach # **T2.01** Segment: **B** Completion Date: **June 5, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, CFF** Why Not assessed: **beaver dam** Rain: **Yes**

Segment Length (ft): **2,222** Segment Location: **From reach break to change in confinement and impoundments south of Shunpike Rd.**

QC Status - Staff: **Provisional** Cons **Passed**

Step 1. Valley and Floodplain

1.1 Segmentation

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		
Continuous w/		
W/in 1 Bankfill		
Texture		

1.5 Valley Features

Valley Width (ft) 0

Width Determination

Confinement Type

Rock Gorge?

Human-caused Change?

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:

Administrative judgment was used to enter stream type and condition in order to develop Fluvial Erosion Hazard (FEH) zones for reaches not completely assessed for Phase 2 data. The classification took into account the buffer and corridor conditions, past land use

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **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: **E**

Bed Material: **Sand**

Subclass Slope: **None**

Bed Form: **Dune-Ripple**

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

Bank Texture	Left	Right
Upper		
Material Type		
Consistency		
Lower		
Material Type		
Consistency		

Bank Erosion	Left	Right
Erosion Length (ft)	0	2
Erosion Height (ft)	0.00	0.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Deciduous	Deciduous

Bank Canopy	Left	Right
Canopy %	1-25	1-25

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	51-100
Sub-dominant	26-50	26-50
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Commercial	Shrubs/Saplin
Mass Failures	0	0
Height	0	0
Gullies	0	0
Height	0	0

Step 4. Flow & Flow Modifiers

4.1 Springs / Seeps

4.2 Adjacent Wetlands

4.3 Flow Status

4.4 # of Debris Jams **0**

4.5 Flow Regulation Type **None**

Flow Regulation Use

Impoundments

Impoundmt. Location

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

(old) Upstrm Flow Reg

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 **1**

Affected Length (ft) **1,500**

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	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	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.

Stream: **Unnamed Tributary** Reach # **T2.01** Segment: **B** Completion Date: **June 5, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, CFF** Rain: **Yes**

Segment Length (ft): **2,222** Segment Location: **From reach break to change in confinement and impoundments south of Shunpike Rd.**

1.6 Grade Controls

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions

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

Narrative:

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Fair**

Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Project:	**Muddy Brook**		**Phase 2 Segment Summary**	page 1 of 2		February 2, 2009	SGAT Version: 4.56
Stream:	**Taft Corners Tributary**	Reach #	**T3.01**	Segment:	**A**	Completion Date:	**June 20, 2008**
Organization:	**Agency of Natural Resources**	Observers:	**EPF, SPP**	Why Not assessed:		Rain:	**Yes**
Segment Length (ft):	**1,147**	Segment Location:	**From the confluence with the main stem just downstream of the I-89 Crossing to the**				

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	222	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	Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Always	Always
Texture	Mixed	Mixed

1.5 Valley Features

Valley Width (ft)	188
Width Determination	Measured
Confinement Type	Broad
Rock Gorge?	No
Human-caused Change?	Yes

Step 2. Stream Channel

2.1 Bankfull Width	20
2.2 Max Depth (ft)	5.20
2.3 Mean Depth (ft)	2.84
2.4 Floodprone Width (ft)	151

Notes:

Channel is incised from historic straightening associated with I-89 construction. Clay present in bed limiting further channel down-cutting. High degree of bank erosion and mass failures along right bank. Habitat highly impacted by change in channel morphology.

Step 2. (Contued)

2.5 Aband. Floodpln	6.50 ft.
Human Elev Floodpln	0.00 ft.
2.6 Width/Depth Ratio	6.97
2.7 Entrenchment Ratio	7.63
2.8 Incision Ratio	1.25
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	0 %
Cobble	0 %
Coarse Gravel	3 %
Fine Gravel	6 %
Sand	15 %
Silt and smaller	76 %

Silt/Clay Present?	Yes
Detritus	25 %
# Large Woody	40

2.13 Average Largest Particle on

Bed	N/A
Bar	N/A

2.14 Stream Type

Stream Type:	E
Bed Material:	Silt
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	Multiple	11.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

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

Bank Erosion	Left	Right
Erosion Length (ft)	156	113
Erosion Height (ft)	4.06	3.90
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	51-75	51-75
Mid-Channel Canopy	Closed	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	51-100
Sub-dominant	26-50	>100
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Mixed Trees
Sub-dominant	Herbaceous	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Forest	Commercial
Mass Failures	0	72
Height	0	11
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	Moderate
4.4 # of Debris Jams	5
4.5 Flow Regulation Type	None
Flow Regulation Use	
Impoundments	
Impoundmt. Location	
4.6 Up/Down strm flow reg	None
(old) Upstrm Flow Reg	

4.7 StormwaterInputs

Field Ditch	1	Road Ditch	3
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	1	1
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	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	No
5.5 Straightening	Straightening
Straightening Length:	996
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.

Stream: **Taft Corners Tributary** Reach # **T3.01** Segment: **A** Completion Date: **June 20, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Rain: **Yes**

Segment Length (ft): **1,147** Segment Location: **From the confluence with the main stem just downstream of the I-89 Crossing to the**

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?
Culvert	8.50	Yes	Yes	Yes	Yes

Problem Scour Below

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**9**	**None**	**No**
7.2 Channel Aggradation	**12**	**None**	**No**
7.3 Widening Channel	**12**		**No**
7.4 Change in Planform	**13**		**Yes**
Total Score	**46**		
Geomorphic Rating	**0.575**		

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	6
6.2 Pool Substrate	6
6.3 Pool Variability	8
6.4 Sediment Deposition	10
6.5 Channel Flow Status	10
6.6 Channel Alteration	7
6.7 Channel Sinuosity	5
6.8 Bank Stability	Left: 6 Right: 6
6.9 Bank Vegetation Protection	Left: 7 Right: 7
6.10 Riparian Vegetation Zone Width	Left: 5 Right: 7
Total Score	90
Habitat Rating	0.45

Habitat Stream Condition **Fair**

Narrative:

The channel has been historically straightened during the construction of I-89 in the early 60's. It has since been down-cutting becoming slightly incised. Overall the segment is stabilized by the interstate and not developing new planform.

Project: Muddy Brook

Phase 2 Segment Summary

February 2, 2009 SGAT Version: 4.56

Stream: **Taft Corners Tributary** Reach # **T3.01** Segment: **B** Completion Date: **June 20, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Why Not assessed: Rain: **Yes**

Segment Length (ft): **773** Segment Location: **From just upstream of S. Brownell Rd. to below the ponded area by the industrial park.**

QC Status - Staff: **Provisional Cons Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **Planform and Scope**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	0	0
height	0	0
Roads	662	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	Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Mixed	Not Evalua

1.5 Valley Features

- Valley Width (ft) **199**
- Width Determination **Measured**
- Confinement Type **Very Broad**
- Rock Gorge? **No**
- Human-caused Change? **Yes**

Step 2. Stream Channel

- 2.1 Bankfull Width **11**
- 2.2 Max Depth (ft) **3.20**
- 2.3 Mean Depth (ft) **2.05**
- 2.4 Floodprone Width (ft) **182**

Notes:

Stable reach with high sinuosity and good floodplain connectivity. Healthy wetland vegetation and buffer provide high quality floodplain functions. High LWD density despite limited woody vegetation from recurrent beaver activity.

Step 2. (Contued)

- 2.5 Aband. Floodpln **3.70** ft.
- Human Elev Floodpln **0.00** ft.
- 2.6 Width/Depth Ratio **5.22**
- 2.7 Entrenchment Ratio **17.01**
- 2.8 Incision Ratio **1.16**
- Human Elevated Inc Rat **0.00**
- 2.9 Sinuosity **High**
- 2.10 Riffles Type **Complete**
- 2.11 Riffle/Step Spacing (ft) **88**

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	0 %
Fine Gravel	5 %
Sand	35 %
Silt and smaller	60 %

- Silt/Clay Present? **Yes**
- Detritus **40** %
- # Large Woody **18**

2.13 Average Largest Particle on

- Bed **N/A**
- Bar **N/A**

2.14 Stream Type

- Stream Type: **E**
- Bed Material: **Silt**
- Subclass Slope: **None**
- Bed Form: **Dune-Ripple**
- Field Measured Slope:

2.15 Reference Stream Type (if different from Phase 1)

3.3 old	Amount	Mean Height
Failures	One	20.00
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Steep**

Bank Texture	Left	Right
Upper		
Material Type	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Clay	Clay
Consistency	Cohesive	Cohesive
Bank Erosion	**Left**	**Right**
Erosion Length (ft)	0	0
Erosion Height (ft)	0.00	0.00
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	98	96
Near Bank Veg. Type	**Left**	**Right**
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin
Bank Canopy	**Left**	**Right**
Canopy %	1-25	1-25
Mid-Channel Canopy	Open	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	51-100
Sub-dominant	51-100	>100
W less than 25	0	0
Buffer Veg. Type	**Left**	**Right**
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Forest	Forest
Mass Failures	47	0
Height	20	0
Gullies	0	0
Height	0	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 **2**
- 4.5 Flow Regulation Type **None**
  - Flow Regulation Use
  - Impoundments
  - Impoundmt. Location
- 4.6 Up/Down strm flow reg **None**
  - (old) Upstrm Flow Reg

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

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
0	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 **No**
- 5.5 Straightening **Straightening**
  - Straightening Length: **97**
- 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.

Stream: **Taft Corners Tributary** Reach # **T3.01** Segment: **B** Completion Date: **June 20, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Rain: **Yes**

Segment Length (ft): **773** Segment Location: **From just upstream of S. Brownell Rd. to below the ponded area by the industrial park.**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions **None**

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

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**15**	**None**	**No**
7.2 Channel Aggradation	**16**	**None**	**No**
7.3 Widening Channel	**17**		**No**
7.4 Change in Planform	**14**		**No**
Total Score	**62**		
Geomorphic Rating	**0.775**		

Channel Evolution Model **F**

Channel Evolution Stage **I**

Geomorphic Condition **Good**

Stream Sensitivity **High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	15
6.2 Pool Substrate	15
6.3 Pool Variability	14
6.4 Sediment Deposition	13
6.5 Channel Flow Status	16
6.6 Channel Alteration	16
6.7 Channel Sinuosity	19
6.8 Bank Stability	Left: 8 Right: 8
6.9 Bank Vegetation Protection	Left: 6 Right: 6
6.10 Riparian Vegetation Zone Width	Left: 8 Right: 7
Total Score	151
Habitat Rating	0.755

Habitat Stream Condition **Good**

Narrative:

Stable reach, with lots of woody debris and good access to its floodplain.

Project: **Muddy Brook** — **Phase 2 Segment Summary** February 2, 2009 SGAT Version: 4.56

Stream: **Taft Corners Tributary** Reach # **T3.01** Segment: **C** Completion Date: **June 20, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP, SEG** Why Not assessed: **beaver dam** Rain: **Yes**

Segment Length (ft): **1,223** Segment Location: **Segment ponded and impounded throughout industrial area; assessed for corridor and**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Flow Status**

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	Hilly	Hilly
Continuous w/	Sometimes	Never
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

Valley Width (ft) **0**

Width Determination

Confinement Type

Rock Gorge?

Human-caused Change?

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:

Given the ponding throughout the length of this segment it was not necessary to enter all of the data and only corridor characteristics were entered.

Administrative judgment was used to enter

Step 2. (Contued)

2.5 Aband. Floodpln **0.00** ft.

Human Elev Floodpln **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: **E**

Bed Material: **Sand**

Subclass Slope: **None**

Bed Form: **Dune-Ripple**

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	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Silt	Silt
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	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	1-25	1-25

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	>100
Sub-dominant	>100	51-100
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Forest	Forest
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

Impoundmt. Location

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

(old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	2

4.9 # of Beaver Dams **1**

Affected Length (ft) **1,223**

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
1	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	0	

5.4 Stream Ford or Animal **Yes**

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.

Stream: **Taft Corners Tributary** Reach # **T3.01** Segment: **C** Completion Date: **June 20, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP, SEG** Rain: **Yes**

Segment Length (ft): **1,223** Segment Location: **Segment ponded and impounded throughout industrial area; assessed for corridor and**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken

4.8 Channel Constrictions **None**

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

Step 7. Rapid Geomorphic Assessment Data

Confinement Type

Channel Evolution Model

Channel Evolution Stage

Geomorphic Condition **Fair**

Stream Sensitivity

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type

Habitat Stream Condition

Narrative:

Project: Muddy Brook

Phase 2 Segment Summary

February 2, 2009 SGAT Version: 4.56

Stream: **Taft Corners Tributary** Reach # **T3.01** Segment: **D** Completion Date: **June 20, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Why Not assessed: Rain: **Yes**

Segment Length (ft): **902** Segment Location: **From just upstream of the confluence with sub tributary T3.01.S1.01 to segment break**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Flow Status**

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	275	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Hilly	Hilly
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Sand	Sand

1.5 Valley Features

- Valley Width (ft) **195**
- Width Determination **Measured**
- Confinement Type **Very Broad**
- Rock Gorge? **No**
- Human-caused Change? **No**

Step 2. Stream Channel

- 2.1 Bankfull Width **11**
- 2.2 Max Depth (ft) **2.50**
- 2.3 Mean Depth (ft) **1.55**
- 2.4 Floodprone Width (ft) **160**

Notes:

Channel is receiving high degree of sediment exported from upstream segment with headcuts and gully. Lower section of channel near road crossing has some channel stability with limited floodplain - high overbank deposition of sands and silts in lower and

Step 2. (Contued)

- 2.5 Aband. Floodpln **4.30** ft.
- Human Elev Floodpln **0.00** ft.
- 2.6 Width/Depth Ratio **7.10**
- 2.7 Entrenchment Ratio **14.55**
- 2.8 Incision Ratio **1.72**
- Human Elevated Inc Rat **0.00**
- 2.9 Sinuosity **Moderate**
- 2.10 Riffles Type **Sedimented**
- 2.11 Riffle/Step Spacing (ft) **44**

2.12 Substrate Composition

Bedrock	0 %
Boulder	0 %
Cobble	0 %
Coarse Gravel	0 %
Fine Gravel	2 %
Sand	70 %
Silt and smaller	28 %

- Silt/Clay Present? **Yes**
- Detritus **20** %
- # Large Woody **9**

2.13 Average Largest Particle on

- Bed **N/A**
- Bar **N/A**

2.14 Stream Type

- Stream Type: **E**
- Bed Material: **Sand**
- Subclass Slope: **None**
- Bed Form: **Dune-Ripple**
- 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	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Silt	Clay
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	69	44
Erosion Height (ft)	4.00	4.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Deciduous	Deciduous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	51-75	51-75

Mid-Channel Canopy **Closed**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	51-100
Sub-dominant	None	>100
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Mixed Trees	Mixed Trees
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Forest	Forest
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin
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 **Abundant**
- 4.3 Flow Status **Low**
- 4.4 # of Debris Jams **4**
- 4.5 Flow Regulation Type **None**
  - Flow Regulation Use
  - Impoundments
  - Impoundmt. Location
- 4.6 Up/Down strm flow reg **None**
  - (old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	1	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
0	5	0
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
1	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 **No**
- 5.5 Straightening **Straightening**
  - Straightening Length: **218**
- 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.

Stream: **Taft Corners Tributary** Reach # **T3.01** Segment: **D** Completion Date: **June 20, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Rain: **Yes**

Segment Length (ft): **902** Segment Location: **From just upstream of the confluence with sub tributary T3.01.S1.01 to segment break**

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?
Culvert	6.00	Yes	Yes	Yes	Yes

Problem Deposition Above,Scour Below

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**12**	**None**	**No**
7.2 Channel Aggradation	**3**	**None**	**Yes**
7.3 Widening Channel	**5**		**No**
7.4 Change in Planform	**8**		**No**
Total Score	**28**		
Geomorphic Rating	**0.35**		

Channel Evolution Model **F**

Channel Evolution Stage **IV**

Geomorphic Condition **Fair**

Stream Sensitivity **Extreme**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	6
6.2 Pool Substrate	6
6.3 Pool Variability	6
6.4 Sediment Deposition	1
6.5 Channel Flow Status	14
6.6 Channel Alteration	13
6.7 Channel Sinuosity	10
6.8 Bank Stability	Left: 2 Right: 2
6.9 Bank Vegetation Protection	Left: 6 Right: 6
6.10 Riparian Vegetation Zone Width	Left: 7 Right: 8
Total Score	87
Habitat Rating	0.435

Habitat Stream Condition **Fair**

Narrative:

A large head cut migration in upslope segment E has increased the sediment load. The channel has become more stable in the lower end of the segment and is actively depositing the increased sediment load from above. See step 5 for further narrative.

Project: Muddy Brook	Phase 2 Segment Summary		February 2, 2009 SGAT Version: 4.56
Stream: Taft Corners Tributary	Reach # T3.01	Segment: E	Completion Date: June 20, 2008
Organization: Agency of Natural Resources	Observers: EPF, SPP	Why Not assessed:	Rain: Yes
Segment Length (ft): 445	Segment Location: From change in entrenchment to just downstream of Harvest Ln.		

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Other Reason**

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	Flat	Flat
Continuous w/	Never	Sometimes
W/in 1 Bankfill	Never	Sometimes
Texture	Silt/Clay	Silt/Clay

1.5 Valley Features

- Valley Width (ft) **135**
- Width Determination **Measured**
- Confinement Type **Very Broad**
- Rock Gorge? **No**
- Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width	5
2.2 Max Depth (ft)	2.50
2.3 Mean Depth (ft)	1.65
2.4 Floodprone Width (ft)	9

Notes:

Incised channel with multiple headcuts. Largest headcut (2.3') has migrated approx. 130' since 2004 aerial imagery, at a rate of approx. 33ft/yr. At this rate headcut will reach Harvest lane within 5 to 8 years and endanger culverts/road crossing.

Step 2. (Contued)

2.5 Aband. Floodpln	6.30 ft.
Human Elev Floodpln	0.00 ft.
2.6 Width/Depth Ratio	3.21
2.7 Entrenchment Ratio	1.60
2.8 Incision Ratio	2.52
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	0 %
Cobble	0 %
Coarse Gravel	0 %
Fine Gravel	5 %
Sand	20 %
Silt and smaller	75 %

Silt/Clay Present? **Yes**

Detritus **5** %

Large Woody **0**

2.13 Average Largest Particle on

- Bed **N/A**
- Bar **N/A**

2.14 Stream Type

- Stream Type: **G**
- Bed Material: **Silt**
- 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	Sand	Sand
Consistency	Cohesive	Non-cohesive
Lower		
Material Type	Clay	Clay
Consistency	Non-cohesive	Non-cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	126	122
Erosion Height (ft)	6.00	6.00
Revetmt. Type	None	None
Revetmt. Length (ft)	0	0

Near Bank Veg. Type	Left	Right
Dominant	Bare	Bare
Sub-dominant	Herbaceous	Herbaceous

Bank Canopy	Left	Right
Canopy %	0	0
Mid-Channel Canopy	Open	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	>100	51-100
Sub-dominant	None	>100
W less than 25	0	0

Buffer Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Forest	Forest
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	
Impoundmt. Location	
4.6 Up/Down strm flow reg	None
(old) Upstrm Flow Reg	

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	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	3	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **440**

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.

Stream: **Taft Corners Tributary** Reach # **T3.01** Segment: **E** Completion Date: **June 20, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Rain: **Yes**

Segment Length (ft): **445** Segment Location: **From change in entrenchment to just downstream of Harvest Ln.**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Taken	GPSTaken

4.8 Channel Constrictions **None**

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

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**2**	**E to G**	**Yes**
7.2 Channel Aggradation	**3**	**None**	**No**
7.3 Widening Channel	**4**		**Yes**
7.4 Change in Planform	**7**		**Yes**
Total Score	**16**		
Geomorphic Rating	**0.2**		

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	1
6.2 Pool Substrate	1
6.3 Pool Variability	0
6.4 Sediment Deposition	1
6.5 Channel Flow Status	10
6.6 Channel Alteration	5
6.7 Channel Sinuosity	5
6.8 Bank Stability	Left: 0 Right: 0
6.9 Bank Vegetation Protection	Left: 0 Right: 0
6.10 Riparian Vegetation Zone Width	Left: 6 Right: 6
Total Score	35
Habitat Rating	0.175

Habitat Stream Condition **Poor**

Narrative:

Channel is largely incised and entrenched from a series of three head cuts that have transported sediment to the downstream segment. This channel is actively changing quickly as the head cut moves upstream.

Project: Muddy Brook

Phase 2 Segment Summary

February 2, 2009 SGAT Version: 4.56

Stream: Taft Corners Tributary — Reach # **T3.01** — Segment: **F** — Completion Date: **June 20, 2008**

Organization: **Agency of Natural Resources** — Observers: **EPF, SPP** — Why Not assessed: — Rain: **Yes**

Segment Length (ft): **642** — Segment Location: **From segment break just downstream of Harvest Ln. to the reach break**

QC Status - Staff: **Provisional** Cons **Passed**

Step 1. Valley and Floodplain

1.1 Segmentation **Channel Dimensions**

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	Flat	Flat
Continuous w/	Never	Never
W/in 1 Bankfill	Never	Sometimes
Texture	Not Evalua	Not Evalua

1.5 Valley Features

- Valley Width (ft) **195**
- Width Determination **Estimated**
- Confinement Type **Very Broad**
- Rock Gorge? **No**
- Human-caused Change? **No**

Step 2. Stream Channel

- 2.1 Bankfull Width **4**
- 2.2 Max Depth (ft) **1.20**
- 2.3 Mean Depth (ft) **0.56**
- 2.4 Floodprone Width (ft) **144**

Notes:

Stable channel upslope of headcut. Streamflow is diffuse through wetland - representative of what Segment E would have been prior to headcut migration and gully formation. Few features present in this segment to quantify. Segment characterized

Step 2. (Contued)

- 2.5 Aband. Floodpln **1.20** ft.
- Human Elev Floodpln **0.00** ft.
- 2.6 Width/Depth Ratio **7.14**
- 2.7 Entrenchment Ratio **36.00**
- 2.8 Incision Ratio **1.00**
- 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	0 %
Cobble	0 %
Coarse Gravel	0 %
Fine Gravel	0 %
Sand	30 %
Silt and smaller	70 %

- Silt/Clay Present? **Yes**
- Detritus **60** %
- # Large Woody **0**

2.13 Average Largest Particle on

- Bed **N/A**
- Bar **N/A**

2.14 Stream Type

- Stream Type: **E**
- Bed Material: **Silt**
- Subclass Slope: **None**
- Bed Form: **Dune-Ripple**
- 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	Sand	Sand
Consistency	Non-cohesive	Non-cohesive
Lower		
Material Type	Clay	Clay
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	Herbaceous	Herbaceous
Sub-dominant	None	None

Bank Canopy	Left	Right
Canopy %	0	0

Mid-Channel Canopy **Open**

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	51-100
Sub-dominant	26-50	26-50
W less than 25	146	0

Buffer Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
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
- Impoundmt. Location
- 4.6 Up/Down strm flow reg **None**
- (old) Upstrm Flow Reg

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	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**
- Straightening Length: **614**
- 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.

Stream: **Taft Corners Tributary** Reach # **T3.01** Segment: **F** Completion Date: **June 20, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Rain: **Yes**

Segment Length (ft): **642** Segment Location: **From segment break just downstream of Harvest Ln. to the reach break**

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?
Culvert	4.00	Yes	Yes	Yes	Yes

Problem Deposition Above

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**14**	**None**	**No**
7.2 Channel Aggradation	**13**	**None**	**No**
7.3 Widening Channel	**15**		**No**
7.4 Change in Planform	**14**		**No**
Total Score	**56**		
Geomorphic Rating	**0.7**		

Channel Evolution Model **F**

Channel Evolution Stage **I**

Geomorphic Condition **Good**

Stream Sensitivity **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **Low**

	Score
6.1 Epifaunal Substrate - Available Cover	3
6.2 Pool Substrate	7
6.3 Pool Variability	2
6.4 Sediment Deposition	10
6.5 Channel Flow Status	6
6.6 Channel Alteration	10
6.7 Channel Sinuosity	7
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: 6
Total Score	79
Habitat Rating	0.395

Habitat Stream Condition **Fair**

Narrative:

Channel is stable. Any significant storm event just causes diffuse flow across the marshy area. However, upslope impervious surfaces are causing increased stream power and channel evolution is likely to occur yielding a channel much like segment E.

Project: Muddy Brook | **Phase 2 Segment Summary** February 2, 2009 SGAT Version: 4.56

Stream: **Taft Corners Tributary** Reach # **T3.02** Segment: **A** Completion Date: **July 2, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Why Not assessed: Rain: **Yes**

Segment Length (ft): **1,372** Segment Location: **From change in substrate type downstream of Harvest Ln. to 100 ft East of the Northeast**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Valley Width**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	113	0
height	10	0
Roads	0	0
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	622	0

1.4 Adjacent Side	Left	Right
Hillside Slope	Hilly	Steep
Continuous w/	Sometimes	Sometimes
W/in 1 Bankfill	Sometimes	Sometimes
Texture	Mixed	Mixed

1.5 Valley Features

- Valley Width (ft) **152**
- Width Determination **Estimated**
- Confinement Type **Very Broad**
- Rock Gorge? **No**
- Human-caused Change? **No**

Step 2. Stream Channel

2.1 Bankfull Width	12
2.2 Max Depth (ft)	2.30
2.3 Mean Depth (ft)	1.49
2.4 Floodprone Width (ft)	152

Notes:

This reach has received a recent influx in stream power over the last decade or so as many new buildings have been built in the surrounding watershed. Overall, the reach seems stable during large storm events because it has the ability to wash out over its

Step 2. (Contued)

2.5 Aband. Floodpln	2.30 ft.
Human Elev Floodpln	0.00 ft.
2.6 Width/Depth Ratio	7.92
2.7 Entrenchment Ratio	12.88
2.8 Incision Ratio	1.00
Human Elevated Inc Rat	0.00
2.9 Sinuosity	Moderate
2.10 Riffles Type	Complete
2.11 Riffle/Step Spacing (ft)	50

2.12 Substrate Composition

Bedrock	0 %
Boulder	1 %
Cobble	31 %
Coarse Gravel	33 %
Fine Gravel	15 %
Sand	17 %
Silt and smaller	3 %

Silt/Clay Present? **No**

Detritus **2** %

Large Woody **2**

2.13 Average Largest Particle on

Bed	9.0	inches
Bar	3.5	inches

2.14 Stream Type

- Stream Type: **C**
- Bed Material: **Gravel**
- Subclass Slope: **b**
- 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 **Undercut**

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

Bank Erosion	Left	Right
Erosion Length (ft)	176	179
Erosion Height (ft)	2.49	3.46
Revetmt. Type	Rip-Rap	None
Revetmt. Length (ft)	19	0

Near Bank Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Deciduous	Shrubs/Saplin

Bank Canopy	Left	Right
Canopy %	0	0
Mid-Channel Canopy	Open	

3.2 Riparian Buffer

Buffer Width	Left	Right
Dominant	51-100	51-100
Sub-dominant	0-25	0-25
W less than 25	338	349

Buffer Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Commercial	Shrubs/Saplin
Sub-dominant	Shrubs/Saplin	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	1
4.5 Flow Regulation Type	None
Flow Regulation Use	
Impoundments	
Impoundmt. Location	
4.6 Up/Down strm flow reg	None
(old) Upstrm Flow Reg	

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	0
Other	0	Tile Drain	0
Overland Flow	0	Urb Strm Wtr Pipe	2

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	3	1
Diagonal	**Delta**	**Island**
1	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
2	1	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	2	No

5.4 Stream Ford or Animal **No**

5.5 Straightening **Straightening**

Straightening Length: **604**

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.

Stream: **Taft Corners Tributary** Reach # **T3.02** Segment: **A** Completion Date: **July 2, 2008**

Organization: **Agency of Natural Resources** Observers: **EPF, SPP** Rain: **Yes**

Segment Length (ft): **1,372** Segment Location: **From change in substrate type downstream of Harvest Ln. to 100 ft East of the**

1.6 Grade Controls **None**

Type	Location	Total	Total Height Above Water	Photo Take	GPSTaken

4.8 Channel Constrictions

Type	Width	Photo Taken?	GPS Taken?	Channel Constriction?	Floodprone Constriction?
Culvert	5.00	Yes	Yes	Yes	Yes

Problem Deposition Above,Scour Below

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Unconfined**

	Score	STD	Historic
7.1 Channel Degradation	**11**	**None**	**No**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**14**		**No**
7.4 Change in Planform	**12**		**No**
Total Score	**48**		
Geomorphic Rating	**0.6**		

Channel Evolution Model **F**

Channel Evolution Stage **I**

Geomorphic Condition **Fair**

Stream Sensitivity **Very High**

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type **High**

	Score
6.1 Epifaunal Substrate - Available Cover	16
6.2 Embeddedness	14
6.3 Velocity/Depth Patterns	12
6.4 Sediment Deposition	11
6.5 Channel Flow Status	12
6.6 Channel Alteration	13
6.7 Frequency of Riffles/Steps	16
6.8 Bank Stability	Left: 6 Right: 6
6.9 Bank Vegetation Protection	Left: 6 Right: 6
6.10 Riparian Vegetation Zone Width	Left: 6 Right: 7
Total Score	131
Habitat Rating	0.655

Habitat Stream Condition **Good**

Narrative:

Some down-cutting but no incision evident in cross-section taken just upstream of Harvest Lane crossing. Large flow events still dissipate onto banks with minor changes in planform.

Project: **Muddy Brook** — **Phase 2 Segment Summary** — February 2, 2009 SGAT Version: 4.56

Stream: **Taft Corners Tributary** Reach # **T3.02** Segment: **B** Completion Date: **July 2, 2008**

Organization: **Agency of Natural Resources** Observers: **SPP** Why Not assessed: Rain: **Yes**

Segment Length (ft): **2,763** Segment Location: **From segment break 100' east of the northeast corner of the home depot building to the end**

QC Status - Staff: Provisional Cons Passed

Step 1. Valley and Floodplain

1.1 Segmentation **Valley Width**

1.2 Alluvial Fan **None**

1.3 Corridor Encroachments

Length (ft)	One	Both
Berms	435	0
height	10	0
Roads	580	914
height	0	0
Railroads	0	0
height	0	0
Improved Paths	0	0
height	0	0
Development	1,859	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	Mixed

1.5 Valley Features

- Valley Width (ft) **22**
- Width Determination **Measured**
- Confinement Type **Semi-confined**
- Rock Gorge? **No**
- Human-caused Change? **Yes**

Step 2. Stream Channel

- 2.1 Bankfull Width **7**
- 2.2 Max Depth (ft) **1.80**
- 2.3 Mean Depth (ft) **1.15**
- 2.4 Floodprone Width (ft) **11**

Notes:

Two cross section were taken for this reach. One (not representative) was taken above the major head cut, resulting in an entrenchment ratio of 2.45, indicating B-type channel.

But downstream of the headcut the channel

Step 2. (Contued)

- 2.5 Aband. Floodpln **4.00** ft.
- Human Elev Floodpln **0.00** ft.
- 2.6 Width/Depth Ratio **6.09**
- 2.7 Entrenchment Ratio **1.56**
- 2.8 Incision Ratio **2.22**
- Human Elevated Inc Rat **0.00**
- 2.9 Sinuosity **Moderate**
- 2.10 Riffles Type **Complete**
- 2.11 Riffle/Step Spacing (ft) **60**

2.12 Substrate Composition

Bedrock	0%
Boulder	1%
Cobble	35%
Coarse Gravel	30%
Fine Gravel	15%
Sand	17%
Silt and smaller	3%

- Silt/Clay Present? **No**
- Detritus **5** %
- # Large Woody **0**

2.13 Average Largest Particle on

- Bed **8.0** inches
- Bar **4.0** inches

2.14 Stream Type

- Stream Type: **G**
- Bed Material: **Cobble**
- Subclass Slope: **None**
- Bed Form: **Step-Pool**
- Field Measured Slope:

2.15 Reference Stream Type (if different from Phase 1)

B 4 Non Riffle-Pool

3.3 old	Amount	Mean Height
Failures	Multiple	7.50
Gullies	None	0.00

Step 3. Riparian Features

3.1 Stream Banks

Typical Bank Slope **Undercut**

Bank Texture	Left	Right
Upper		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive
Lower		
Material Type	Mix	Mix
Consistency	Cohesive	Cohesive

Bank Erosion	Left	Right
Erosion Length (ft)	29	79
Erosion Height (ft)	3.00	3.00
Revetmt. Type	Rip-Rap	Rip-Rap
Revetmt. Length (ft)	39	38

Near Bank Veg. Type	Left	Right
Dominant	Herbaceous	Herbaceous
Sub-dominant	Shrubs/Saplin	Shrubs/Saplin

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	51-100	>100
W less than 25	1,537	822

Buffer Veg. Type	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Mixed Trees	Mixed Trees

3.3 Riparian Corridor

Corridor Land	Left	Right
Dominant	Shrubs/Saplin	Shrubs/Saplin
Sub-dominant	Commercial	Forest
Mass Failures	43	37
Height	7	8
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
  - Impoundmt. Location
- 4.6 Up/Down strm flow reg **None**
  - (old) Upstrm Flow Reg

4.7 StormwaterInputs

Field Ditch	0	Road Ditch	2
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
1	4	1
Diagonal	**Delta**	**Island**
0	0	0

5.2 Other Features

Flood	Neck Cutoff	Avulsion	Braiding
1	0	0	0

5.3 Steep Riffles and Head Cuts

Steep Riffles	Head Cuts	Trib Rejuv.
0	1	No

- 5.4 Stream Ford or Animal **No**
- 5.5 Straightening **Straightening**
  - Straightening Length: **2,407**
- 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.

Stream: **Taft Corners Tributary** Reach # **T3.02** Segment: **B** Completion Date: **July 2, 2008**

Organization: **Agency of Natural Resources** Observers: **SPP** Rain: **Yes**

Segment Length (ft): **2,763** Segment Location: **From segment break 100' east of the northeast corner of the home depot building to**

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?
Culvert	5.00	Yes	Yes	Yes	Yes

Problem Scour Below

Step 7. Rapid Geomorphic Assessment Data

Confinement Type **Confined**

	Score	STD	Historic
7.1 Channel Degradation	**3**	**Other**	**Yes**
7.2 Channel Aggradation	**11**	**None**	**No**
7.3 Widening Channel	**12**		**No**
7.4 Change in Planform	**11**		**No**
Total Score	**37**		
Geomorphic Rating	**0.4625**		

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	13
6.3 Velocity/Depth Patterns	9
6.4 Sediment Deposition	10
6.5 Channel Flow Status	10
6.6 Channel Alteration	9
6.7 Frequency of Riffles/Steps	15
6.8 Bank Stability	Left: 4 Right: 4
6.9 Bank Vegetation Protection	Left: 6 Right: 6
6.10 Riparian Vegetation Zone Width	Left: 1 Right: 3
Total Score	101
Habitat Rating	0.505

Habitat Stream Condition **Fair**

Narrative:

Channel is down-cutting from point of headcut which will move upstream. Stream type departure from B to G.

Appendix C. VTDEC Biotic Sampling Data

Macroinvertebrate Samping Data

Date Sampled	VTDEC Site ID	Location	River Mile	SGA Reach	Mean Density	Mean Species Richness	Mean EPT* Richness	Community Assessment
9/8/1988	490500000012	Muddy Brook	2.2	M05	1532	32	13	Poor
7/31/1990	490500000012	Muddy Brook	2.2	M05	1908	35	17	Good
9/30/1993	490500000012	Muddy Brook	2.2	M05	2256	40	20	Very Good
10/5/2000	490500000012	Muddy Brook	2.2	M05	1810	38	13	Fair
10/14/2003	490500000012	Muddy Brook	2.2	M05	2164	41	18	Good
1997	NA	Tributary 4	0.2	T3.01	1316	35	6	NA
2005	NA	Tributary 4	0.2	T3.01	79	25	1	NA

* EPT: Pollution sensitive families of Ephemeroptera, Plecoptera, and Trichoptera

Fish Samping Data

Date Sampled	VTDEC Site ID	Location	River Mile	SGA Reach	MWIBI†	Community Assessment
9/8/1988	490500000012	Muddy Brook	2.2	M05	23	Poor
7/31/1990	490500000012	Muddy Brook	2.2	M05	25	Poor
9/30/1993	490500000012	Muddy Brook	2.2	M05	33	Good
1993	NA	Tributary 4	0.2	M15	35	Good
1995	NA	Tributary 4	0.2	T3.01	33	Good
1997	NA	Tributary 4	0.2	T3.01	31	Good
1999	NA	Tributary 4	0.2	T3.01	31	Fair
2002	NA	Tributary 4	0.2	T3.01	33	Good

† Index of Biological Integrity: Mixed Water (MW) index

APPENDIX D – Shelburne Pond Summary

The following is an excerpt from:

VT Department of Envionmental Conservation. 2008. Development of TMDL Capacity for Nutrient-impaired Lakes in Vermont, Final Project Summary and Reporting Statement for USEPA Cooperative Agreement X-97124401. Waterbury, VT, USA.

Shelburne Pond is a 452-acre lake located in the Champlain Valley. This shallow, high-alkalinity lake is fringed by large wetlands, and a considerable portion of the lakeshore is in conservation ownership. There is no direct development on the lakeshore, and a mix of agricultural, forest, and low-density residential characterizes the watershed. Over the past 20 years, much of the agricultural lands have gone out of production, and have been replaced by low density, rural single-family homes. Shelburne Pond supports a wide variety of warmwater species, and hosts tremendous waterfowl use. Recreationally, Shelburne Pond supports a large annual contingent of anglers, paddlers, and hunters. The pond is also heavily used in winter for ice activities. It is an ecologically and recreationally significant resource.

Shelburne Pond also has the highest total phosphorus concentration of any lake monitored by WQD over the long-term. The mean spring total phosphorus concentration is 92 ppb (± 7.2, std. err.), based on 22 years of measurement. During summer, cyanobacterial blooms of literally “epic” proportions can develop. WQD scientists have observed meter-thick accumulations of cyanobacteria along shore, and pervasive bloom conditions across the entire lake surface. Such bloom conditions preclude recreational uses of the lake, and have prompted the VT Department of Health to post warnings against exposure to the blooms. In addition to persistent algal growth, the lake has experienced major fish kills in the past due in part to oxygen depletion from excessive productivity. Paradoxically, these prior kills may not have significantly impacted the quality of the present fishery. In summer 2007, a joint EPA-WQD fish sampling effort on the lake yielded numerous large and even trophy-sized northern pike and largemouth bass, despite a relatively low sampling effort, and poor sampling conditions. Finally, being quite close to the University of Vermont (UVM), Shelburne Pond has been extensively studied.

In order to address the nutrient impairment on this lake it is necessary to understand the background, or natural phosphorus concentrations that would have been expected absent any major watershed stressors. WQD’s basic hypothesis for this lake has been that it is to some degree naturally eutrophic. Were this the case, it would be inappropriate to manage the lake towards a mesotrophic state. To address this question, WQD commissioned a paleolimnological investigation of the lake, from a multidisciplinary team led by UVM. The purpose of this investigation was to determine the likely historic trophic state of the lake, to provide guidelines for management.

The UVM team collected so-called “long” and “short” cores on the lake. The long core provided historical perspective in the range of 5,000 years, while the short core was collected specifically to capture the more recent 150-year time period. The team used a multi-proxy approach relying on ^{210}Pb and ^{14}C dating, sediment phosphorus and silica, elemental and isotopic ratios of C and N, fossil pigments, and sediment diatoms, to reconstruct the trophic history of the lake. The results of the analysis (Appendix C), as described in the following quotation, were unambiguous:

“All paleo-productivity proxies indicate that Shelburne Pond was oligo-mesotrophic before European settlement, and has become increasingly productive since the mid 19th century (~1850). Eutrophication rates intensified after ~1900, and reached peak levels during the past two decades (post-1990). Comparison of the sedimentary record with historical data suggests a causal relationship between deteriorating water quality in the pond and human activities in its watershed. Forest clearing since 1810, a switch to mechanized agriculture around ~1850, and intensive dairy farming during most of the 20th century, all resulted in progressive nutrient enrichment.

Despite these significant recent trends, data extending past the post-settlement record suggest that, although generally lower, Shelburne Pond’s productivity levels were at times quite significant during the past few thousand years. The causes of these, apparently natural, fluctuations remain to be investigated.”

This conclusion is emphatic that the historical background in the pond is a meso-oligotrophic state. What remains unanswered, however, is whether the lake can at this point be returned to that condition. There are two pathways available: 1) set a target concentration, and develop a TMDL with loading allocations; or, 2) conduct a Use Attainability Analysis to identify the current water-quality limitation of the lake, and manage the watershed towards the most realistically-attainable condition.

Given the current condition of the watershed, it is difficult to see how reductions of external loads can be achieved in a manner sufficient to meet a loading capacity in Shelburne Pond aimed at any reasonable in-lake phosphorus concentration. The internal sediment recycling in the lake is very likely a dominant phosphorus source; one that is increasing in magnitude with the continuing increases in growth of nitrogen-fixing cyanobacteria that senesce to the lake sediments annually. Given the shallow, windswept nature of the pond, it is unlikely that chemical controls on internal recycling would successfully control the sediment-phosphorus cycle. Likewise, mechanistic solutions to increase sediment-phosphorus retention by aeration would be cost and energy-prohibitive. Given these considerations, WQD is presently initiating discussions about drafting a Use Attainability Analysis for Shelburne Pond. Such an approach would articulate the need for achievable controls on watershed loads, while acknowledging the existing water quality limitations in Shelburne Pond that result from historical insults to the lake.