Crosby Brook Phase 2
Stream Geomorphic Assessment Summary

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Applied Watershed Science & Ecology

Prepared for:
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Executive Summary

- Fitzgerald Environmental Associates, LLC. (FEA) was retained by WCNRCD in 2007 to carry out Phase 1 and 2 assessments following the Stream Geomorphic Assessment (SGA) Protocols developed by VTDEC.

- The Crosby Brook watershed is located in the towns of Brattleboro and Dummerston. It has a drainage area of 5.7 square miles and outlets to the Connecticut River south of Route 9. Its surface waters are divided into two main branches, which join near Exit 3 of Interstate 91. The Mainstem channel network has an overall slope of 2.3%, and a majority of its reaches have B and C-type valley geometry. The South Branch, with a drainage area of 1.8 square miles, has an overall channel slope of 3.1%. A majority of its reaches have A and B-type valley geometry.

- A total of 16 reaches were identified during the Phase 1 analysis for the 10.1 mile channel network. Based on an analysis of impact ratings generated from the Phase 1 data, 9 reaches were selected for further Phase 2 assessment in 2008, including 6 reaches on the Mainstem and 3 reaches on the South Branch.

- During the Phase 2 surveys, the division of Mainstem reaches resulted in a total of 9 segments, while the division of SB reaches resulted in a total of 7 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), and channel evolution stage and stream sensitivity.

- Stream type departures were noted on three segments in the lower watershed: M02, T1.01, and T1.02-B. The extreme changes in channel geometry outside of the normal range of adjustments indicated that these areas are highly sensitive to further watershed impacts.

- The lower zone of the watershed is experiencing the greatest degree of channel adjustment and decline in physical habitat. These adjustments, in conjunction with riparian buffer loss and increased stormwater runoff, are leading to a decline in biotic integrity. The large gully on the mainstem has had a severe impact on the lower watershed conditions (e.g., supply of fine sediment to the channel), and the deleterious effects of recent commercial development and floodplain encroachment in this zone of the watershed is also evident.

- Of the 17 assessed bridges and culverts, only 11 accommodate 75% of the bankfull channel width. In addition, 7 structures are causing significant upstream or downstream erosion.
1.0 Introduction and Project Overview

The Windham County Natural Resources Conservation District (WCNRCD) identified the Crosby Brook watershed in Dummerston and Brattleboro, Vermont for assessment of fluvial geomorphic conditions. The study is part of a larger effort to characterize the physical and biotic conditions of the watershed and to aid in the identification of stressors on aquatic biota communities. Fitzgerald Environmental Associates, LLC. (FEA) was retained by WCNRCD in 2007 to carry out Phase 1 and 2 assessments following the Stream Geomorphic Assessment (SGA) Protocols developed by the Vermont Department of Environmental Conservation (VTDEC, 2007).

Biotic samples collected by VTDEC throughout the Crosby Brook watershed have consistently shown an impaired condition in the lower reaches of the watershed (VTDEC, 2005). The impairment is thought to be caused by increased sediment loading and elevated stream temperatures in the lower and middle reaches of the watershed resulting from urbanization and channelization since the construction of Interstate 91 in the 1960’s. A discussion of recent biological sampling data that summarized the environmental stressors on the aquatic communities is included in section 2.5.

Phase 1 data was collected by FEA for the entire watershed in 2007 and summarized for the Mainstem and South Branch (FEA, 2007). A total of 16 reaches were identified during the Phase 1 analysis for the 10.1 mile channel network. Based on an analysis of impact ratings generated from the Phase 1 data, 9 reaches were selected for further Phase 2 assessment in 2008, including 6 reaches on the mainstem and 3 reaches on the South Branch (SB). The Phase 1 and 2 SGA data will aid WCNRCD and VTDEC in the identification of sediment loading areas and channel adjustments that are degrading habitat conditions. In addition, the SGA data will form the basis for future stream corridor and fluvial erosion hazard planning efforts in the watershed.

2.0 Watershed Background

2.1 Geographic Setting and Land Use History

The Crosby Brook watershed is located in the Lower Connecticut River Basin in southeastern Vermont (Figure 1). The watershed has a drainage area of 5.7 square miles and outlets to the Connecticut River just south of the Route 9 river crossing. It is dissected by Interstate 91 in the lower reaches and Route 5 to the northeast (Figure 2). Stemming from Route 5 and the Exit 3 area is a commercial-industrial zone within the northern limits of the Town of Brattleboro. There are numerous road crossings and
significant urbanization of the stream corridor in between the I-91 northbound lane and commercial land to the west of Route 5. There are fewer roads in upper watershed where a mostly forested landscape is interspersed with farmland along Black Mountain Road and Dutton Farm Road. Land cover data based on imagery from 2005 are summarized in Table 1. The watershed is currently 60% forested, with approximately 10% covered by agricultural lands (including extensive orchards). Residential lands occupy 10% of the watershed, with lesser amounts occupied by commercial/industrial lands (4.4%) and transportation corridors (6.4%). The watershed has a moderate degree of impervious cover (8.7%), within a range (5-10%) associated with decline of channel stability and biotic integrity in small urbanizing watersheds in Chittenden County (Fitzgerald, 2007).

Table 1. Land Cover for Crosby Brook Watershed

<table>
<thead>
<tr>
<th>Land Cover Type*</th>
<th>Entire Watershed</th>
<th>North Branch†</th>
<th>South Branch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forested</td>
<td>60.2%</td>
<td>63.5%</td>
<td>53.2%</td>
</tr>
<tr>
<td>Agriculture</td>
<td>10.7%</td>
<td>6.6%</td>
<td>19.6%</td>
</tr>
<tr>
<td>Residential</td>
<td>9.9%</td>
<td>9.4%</td>
<td>10.8%</td>
</tr>
<tr>
<td>Commercial/Industrial</td>
<td>4.4%</td>
<td>6.3%</td>
<td>0.4%</td>
</tr>
<tr>
<td>Transportation</td>
<td>6.4%</td>
<td>6.4%</td>
<td>6.3%</td>
</tr>
<tr>
<td>Water &amp; Wetland</td>
<td>8.4%</td>
<td>7.8%</td>
<td>9.7%</td>
</tr>
</tbody>
</table>

* 2002 LandSat Data from UVM Spatial Analysis Lab (SAL, 2005)
† Upslope watershed beginning at Reach M02

Historically, the impacts of agricultural practices on the Vermont landscape played an important role in the legacy effects on waterways like the Crosby Brook. Prior to the forest clearing associated with human settlement, logging, and farming, the Crosby Brook watershed would have been a mixture of deciduous and coniferous forest. Deforestation and grazing, largely from sheep farms and other agriculture, likely left much of the watershed devoid of trees at one time or another (Albers, 2000). This landscape change had a tremendous impact on waterways like the Crosby Brook. Exposed soil on steep slopes was eroded and carried to the channel where it aggraded in areas with less slope.
Figure 2. Crosby Brook subwatershed map. Starred reach names were selected for Phase 2 surveys.
(e.g., intersection of Routes 5 and 9); a legacy that still influences the way Vermont’s rivers and streams are managed today.

During the 20th century, significant changes occurred within the Crosby Brook watershed that can be documented with historical surveys and imagery. The construction of Interstate 91 (I-91) and Route 5 reshaped the slope and profile of 3 of the lower reaches in the watershed. Prior to I-91 construction, the Crosby Brook channel occupied a wide, alluvial valley north of the confluence of both branches (Figure 3). This wide valley likely had numerous floodplain wetlands that helped attenuate fine sediment and floodflows from the upper watershed. With the construction of I-91 and the channelization of the mainstem to the west of Route 5, commercial development was likely facilitated due to the filling of floodplain wetlands. Today, commercial development in the lower watershed is dense and is the source of numerous stressors on the physical stability and habitat conditions (Figures 4 and 5).

Figure 3. 1954 Topographic Survey of the area north of Brattleboro at the junction of Routes 5 and 9 prior to I-91 construction (UNH, 2008).
2.2 Geologic & Geomorphic Setting

The underlying geology of the Crosby Brook watershed is comprised of quartz and limestone bedrocks characteristic of the Waits River Formation in the Lower Connecticut River basin (Doll et al., 1961). The Gile Mountain Formation, which is similar to the Waits River Formation and contains a mixture of schist and marble, is found in the eastern section of the watershed. The weathering of the sea bottom sediments in both of these formations results in basic soils that support communities of rich woods species. The Black Mountain formation, located to the west of the watershed, is an igneous pluton comprised of granite bedrock.

The presence of Glacial Lake Hitchcock had a profound effect on the surficial geology of the area. This lake extended from central Connecticut north through the Connecticut basin to St. Johnsbury during the retreat of the Laurentide ice sheet beginning approximately 18,000 years ago (Ridge and Larson, 1990). The great size of the lake, combined with the erosive forces of the glacier moving over bedrock surfaces allowed for
Crosby Brook has two main branches, referred to by VTDEC as the Mainstem and South Branch (SB). Due to the larger watershed area draining the northern branch, it was also chosen as the “Mainstem” channel in the SGA analysis. All reaches of this branch are ordered alphanumerically (beginning with M01), including the lowermost reach below the development of annual layering of fine sediments known as varves. The varves, formed by the seasonal variations in sediment supply to the lake, can be observed throughout the lower watershed where slopes have become exposed due to erosion and gullying.

In addition to the fine sediment deposits (e.g., clay) associated with Lake Hitchcock, a layer of dense glacial till is present throughout the watershed. Overlying the till in some areas are sand deposits that likely formed due to ice-contact (Springston, 2007). The sand deposits found along the steep valley side slopes in the lower watershed appear to be susceptible to landslides, as evidenced by the large failing slope in lower reach T1.02. Lesser amounts of large scale alluvial deposits are found in the wide, low-sloped valleys associated with reaches M05 and T1.03.

### Table 2. Crosby Brook Reference Reach Characteristics

<table>
<thead>
<tr>
<th>Reach Number</th>
<th>Drainage Area (sq. mi.)</th>
<th>Channel Length (mi)</th>
<th>Channel Slope (%)</th>
<th>Channel Width (ft.)</th>
<th>Sinuosity</th>
<th>Valley Width (ft.)</th>
<th>Confinement Ratio</th>
<th>Type*</th>
<th>Type**</th>
<th>Stream Type</th>
<th>Bedform†</th>
</tr>
</thead>
<tbody>
<tr>
<td>M01</td>
<td>Yes</td>
<td>5.7</td>
<td>0.7</td>
<td>1.2</td>
<td>28.2</td>
<td>1.07</td>
<td>150</td>
<td>5.3</td>
<td>NW</td>
<td>C</td>
<td>Riffle-Pool</td>
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<tr>
<td>M02</td>
<td>Yes</td>
<td>3.7</td>
<td>0.5</td>
<td>0.7</td>
<td>23.3</td>
<td>1.03</td>
<td>227</td>
<td>9.7</td>
<td>BD</td>
<td>C</td>
<td>Riffle-Pool</td>
</tr>
<tr>
<td>M03</td>
<td>Yes</td>
<td>2.8</td>
<td>0.6</td>
<td>1.1</td>
<td>20.6</td>
<td>1.07</td>
<td>200</td>
<td>9.7</td>
<td>BD</td>
<td>C</td>
<td>Riffle-Pool</td>
</tr>
<tr>
<td>M04</td>
<td>Yes</td>
<td>2.6</td>
<td>0.6</td>
<td>1.4</td>
<td>19.9</td>
<td>1.10</td>
<td>100</td>
<td>5.0</td>
<td>NW</td>
<td>C</td>
<td>Riffle-Pool</td>
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<tr>
<td>M05</td>
<td>Yes</td>
<td>2.4</td>
<td>0.5</td>
<td>0.3</td>
<td>19.4</td>
<td>1.20</td>
<td>400</td>
<td>20.7</td>
<td>VB</td>
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<td>Riffle-Pool</td>
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<tr>
<td>M06</td>
<td>Yes</td>
<td>2.2</td>
<td>0.7</td>
<td>2.5</td>
<td>18.4</td>
<td>1.05</td>
<td>150</td>
<td>8.1</td>
<td>BD</td>
<td>C</td>
<td>Riffle-Pool</td>
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<tr>
<td>M07</td>
<td>No</td>
<td>1.6</td>
<td>1.0</td>
<td>3.1</td>
<td>16.1</td>
<td>1.03</td>
<td>50</td>
<td>3.1</td>
<td>SC</td>
<td>B</td>
<td>Step-Pool</td>
</tr>
<tr>
<td>M08</td>
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<td>0.5</td>
<td>0.7</td>
<td>7.4</td>
<td>9.4</td>
<td>1.00</td>
<td>15</td>
<td>1.6</td>
<td>NC</td>
<td>A</td>
<td>Step-Pool</td>
</tr>
<tr>
<td>M09</td>
<td>No</td>
<td>0.1</td>
<td>0.3</td>
<td>3.6</td>
<td>4.9</td>
<td>1.06</td>
<td>25</td>
<td>5.1</td>
<td>NW</td>
<td>B</td>
<td>Step-Pool</td>
</tr>
<tr>
<td>T1.01</td>
<td>Yes</td>
<td>1.8</td>
<td>0.5</td>
<td>1.4</td>
<td>17.1</td>
<td>1.03</td>
<td>120</td>
<td>7.0</td>
<td>BD</td>
<td>C</td>
<td>Riffle-Pool</td>
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<tr>
<td>T1.02</td>
<td>Yes</td>
<td>1.7</td>
<td>0.8</td>
<td>4.5</td>
<td>16.5</td>
<td>1.01</td>
<td>40</td>
<td>2.4</td>
<td>SC</td>
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<tr>
<td>T1.03</td>
<td>Yes</td>
<td>1.1</td>
<td>0.8</td>
<td>0.2</td>
<td>13.5</td>
<td>1.06</td>
<td>381</td>
<td>28.2</td>
<td>VB</td>
<td>E</td>
<td>Dune-Ripple</td>
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<tr>
<td>T1.04</td>
<td>No</td>
<td>0.8</td>
<td>0.2</td>
<td>4.3</td>
<td>11.9</td>
<td>1.20</td>
<td>40</td>
<td>3.4</td>
<td>NC</td>
<td>B</td>
<td>Step-Pool</td>
</tr>
<tr>
<td>T1.05</td>
<td>No</td>
<td>0.4</td>
<td>1.0</td>
<td>4.9</td>
<td>8.9</td>
<td>1.03</td>
<td>15</td>
<td>1.7</td>
<td>NC</td>
<td>A</td>
<td>Step-Pool</td>
</tr>
<tr>
<td>T2.01</td>
<td>No</td>
<td>0.5</td>
<td>0.5</td>
<td>3.4</td>
<td>9.7</td>
<td>1.02</td>
<td>55</td>
<td>5.7</td>
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<td>Step-Pool</td>
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<tr>
<td>T2.02</td>
<td>No</td>
<td>0.1</td>
<td>0.7</td>
<td>4.8</td>
<td>5.3</td>
<td>1.01</td>
<td>15</td>
<td>2.8</td>
<td>SC</td>
<td>A</td>
<td>Step-Pool</td>
</tr>
</tbody>
</table>

* NW = Narrow; SC = Semi-confined; BD = Broad; VB = Very Broad

§ Valley Width estimated remotely for italicized values

** per Rosgen (1994)

† per Montgomery & Buffington (1997)
the confluence with the SB (reach M01). Prior to the confluence with the SB near I-91 exit 3, the mainstem drainage area is 3.7 square miles. The SB, referred to in the SGA database as T1 because it is the first major tributary to the mainstem, has drainage area at the confluence of 1.8 square miles. Table 2 summarizes the reference stream characteristics for the 16 study reaches.

The mainstem channel network has an overall slope of 2.3%, and a majority of its reaches have C-type channel geometry under reference conditions. Reaches along the mainstem are found in a wide array of confinement types, from very broad along Middle Road to confined in the upper reaches above Dutton Farm Road. Including the reaches assessed for Phase 2 data, grade controls were noted in reaches M01, M03, M04, and M06. During the Phase 2 surveys, the division of mainstem reaches resulted in a total of 9 segments, which are described in further detail in Section 4.2.

The SB channel network has an overall slope of 3.1%, and a majority of its reaches have A and B-type channel geometry. Many of the SB reaches are found in confined valley settings, with the exception of T1.01 and T1.03. Within the 3 reaches assessed for Phase 2 data, grade controls were noted only in reach T1.02. During the Phase 2 surveys, the division of SB reaches resulted in a total of 7 segments, which are described in further detail in Section 4.2.

2.3 Ecological Setting

The Crosby Brook watershed is found within the Southern Vermont Piedmont Biophysical Region (Thompson and Sorenson, 2000). This region is found along the eastern border of Vermont and extends from White River Junction down to Massachusetts. It is characterized by gentle rolling hills and bedrock geology that supports Northern Hardwood Forest communities. Some areas of igneous intrusions (e.g., granitic plutons) support rare communities, such as the Pitch Pine-Oak-Heath community found a top Black Mountain to the west of the Crosby Brook watershed. Rich soils of loam and silt along the Connecticut River that once supported extensive areas of silver maple (Acer saccharinum) and ostrich fern (Matteuccia struthiopteris) were converted to agricultural use during European settlement in the late 18th century. Within the Crosby Brook watershed (along Route 5), these areas were long used for agriculture but have since been converted to commercial uses.

Elevations within the watershed range from 220 feet at the confluence with the Connecticut River, up to approximately 1,100 feet at the base of Black Mountain. With an average annual rainfall of 45 inches and a temperate climate, the forest cover is
comprised primarily of mixed hardwood tree species, with areas of white pine (*Pinus strobus*) and eastern hemlock (*Tsuga Canadensis*) found within younger growth and along steeper slopes, respectively. During the Phase 2 surveys, some aggressive invasive species were noted along the channel network. Along the mainstem, garlic mustard (*Alliara petiolata*), a low growing biennial herb that is particularly aggressive at outcompeting native ground cover, was observed in many locations. Along the SB in the vicinity of Black Mountain Road, Japanese knotweed (*Polygonum cuspidatum*) was also noted along the exposed banks and was contributing to bank instability by shading out native woody vegetation.

Extensive wetlands occupy two large areas within the watershed (NWI, 2003). Along the mainstem, a significant wetland which was likely cleared and converted to pasture during European settlement, is found along Reach M05. Along the SB, a large wetland complex is found within the wide alluvial valley of Reach T1.03. The southern area of this wetland complex was historically drained and is now utilized for recreational fields, while the northern portion is intact and has abundant beaver activity. The low lying areas around I-91 Exit 3 likely had extensive floodplain wetlands that were disconnected from the channel and filled during I-91 construction. The National Wetlands Inventory mapping does not indicate significant wetlands in this area today.

Historically, Crosby Brook has supported a healthy population of brook trout (*Salvelinus fontinalis*), a fact that is well known by local fishermen. In addition, other common coldwater species associated with brook trout would be present in the watershed under reference conditions, such as slimy sculpin (*Cottus cognatus*), blacknose dace (*Rhinichthys atratulus*), and creek chub (*Semotilus atromaculatus*). A summary of current biological community based on recent VTDEC sampling is included in Section 2.5.

### 2.4 Channel and Floodplain Management History

Extensive channel straightening was carried out on both branches during the construction of I-91 in the late 1950’s and early 1960’s (see Figures 4 and 5). Straightening in the lower watershed has been problematic for water quality and habitat conditions by causing: 1) a simplification of the channel morphology and a loss of habitat for aquatic biota, 2) wetland floodplain disconnection in Reaches M01 and T1.01, and 3) increased sediment transport capacity to the lowest reach of the watershed, M01, where biotic conditions have suffered the greatest decline (VTDEC, 2005). Although the riparian vegetation has recovered along stretches of both reaches, the bank armoring and adjacent berms prevent the redevelopment of sinuosity and floodplain in what would otherwise be an alluvial, sediment attenuating zone of the watershed.
In addition to historical impacts from the I-91 construction, recent commercialization of the Route 5 corridor has likely increased runoff to the channel, and in some cases has resulted in direct alteration to the channel planform. In Reach M02, the area immediately downstream of the I-91 crossing was more recently straightened to make way for a car dealership (Figure 6). Additional straightening in the lower watershed such as this has exacerbated the problems summarized above, and led to further degraded biotic integrity.

![Figure 6. Area of straightening to accommodate increased commercial development. The 1962 channel location is shown as dashed blue and the current location is solid blue.](image)

### 2.5 Recent Biological Sampling

Crosby Brook is classified as a Class B/Coldwater fishery per the Vermont Water Quality Standards. VTDEC undertook an extensive sampling effort in the watershed beginning in 2002 in order to better understand the environmental stressors on the aquatic community (VTDEC, 2005). The macroinvertebrate and fish communities were sampled at 9 locations along the mainstem and SB. The reaches were sampled over the course of 3 years to better understand the temporal changes in the watershed. In addition, the sample sites spanned from the mouth to headwaters to assess the impact of increased in urban land use and riparian modifications in a downstream direction along both channel networks. An excerpt of the data and findings has been included in Appendix D. The findings indicate that the upper reaches of both branches have adequate habitat conditions
to support the expected macroinvertebrate communities. However, below I-91 the fish and macroinvertebrate communities of both branches decline to fair and poor conditions. The lowest sample site prior to the confluence with the Connecticut River has consistently shown fair and poor macroinvertebrate assemblages. Based on the assemblage characteristics, the lower areas of the watershed appear to be stressed by temperature, siltation of the bed substrate with fine sediments, and habitat alterations resulting from channel straightening.

3.0 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 Crosby Brook watershed using the protocols forms the basis for the preliminary project identification carried out as part of the River Corridor Planning effort.

The SGA protocols include three phases (VTDEC, 2007). Phase 1 assessments employ remote sensing techniques, along with limited field verification, to identify background conditions in the watershed. The Phase 1 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 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 describe the degree to which the channel will adjust to human impacts in the future. Phase 3 surveys involve the collection of detailed, reach-scale survey data for use in project development and monitoring.
Phase 1 data were collected by FEA for the entire watershed in 2007 and summarized for the mainstem and SB (FEA, 2007). A total of 16 reaches were identified during the Phase 1 analysis for the 10.1 mile channel network, and 9 reaches were selected for further Phase 2 assessment in 2008, including 6 reaches on the mainstem and 3 reaches on the SB. A total of 16 segments were assessed for Phase 2 data, and data were entered into the Data Management System (DMS). All major human impacts and natural features noted during the Phase 2 surveys were indexed in a GIS using the Feature Indexing Tool (FIT; VTDEC, 2007). Reach summary statistics and DMS reach sheets are included in Appendix B. Bed substrate histograms and cross-section plots are included in Appendices E and F on a CD-ROM, respectively. Digital photographs are also included in Appendix G on the CD-ROM.

RMP staff shared responsibility with FEA for the Quality Assurance and Control (QA/QC) of the Phase 1 and 2 datasets. The DMS database for Phase 2 reaches was finalized in June, 2008. A QA/QC summary is included in Appendix C.

4.0 Results

The following section summarizes the results of the field observations and data analysis. Section 4.1 summarizes watershed-scale stressors on the physical stability and habitat conditions of the channel as well as broad approaches to addressing these stressors. Section 4.2 summarizes reach-scale conditions and stressors. A discussion of broad-scale projects that will be further explored during the forthcoming River Corridor Planning phase of the Crosby Brook study is included in Section 5.0. Reach-scale mapping and data summaries are included in Appendices A and B, respectively.

4.1 Watershed Scale Stressors

4.1.1 Hydrologic Regime Impacts

The impacts of urbanization on waterways has been studied across many ecoregions of the US (CWP, 2003), with a growing body of evidence showing the high sensitivity of stream systems to development. Many stream ecologists across the country have shown that urban land use has detrimental effects on aquatic biota (Coles et al., 2004; Fitzpatrick et al., 2004), and watershed scientists have long known that urban land use increases sediment and nutrient loading to receiving waters (CWP, 2003). Research is beginning to show the effects of stormwater runoff on relative sediment yield due to channel
instability (Trimble, 1997; Nelson and Booth, 2002), and on physical habitat conditions (Coles et al., 2004; McBride and Booth, 2005).

The Crosby Brook watershed has a moderate degree of impervious cover, with much of it concentrated in the lower watershed. By comparing the response of sensitive biota in the lower Crosby Brook to other study sites in urbanizing watersheds in Chittenden County (Figure 7), we see a similar response. The Crosby Brook watershed, although only moderately urbanized, supports a reduced community of sensitive biota. Further development within the watershed without the use of the effective stormwater BMPs to mitigate these impacts could further degrade the biotic communities in the lower watershed.

![Graph showing the relationship between EPT richness and watershed impervious cover. The equation y = 1.9826x^{0.5954}, R^2 = 0.73, N = 21 is displayed.](image)

Figure 7. Response of sensitive macroinvertebrates to impervious cover for study sites in Chittenden County (Fitzgerald 2007). Crosby Brook data point (VTDEC, 2005) for Reach M01 shown in red.

Seasonal temperature data collected by VTDEC for sites on the mainstem and SB of Crosby Brook show elevated temperatures in the lowest reach (M01). During the late summer months, numerous consecutive days had stream temperatures that exceeded the upper tolerance limits of brook trout. Elevated temperatures in M01 are likely brought on by a number of direct and indirect impacts from urbanization, including 1) loss of riparian vegetation along the stream banks resulting in greater solar radiation, 2) brief summer rainfall events carrying excess heat energy from adjacent impervious cover directly to the channel, and 3) reduced influx of cooler groundwater to the channel.
4.1.2 Sediment Regime Impacts

A high degree of sedimentation of fine sands has been observed in the lower reaches of Crosby Brook, contributing to the degraded biological conditions. While some upland and instream sources of fine sediment have been observed and mapped by VTDEC in the past, including the large gully on the mainstem (Figure 9), this study sought to: 1) understand the relative impact of known sediment sources, and 2) identify and map additional sources of sediment in the watershed.
The volume of sediment delivered by the mainstem gully was calculated by VTDEC to be 32,000 ft³, or the equivalent of 85 dump truck loads of fine sediment since the
initiation of the headcut in approximately 1960 (VTDEC Stormwater, 2007). Using the bed substrate data collected during the Phase 2 surveys, average bed substrate histograms were compiled for the sample sites above and below the gully confluence with the mainstem. Upstream of the gully, where sediment sources are mainly limited to mass failures along the channel boundaries, the modal substrate class was coarse gravel (16 – 64mm), with a normal distribution around the mode (Figure 10). Below the gully, there is a clear and sharp increase in the degree of fine sediments in the channel, with a modal class of sand and a distribution that is skewed towards the finer classes. The increase in fine sediments reduces fish and macroinvertebrate habitat by filling pools, embedding larger substrate, and reducing dissolved oxygen levels. The net effect of increased fine sedimentation and impacts to the hydrologic regime are seen in the reduced richness values in the lowest reaches.

The mass failure in segment T1.02-A along Black Mountain Road is also a significant source of sediment in the SB channel. However, a similar data summary compiled for reaches upstream and downstream of the slope failure do not show a distinct difference as seen in the mainstream reaches. Further discussion of the sediment impacts associated with the mass failure is included in the T1.02-A segment summary in the following section.

4.2 Reach Summaries

Mainstem Reaches

M01-A
Segment M01-A is found from the confluence with the Connecticut River up to a change in slope where the channel turns west towards the railroad tracks. The segment is 0.4 miles long and has an overall channel slope of approximately 3.0%. The semi-confined valley setting and low entrenchment ratio (ER = 1.2) indicated A3 channel geometry (Rosgen, 1994) with step-pool bed morphology (Montgomery and Buffington, 1997). Near the mouth there is a high degree of deposition of fine sands and silts (Figure 12), and the formation of bar features appears unnatural for the high-gradient nature of the channel. There are two large grade controls in the middle and upper section of the reach that control potential vertical adjustments, and likely act as a barrier for fish migration from downstream (Figure 13). VTDEC fish sampling results indicate that fish species typically observed in small tributaries to the Connecticut River were absent above the lowermost waterfall (VTDEC, 2005). One stream ford provides access across the channel from Connecticut River Drive, and has resulted in minor impacts to the channel from the removal of riparian vegetation.
A very high degree of sedimentation was observed throughout the segment, even in higher gradient areas. The cross-section taken in a high gradient portion of reach shows a high sedimentation of fines despite the high transport capacity. The bed is dominated by cobble (42%), however the plot of substrate classes indicates an increase in sand and silt sediments (38%). Because of the bedrock controls and limited direct impacts to the channel, the majority of the segment is stable (RGA condition “Good”, CEM stage I); however there is significant aggradation in the lower segment as noted above. There is good habitat diversity due to numerous pools and a protected riparian corridor and buffer (RHA condition “Good”); however upslope sources of fine sediments are severely compromising habitat quality. The LWD density for this reach was above the average for mainstem reaches (108 pieces/mile).

M01-B
Segment M01-B is found from a break in slope near the railroad tracks up to the confluence with the SB. The segment is 0.3 miles long and has an overall channel slope of approximately 0.5%. Under reference conditions we would expect this segment to be found in a broad, alluvial valley that supports a meandering channel profile. Encroachments from the railroad, Route 9, and commercial development upon the channel have reduced the available floodplain area. As a result, the channel is found in an altered, semi-confined valley setting with a lower than expected entrenchment ratio (ER = 2.8). Channel and floodplain measurements indicated C-type channel geometry with riffle-pool bed morphology. Numerous slope failures were noted along the right bank of the segment, some reaching heights of 12 feet (Figure 14). Channel incision (IR = 1.5), likely caused by a decreased belt-width and floodplain area as well as increased in stormwater runoff from nearby impervious cover, is exacerbating the increased sediment supply from the slope failures through further downcutting at the slope toes. Bank armoring was present along the left bank mid-segment, and the limited woody buffer...
vegetation in the upper reach (Figure 15) likely results in increased summer stream temperatures.

Figure 14. Mass failure in lower M01-B                      Figure 15. M01-B above Route 5 crossing.

A very high degree of fine sedimentation was observed throughout segment. The cross-section taken in a high gradient portion of reach shows a high sedimentation of fine sediments. The bed is dominated by sand (49%), with lesser amounts of fine gravel (27%) and silts (13%). Due to the change in valley morphology and the moderate to high channel incision noted throughout, the segment is moderately unstable with a high degree of vertical and lateral adjustment processes (RGA condition “Fair”, CEM stage II). There is fair to good habitat diversity due to numerous pools and riffles, however the increase in fine sediments and limited buffer and corridor protection resulted in a decreased habitat score (RHA condition “Fair”). VTDEC sampling data indicate that the presence of a well-defined riffle-pool profile in the lower segment supports a good to fair biotic community, however the impacts of increased fine sediments were noted in the high proportion of species tolerant to pollution. The LWD density for this reach was well below the average for mainstem reaches (47 pieces/mile).

**M02**

Reach M02 is found from the confluence with the SB up to the confluence with the next major tributary (T2) upslope of the I-91 crossing. The reach is 0.5 miles long and has an overall channel slope of 0.7%. Under reference conditions we would expect this reach to be found in a broad, alluvial valley that supports a meandering channel profile. Extensive channel straightening (approximately 90% of reach length) from the construction of I-91 and more recent encroachments from commercial development along Route 5 has reduced the channel to a simplified form with no floodplain access and limited habitat diversity. Similar to Segment M01-B, M02 is found in an altered, semi-confined valley setting with a very low entrenchment ratio (ER = 1.5). Channel and floodplain...
measurements indicated the reach has undergone a stream type departure from C-type geometry with riffle-pool bedform to F-type geometry dominated by plane bed features (Figure 16). Despite the increased channel slope, sediment supply from upslope sources (e.g., gully on Pepsi property) appears to be exceeding transport capacity, as a high degree of sand and fine gravel sedimentation was observed below the I-91 crossing.

Above the I-91 crossing near the reach break with M03, the channel has begun to redevelop sinuosity in the absence of hard bank armoring. It is evident that a slope change (e.g., headcut) initiated by the I-91 construction migrated upslope through this area, as the channel profile at the reach break suggests stage IV of channel evolution (Schumm, 1977). This concept is further supported by the widening and aggradation (stage III) observed in the lower section of reach M03 downstream of a grade control. In upper M02, the redevelopment of a sinuous planform has caused recent slope failures that supply large amounts of sand sediments (fill from I-91 construction) to the channel (Figure 17).

Due to the departure in valley and channel morphology and the high channel incision, the segment is considered extremely sensitive to further human impacts (RGA condition “Poor”, CEM stage II). There is very limited habitat diversity due to extensive straightening, increase in fine sediments, and limited buffer and corridor protection (RHA condition “Poor”). VTDEC sampling data indicate that the fish and macroinvertebrate communities have been highly impacted, supporting fair to poor conditions. The LWD density for this reach was the lowest for any of the mainstem reaches (30 pieces/mile).

One remaining area of undeveloped corridor in the lowermost section of M02 is worth noting from a project identification perspective. This area is found from the Exit 3 ramp up to the first commercial development within the stream corridor (Figure 18).
Approximately 550 feet of undeveloped land is found to the east and west of the current channel, however the channel has shown no signs of redeveloping a sinuous planform due to the historic channel straightening and deepening. This area will be explored in further detail during the preliminary project identification effort.

Figure 18. Undeveloped corridor in lower M02 immediately upstream of the Exit 3 ramp.

**M03**

Reach M03 is found from the confluence with the T2 up to a break in channel slope immediately upstream of Ryan Road. The reach is 0.6 miles long and has an overall channel slope of 1.1%. The broad valley and channel measurements indicated the reach has C-type geometry with riffle-pool bedform. A grade control is found mid-reach that has limited the extent to which channel adjustments caused by I-91 construction affect the reach. Below this grade control significant channel widening was observed, with aggradation from the adjacent gully on the Pepsi property exacerbating these adjustments (Figure 19). Above the grade control, a more sinuous planform was observed, however channel incision was still noted in this area (IR = 1.5). A small berm was noted along the left bank of the historically-straightened section adjacent the open field. The potential removal of this berm to increase floodplain access in the upper reach will be further explored during the preliminary project identification effort. The culvert beneath Ryan
Road is perched, causing minor erosion downstream, and likely limiting the migration of fishes upstream (Figure 20).

Figure 19. Aggradation and widening in lower M03.        Figure 20. Perched culvert beneath Ryan Road.

Due to the increased aggradation from the gully and ongoing channel incision and widening, the channel has a very high sensitivity to ongoing impacts (RGA condition “Fair”, CEM stage III). Overall the habitat conditions of the reach were fair to good, with good epifaunal substrate and cover. However, a relatively high degree of embeddedness from increases in fine sand (23% of bed substrate) resulted in a reduced habitat score (RHA condition “Fair”). The LWD density for this reach was very high due to the healthy riparian buffer in the lower reach and high recruitment (105 pieces/mile).

M04
Reach M04 is found from the Ryan Road crossing up to the Middle Road crossing. The reach is 0.6 miles long and has an overall channel slope of 1.4%. The broad valley and channel measurements indicated the reach has C-type geometry with riffle-pool bedform. Some areas of the valley are narrow to confined where the Route 5 embankments occupy the historic valley, however there is still accessible floodplain within these areas. A cross section taken mid-reach indicates good floodplain connectivity with little channel incision (Figure 21). A grade control is found in the lower reach that limits potential vertical adjustments along the channel network. In the upper reach where the valley widens, the site of an old beaver impoundment has altered the riparian vegetation (Figure 22). A second cross section taken in this location indicates similar channel dimensions and substrate to the lower reach. Moderate aggradation of gravel associated with two large debris jams was noted immediately downstream of the Middle Road crossing. If further aggradation occurs, erosion and flooding downstream of the road crossing could become problematic.
The channel stability and floodplain connectivity was good throughout the reach. (RGA condition “Good”, CEM stage I). Overall the habitat conditions of the reach were good, with excellent epifaunal substrate and cover and limited embeddedness (RHA condition “Good”). The LWD density for this reach was very high due to the healthy riparian buffer in the lower reach and high recruitment potential (113 pieces/mile).

**M05**

Reach M05 is found from just upstream of the first Middle Road crossing up to the second Middle Road crossing to the north. The reach is 0.6 miles long and has an overall channel slope of 0.3%. The very broad valley and low width-to-depth ratio of the channel indicated the reach has E-type geometry with riffle-pool bedform. The wide alluvial valley probably formed in conjunction with the channel meandering throughout, however historic channel straightening appears to have relocated the channel along the left valley wall to make way for pasture or hay fields. A cross section taken mid-reach indicates good floodplain connectivity with little channel incision (IR=1.1; Figure 23), despite the presence of some terraces in the lower and upper reach. One minor tributary enters the main channel from the east and has developed a large gully that extends 70 feet upstream. This gully is supplying large amounts of sediment to the channel, resulting in aggradation and a large mass failure immediately downstream. This area will be explored in further detail during the preliminary project identification effort.
The channel stability and floodplain connectivity was good throughout the reach, with some evidence of floodplain redevelopment in the upper and lower reach (Figure 24; RGA condition “Good”, CEM stage IV). Overall the habitat conditions of the reach were fair, with good epifaunal substrate and cover and limited embeddedness, but with reduced riparian vegetation and buffer in the upper reach (RHA condition “Fair”). The LWD density for this reach was very low due to the lack of a healthy riparian buffer on the right bank and limited recruitment potential (44 pieces/mile).

M06-A
This is a short segment found just upstream of the Middle Road crossing. The segment is 0.2 miles long and has channel slope of 2.8%. The segment is situated in a broad valley prior to a transition to a narrow valley in the upslope segment. Channel dimensions measured at the cross section indicate the segment has Cₖ geometry with riffle-pool bedform. There are two large mass failures mid-segment along the right bank where the channel cuts into the steep valley slope, comprised of sand substrate (Figure 25). These slope failures appear to be worsened by channel incision brought on by a small area of dredging immediately upslope. There is a small cistern that diverts water to an adjacent pond (Figure 26), and the gravel deposition upslope of the diversion was removed (time frame of removal is not clear) to protect the instream structure.
Channel incision was evident at the cross section in the upper segment (IR = 1.9). The channel stability and floodplain connectivity was fair throughout the lower segment, resulting in a segment with a moderate degree of vertical adjustment and a very high sensitivity to further human impacts (RGA condition “Fair”, CEM stage II). Overall the habitat conditions of the segment were good, with adequate epifaunal substrate and cover and limited embeddedness, and with healthy riparian vegetation and buffer (RHA condition “Good”). The LWD density for this segment was slightly below the average for the mainstem reaches (72 pieces/mile).

**M06-B**

This segment is found from a change in valley width and slope up to the crossing of Houghton Road. The segment is 0.2 miles long and has channel slope of 3.2%. The segment is situated in a narrowly confined valley prior to another transition back to a broad valley in the upslope segment. Channel dimensions measured at the cross section indicated B-type geometry with step-pool bedform, and cobble substrate. Although Houghton Road occupies part of the historical valley, and has reduced the floodplain area (ER = 1.6), the segment has adequate vertical controls and appeared stable with excellent step-pool formation (Figure 27). One grade control was noted in the lower segment. The culvert beneath Houghton road is undersized but did not show signs of significant erosion or scour at the outfall (Figure 28).
Although the floodprone area was reduced by the presence of the adjacent road, resulting in a lower than expected entrenchment ratio (ER = 1.6), no channel incision was noted at the cross section. The channel stability was good throughout, resulting in a segment with a limited adjustment processes and a moderate sensitivity to further human impacts (RGA condition “Good”, CEM stage II). Overall the habitat conditions of the segment were good, with excellent epifaunal substrate and cover and limited embeddedness (RHA condition “Good”). The LWD density was average for the mainstem reaches (85 pieces/mile).

**M06-C**

This segment is found from the first crossing of Houghton Road up to the second crossing. The segment is 0.3 miles long and has channel slope of approximately 1.0%. It is situated in a broad valley following a transition from the confined valley in the downstream segment. Channel dimensions measured at the cross section indicated C-type geometry with riffle-pool bedform, and coarse gravel substrate (Figure 29). Good floodplain connectivity was noted throughout, and field measured channel dimensions corresponded well to those predicted by the VTDEC hydraulic geometry regressions (VTDEC, 2007). One area of increased aggradation of gravel and sand was observed mid-reach and is caused by two large debris jams. Immediately upstream of the Tucker Reed Road crossing are direct channel impacts associated with a residence on the right bank. Lack of woody buffer vegetation is causing bank erosion on the right bank, and an old dam (with a defunct sluice gate) once used to create an on-stream pond is still in place (Figure 30). The channel has been reshaped immediately upstream of the structure, and hard bank armoring is protecting the upslope banks from eroding. However, the upstream banks are very high (due to historic aggradation behind the dam) and will likely fail in the long-term.
Despite the direct channel impacts noted in the upper segment, the overall stability was good throughout, resulting in a segment with a limited to minor adjustment processes (RGA condition “Good”, CEM stage I). The overall habitat conditions of the segment were good, with reference riffle-pool formation and limited embeddedness (RHA condition “Good”). The LWD density for this segment was very high due to the healthy riparian buffer and high recruitment potential, as well as the large debris jam mid-segment (194 pieces/mile).

**South Branch (SB) Reaches**

**T1.01**
This is the lowermost reach of the SB of Crosby Brook. It is found from the confluence with the mainstem up to a sharp bend in the channel along Black Mountain Road. The reach is 0.5 miles long and has channel slope of 1.4%. Due to the impacts from the construction of I-91, the reach has undergone a similar departure from reference conditions as nearby Reach M02. Under reference conditions we would expect this reach to be found in a broad, alluvial valley that supports a meandering channel profile. Extensive channel straightening (approximately 50% of reach length) from the construction of I-91 and encroachments along Black Mountain Road has reduced the channel to a simplified form with no floodplain access and limited habitat diversity. The reach is currently found in an altered, narrow valley setting with an unnaturally low entrenchment ratio (ER = 1.5). Channel and floodplain measurements indicated the reach has undergone a stream type departure from C-type geometry with riffle-pool bedform to F-type geometry dominated by plane bed features (Figure 31).
Two other areas of the reach are noteworthy. In the lowermost section of the reach, approximately 200 feet upstream of the confluence with the mainstem, there is an adjacent intact wetland along the right bank. This wetland extends for approximately 350 feet along the channel, providing valuable floodplain access prior to the channel entering the highly urbanized zone. This wetland floodplain will be further explored for protection during the project identification effort. Secondly, there is severe bank erosion occurring on the right bank downstream of the I-91 culvert (Figure 32). Although this erosion is not immediately endangering adjacent infrastructure, it represent a significant supply of sediment to the channel.

Due to the departure in valley and channel morphology and the high channel incision (due to human elevated floodplain), the reach is considered extremely sensitive to further human impacts (RGA condition “Fair”, CEM stage II). There is very limited habitat diversity due to extensive straightening and limited buffer and corridor protection (RHA condition “Fair”). VTDEC sampling data indicate that the fish and macroinvertebrate communities have not been impacted by the historic impacts to the channel, as good to excellent conditions were noted during two years of sampling. The LWD density for this reach was average for the SB reaches (47 pieces/mile).

**T1.02-A**

This segment was delineated to capture the short, unconfined section of channel associated with the large mass failure along Black Mountain Road. It is found from the sharp bend in the channel along Black Mountain Road up to 200 feet south of the intersection with Kipling Road. The segment is 0.2 miles long (1000 feet), and the field measured channel slope was 2.2%. One headcut was noted in the lower reach that is causing a disconnect between the channel and floodplain. Two channel cross sections were measured to better understand the variability in channel incision within the segment.
One cross section in the lower segment below the headcut revealed severe incision (IR = 1.9), while another above the headcut indicated only minor incision (IR = 1.1). The incised section of the segment represents a majority (~70%), and has likely been exacerbating the increased supply of sediment to lower reaches from the mass failure (Figure 33) and other bank failures (Figure 34).

![Figure 33. Large mass failure in upper T1.02-A.](image1)

![Figure 34. Bank erosion mid-segment T1.01-A.](image2)

The large mass failure is found along the right bank, and measures 130 feet in length by 35 feet in height. Based on observations by Brattleboro Town officials, the slope failure has become worse in recent years. A review of historical photography from 1962 suggests that the failure did not exist at that time (Figure 35), and has perhaps developed as a result of increased incision at the site since that time period.

![Figure 35. 1962 aerial photograph of T1.02-A. Red arrow points to current site of mass failure.](image3)
Due to the severe incision and channel adjustment features, this segment is considered highly sensitive to further human impacts (RGA condition “Fair”, CEM stage II). The habitat diversity is compromised by aggradation of fine sediments from the slope failure, and a loss of bed features due to the channel incision (RHA condition “Fair”). The LWD density for this segment was slightly above the average for SB reaches (58 pieces/mile).

**T1.02-B**

This segment found the intersection of Kipling and Black Mountain Roads up to the next road crossing. The segment is 0.3 miles long and has channel slope of approximately 5.6%. Due to the impacts from the encroachment of Black Mountain Road, the segment has undergone a departure from reference conditions. Under reference conditions we would expect this reach to have B_type channel geometry, and a narrow but accessible floodplain. Extensive channel encroachment (95% of segment length) from the road bed and berm along Black Mountain Road has reduced the channel to a simplified form with no floodplain access and limited habitat diversity. The channel currently has an unnaturally low entrenchment ratio (ER = 1.3), and a disconnected, human elevated floodplain (IR/HEF = 2.6). Channel and floodplain measurements indicated the reach has undergone a stream type departure from B-type to F-type geometry (Figure 36). Step-pool bed morphology was dominant, but large stretches of channel also exhibited plane bedform. Severe bank erosion is extensive along the right bank (Figure 37), but is limited along the left bank due to road bed armoring.

![Figure 36. F-type geometry in T1.02-B.](image1)
![Figure 37. Bank erosion in lower T1.02-B.](image2)

Due to the departure in valley and channel morphology and the high channel incision (due to human elevated floodplain), the segment is considered extremely sensitive to further human impacts (RGA condition “Poor”, CEM stage II). There is very limited habitat diversity due to extensive encroachment and limited buffer and corridor.
protection (RHA condition “Fair”). The LWD density for this segment was slightly above the average for SB reaches (59 pieces/mile).

T1.02-C
This short segment is found from the last Black Mountain Road crossing up to a sharp change in channel slope and valley confinement at the Dickinson Road crossing. The segment is 475 feet long and has channel slope of approximately 7.0%. Immediately upstream of the road crossing is an 18 foot waterfall, followed by a series of grade controls in the lower segment. There is excellent step-pool formation mid-segment (Figure 38), followed by another series of ledge grade controls in the upper segment (Figure 39). Channel and floodplain measurements indicate a stable A-type channel.

![Figure 38. Step-pool bedform in T1.02-C.](image1)
![Figure 39. Bedrock grade controls in upper T1.02-C.](image2)

The segment is stable and has good riparian buffer protection. Reference conditions were noted for channel stability and habitat conditions (RGA/RHA conditions “Reference”). The LWD density for this segment was slightly above the average for SB reaches (55 pieces/mile).

T1.02-D
This short segment (700 feet) was delineated to describe the change in channel and valley dimensions that occur immediately downstream of the Dickinson Road crossing. At this point the valley widens to an unconfined setting, and the channel slope decreases to approximately 0.5%. An old impoundment (with a breached dam) is located at the segment break below Dickinson Road. This impoundment appears to be aggrading fine sediment from upslope areas (Figure 40), and a significant source of road sediment runoff was noted during the field assessment on the upstream side of the road crossing (Figure 41). Brattleboro Town officials were made aware of the problem during a site visit in April, 2008. The culvert beneath Dickinson Road is severely undersized (3.0 feet width)
with respect to the upstream stable channel width (9 feet). This has the effect of increasing flooding in the field along the right bank upstream of the crossing, perhaps alleviating flooding problems downstream along Black Mountain Road where more undersized culverts exist. Nevertheless, the inadequate capacity of the culvert to accommodate larger streamflows has resulted in a partially failed headwall on the upslope end – a problem that will likely need to be addressed by the Town in the near future.

![Figure 40. Old impoundment in lower T1.02-D](image)

![Figure 41. Sediment source from Dickinson Road.](image)

The channel dimensions indicate E-type channel geometry with some riffle-pool formation in the upper segment. Some channel incision was noted in the cross section mid-segment (IR = 1.6). A small terrace is forming along the lower banks that suggests stage II of channel evolution. Due to the incision and lack of a healthy riparian buffer, fair physical stability and habitat was noted (RGA/RHA conditions “Fair”). Due to limited recruitment potential, the LWD density for this segment was well below the average for SB reaches (16 pieces/mile).

T1.02-E

This short segment is found from the change in channel slope and valley confinement 700 feet upstream of Dickinson Road crossing up to the reach break with T1.03. The segment is 950 feet long and has channel slope of approximately 2.5%. Two defunct dams (Figure 42) that historically served impoundments for cattle (drinking water) were noted in the lower segment. While a minor degree of aggradation of fine sediment is occurring behind these structures, little to no channel adjustments are found in their immediate vicinity. The segment ends where the valley widens and the channel slope decreases (Figure 43).
The segment has B-type channel dimensions and plane bedform (reference bedform). Overall the channel is stable and has good riparian buffer protection. Good conditions were noted for channel stability and habitat conditions (RGA/RHA conditions “Good”). The LWD density for this segment was slightly above the average for SB reaches (45 pieces/mile).

**T1.03**
Reach T1.03 is found from a drastic change in valley confinement up to Scott’s Farm on Kipling Road. The reach is 0.8 miles long and has an overall channel slope of 0.2%. The very broad valley and low width-to-depth ratio of the channel indicated E-type geometry with dune-ripple bedform. The wide alluvial valley probably formed in conjunction with channel meandering processes over time, however historic channel straightening appears to have relocated the channel in the lower reach along the left valley wall to make way for pasture or hay fields, and now athletic fields.

A cross section taken in the lower reach indicates good floodplain connectivity with minor channel incision (IR=1.3; Figure 44). A berm follows the left bank within 20 to 25 feet of channel for much of lower and middle reach. This berm may have been part of old farm road, and does not severely disconnect channel from floodplain, since a majority of floodplain width is on the right bank. The channel dimensions change mid-reach for approximately 700 feet where the near bank vegetation changes from herbaceous to shrub-sapling. Within this area the channel becomes wider and deeper, but E-type channel...
dimensions were measured to verify that no segmentation was necessary.

Some bank erosion was noted in the vicinity of the second channel crossing mid-reach. Downstream of the culvert and crossing (providing access to the World Learning pond) there is an area of failed bank armoring and erosion (3 feet high; Figure 45). Upstream of this crossing, the channel enters an area of beaver activity where the riparian vegetation becomes dominated by herbaceous plants and alders (Figure 46).

![Figure 45. Bank erosion mid-reach below a crossing.](image1)

![Figure 46. Herbaceous buffer in upper T1.03.](image2)

The channel stability and floodplain connectivity was fair, with some evidence of incision in lower reach (RGA condition “Fair”, CEM stage II). Overall the habitat conditions of the reach were fair, with impacts attributed to reduced riparian vegetation and historic channel straightening (RHA condition “Fair”). The LWD density for this reach was very low due to the lack of a healthy riparian buffer on the right bank and limited recruitment potential (18 pieces/mile).

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 3.
<table>
<thead>
<tr>
<th>Reach/Segment</th>
<th>Road Name</th>
<th>Road Type</th>
<th>Location</th>
<th>Struct. Height (ft)</th>
<th>Stream Width (ft)</th>
<th>Struct. Width (ft)</th>
<th>Struct/Stream Width*</th>
<th>Floodplain Filled?</th>
<th>Stream Approach</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>M01-B Bridge</td>
<td>Railroad</td>
<td>Railroad</td>
<td>Railroad crossing just upstream of segment break.</td>
<td>9.5</td>
<td>20.0</td>
<td>19.0</td>
<td>95%</td>
<td>Partially</td>
<td>Channelized Straight</td>
<td>Stable structure, heavily armored on upstream end. Armoring prevent native woody vegetation from re-developing on upstream end.</td>
</tr>
<tr>
<td>M01-B Bridge</td>
<td>Route 5</td>
<td>Paved</td>
<td>Route 5 crossing.</td>
<td>5.4</td>
<td>22.0</td>
<td>30.0</td>
<td>136%</td>
<td>Entirely</td>
<td>Channelized Straight</td>
<td>Large side bar on upstream left bank may be forming more due to runoff and snow removal from Mobil parking lot than from bridge being undersized.</td>
</tr>
<tr>
<td>M01-B Bridge</td>
<td>I-91 Ramp</td>
<td>Paved</td>
<td>I-91 Exit 3 ramp.</td>
<td>7.0</td>
<td>21.8</td>
<td>20.0</td>
<td>92%</td>
<td>Partially</td>
<td>Channelized Straight</td>
<td>Large side bar developed on left bank downstream end, causing deposition within structure.</td>
</tr>
<tr>
<td>M02 Bridge</td>
<td>I-91</td>
<td>Paved</td>
<td>I-91 crossing (2 lanes).</td>
<td>4.5</td>
<td>23.0</td>
<td>25.0</td>
<td>109%</td>
<td>Partially</td>
<td>Mild Bend</td>
<td>Very high degree of sedimentation. Little clearance due to aggradation of fine sediment.</td>
</tr>
<tr>
<td>M03 Culvert</td>
<td>Ryan Rd.</td>
<td>Gravel</td>
<td>Just west of intersection with Route 5.</td>
<td>7.0</td>
<td>23.8</td>
<td>7.0</td>
<td>29%</td>
<td>Partially</td>
<td>Naturally Straight</td>
<td>Only minor failing of bank armoring on downstream end, mainly on right bank. Not endangering road or short-term integrity of structure.</td>
</tr>
<tr>
<td>M04 Culvert</td>
<td>Middle Rd.</td>
<td>Paved</td>
<td>Just north of intersection with Route 5.</td>
<td>7.0</td>
<td>21.0</td>
<td>7.0</td>
<td>33%</td>
<td>Partially</td>
<td>Channelized Straight</td>
<td>Culvert height is 7.0' but due to aggraded material in structure clearance is only 4.3'</td>
</tr>
<tr>
<td>M05 Culvert</td>
<td>Middle Rd.</td>
<td>Paved</td>
<td>Just south of intersection with Houghton Rd.</td>
<td>7.0</td>
<td>16.0</td>
<td>7.0</td>
<td>44%</td>
<td>Partially</td>
<td>Mild Bend</td>
<td>Some bank erosion beginning to occur downstream of structure where armoring is failing. Vicinity of road well armored and erosion not yet endangering road or embankment.</td>
</tr>
<tr>
<td>M06-B Bridge</td>
<td>Driveway</td>
<td>Gravel</td>
<td>Driveway stemming from Houghton Rd mid-segment.</td>
<td>10.6</td>
<td>18.0</td>
<td>18.5</td>
<td>103%</td>
<td>Partially</td>
<td>Naturally Straight</td>
<td>No significant impacts from bridge. Segment is heavily armored and grade control is present immediately downstream.</td>
</tr>
<tr>
<td>M06-B Culvert</td>
<td>Houghton Rd.</td>
<td>Paved</td>
<td>Houghton Rd crossing upper.</td>
<td>7.0</td>
<td>16.0</td>
<td>9.0</td>
<td>56%</td>
<td>Partially</td>
<td>Mild Bend</td>
<td>Minor failing of armoring on downstream end - not endangering road or structural integrity.</td>
</tr>
<tr>
<td>Reach/Segment</td>
<td>Road Name</td>
<td>Road Type</td>
<td>Location</td>
<td>Struct. Height (ft)</td>
<td>Stream Width (ft)</td>
<td>Struct. Width (ft)</td>
<td>Struct/Stream Width*</td>
<td>Flood-plain Filled?</td>
<td>Stream Approach</td>
<td>COMMENTS</td>
</tr>
<tr>
<td>---------------</td>
<td>-----------</td>
<td>-----------</td>
<td>----------</td>
<td>--------------------</td>
<td>------------------</td>
<td>-------------------</td>
<td>---------------------</td>
<td>---------------------</td>
<td>-----------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>M06-C Bridge</td>
<td>Tucker Reed Rd.</td>
<td>Gravel</td>
<td>Just east of intersection with Houghton Rd.</td>
<td>5.0</td>
<td>18.0</td>
<td>6.2</td>
<td>34%</td>
<td>Partially</td>
<td>Mild Bend</td>
<td>Armoring on right bank upslope is failing, and bank is eroding behind it. Lawn from house extends up to edge of armoring - could be stabilized in long-term with woody vegetation planting.</td>
</tr>
<tr>
<td>M06-C Culvert</td>
<td>Houghton Rd.</td>
<td>Paved</td>
<td>At reach break with M07.</td>
<td>6.0</td>
<td>18.0</td>
<td>6.5</td>
<td>36%</td>
<td>Partially</td>
<td>Naturally Straight</td>
<td>Scour and deposition on the left bank downstream of structure, with some channel incision.</td>
</tr>
<tr>
<td>T1.01 Culvert</td>
<td>I-91</td>
<td>Paved</td>
<td>I-91 crossing (2 lanes).</td>
<td>7.0</td>
<td>17.0</td>
<td>11.0</td>
<td>65%</td>
<td>Partially</td>
<td>Channelized Straight</td>
<td>Very high degree of bank erosion on right bank downstream of structure. Erosion limited to ~200' below crossing and is not endangering infrastructure in right corridor.</td>
</tr>
<tr>
<td>T1.01 Culvert</td>
<td>Black Mtn. Rd.</td>
<td>Paved</td>
<td>Just south of intersection with Crescent Dr.</td>
<td>4.0</td>
<td>17.0</td>
<td>4.0</td>
<td>24%</td>
<td>Entirely</td>
<td>Sharp Bend</td>
<td>Culvert is severely undersized, however aggradation above is not endangering road/structure currently. Town officials recognize that structure is undersized.</td>
</tr>
<tr>
<td>T1.02-B Arch</td>
<td>Black Mtn. Rd.</td>
<td>Gravel</td>
<td>Upper Black Mt Rd crossing.</td>
<td>4.9</td>
<td>17.5</td>
<td>7.0</td>
<td>40%</td>
<td>Partially</td>
<td>Naturally Straight</td>
<td>Minor scour at upstream end on left bank, but nearby grade controls limit vertical adjustments. Tributary entering on right bank downstream end is incised and banks are eroding along road.</td>
</tr>
<tr>
<td>T1.02-D Culvert</td>
<td>Dickinson Rd.</td>
<td>Gravel</td>
<td>Just east of intersection with Black Mt Rd.</td>
<td>3.0</td>
<td>9.0</td>
<td>3.0</td>
<td>33%</td>
<td>Partially</td>
<td>Mild Bend</td>
<td>Town officials note that culvert is undersized and headwall is failing on upstream end. Culvert holds back high flows and allows upstream segment D to access floodplain on right bank despite channel incision.</td>
</tr>
<tr>
<td>T1.03 Bridge</td>
<td>NA - Trail</td>
<td>Trail</td>
<td>Lower athletic field access trail.</td>
<td>3.5</td>
<td>4.3</td>
<td>16.5</td>
<td>384%</td>
<td>Partially</td>
<td>Naturally Straight</td>
<td>Structure not significantly impacting channel. Floodprone width is constricted, but floodplain is wide and accessible upstream and downstream.</td>
</tr>
<tr>
<td>T1.03 Culvert</td>
<td>NA - Trail</td>
<td>Trail</td>
<td>Access trail to SIT pond.</td>
<td>5.0</td>
<td>12.0</td>
<td>5.0</td>
<td>42%</td>
<td>Partially</td>
<td>Channelized Straight</td>
<td>Severe bank erosion on downstream end of culvert due to limited boundary resistance from lack of native plants/trees.</td>
</tr>
</tbody>
</table>

* Bolded values are structure widths less than 75% of the bankfull channel width.
Of the 17 structures assessed, only 11 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 both incompatible from a bankfull width approach and causing significant upstream or downstream erosion include the following: M05, Middle Road Culvert; M06-C, Tucker Reed Road bridge; M06-C, Houghton Road culvert; T1.01, I-91 culvert; T1.03, Trail culvert. Structures that have severe aggradation above or below that is threatening the long-term integrity of the structure include the following: M02, I-91 bridge; M04, Middle Road culvert. These structures should be considered high-priority for replacement by town and state agencies, and will be explored in further detail in the forthcoming River Corridor Planning phase of the Crosby Brook study.

5.0 Conclusions and Future Work

The watershed and reach scale stressors described above indicate that the lower zone of the watershed is experiencing the greatest degree of channel adjustment and decline in physical habitat. Channel adjustments, in conjunction with riparian buffer loss and increased stormwater runoff are leading to a decline in biotic integrity. While the large gully on the mainstem has certainly had a severe impact on the lower watershed conditions (especially in the supply of fine sediment to the channel), the deleterious effects of recent commercial development and floodplain encroachment in this zone of the watershed is also evident. 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.

The Crosby Brook study of geomorphic and habitat conditions will continue in 2008 with a more detailed review of the watershed and reach-scale stressors. This effort will involve the following components that will 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:

1. Development of stressor identification and departure analysis maps.
2. Summary of potential projects to address stressors causing channel instability and degraded physical habitat.
3. Prioritized “active” and “passive” restoration projects, and further development of three identified projects, including landowner outreach and conceptual designs.

4. Fluvial Erosion Hazard (FEH) Zone mapping and analysis to a) compare FEH zoning overlays with alternative corridor management strategies developed from the study, and b) summarize existing land assets (e.g., wetlands, town-owned lands) and liabilities (e.g., structures) within the corridor at the reach scale.
6.0 References


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


University of Vermont Spatial Analysis Laboratory, 2005, Landsat Based Land Cover/Land Use Dataset for Vermont. Available at: www.vcgi.org. Accessed April, 2006

VTDEC (Vermont Department of Environmental Conservation), 2005, The Biological Condition of Crosby Brook and Exploration of the Environmental Stressors on Aquatic Communities, April, 2005

VTDEC (Vermont Department of Environmental Conservation) Stormwater Section, 2007, Sediment Sources in the Crosby Brook Watershed, Powerpoint summary presented to public in May, 2007.
Appendix A

Crosby Brook Reach Mapping
Crosby Brook Phase 2 Mapping
Reaches M05 & M06

Subwatershed Boundaries
Segment Breaks
Cross Section Locations
Crosby Bk Surface Waters
Crosby Brook Phase 2 Mapping
Reaches T1.02 & T1.03

Subwatershed Boundaries
Segment Breaks
Cross Section Locations
Crosby Bk Surface Waters

Fitzgerald Environmental Associates, LLC.
www.fitzgeraldenvironmental.com
Appendix B

Reach Summary Data
## Appendix B - Phase 2 Reach Summary Statistics

<table>
<thead>
<tr>
<th>Reach/Segment</th>
<th>Stream Type</th>
<th>Dominant Bed Material</th>
<th>Bedform</th>
<th>STD*</th>
<th>Reference Stream Type†</th>
<th>Reference Bed Material†</th>
<th>Reference Bedform†</th>
<th>RHA Score</th>
<th>RHA Condition</th>
<th>RGA Score</th>
<th>RGA Condition</th>
<th>Reach Sensitivity</th>
<th>CEM** Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>M01-A</td>
<td>A</td>
<td>Gravel</td>
<td>Step-Pool</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td>0.70</td>
<td>Good</td>
<td>0.74</td>
<td>Good</td>
<td>High</td>
<td>F I</td>
</tr>
<tr>
<td>M01-B</td>
<td>C</td>
<td>Sand</td>
<td>Riffle-Pool</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td>0.42</td>
<td>Fair</td>
<td>0.41</td>
<td>Fair</td>
<td>Very High</td>
<td>F II</td>
</tr>
<tr>
<td>M02</td>
<td>F</td>
<td>Gravel</td>
<td>Plane Bed</td>
<td>Yes</td>
<td>C</td>
<td>Gravel</td>
<td>Riffle-Pool</td>
<td>0.34</td>
<td>Poor</td>
<td>0.33</td>
<td>Poor</td>
<td>Extreme</td>
<td>F II</td>
</tr>
<tr>
<td>M03</td>
<td>C</td>
<td>Gravel</td>
<td>Riffle-Pool</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td>0.63</td>
<td>Fair</td>
<td>0.48</td>
<td>Fair</td>
<td>Very High</td>
<td>F III</td>
</tr>
<tr>
<td>M04</td>
<td>C</td>
<td>Gravel</td>
<td>Riffle-Pool</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td>0.72</td>
<td>Good</td>
<td>0.68</td>
<td>Good</td>
<td>High</td>
<td>F I</td>
</tr>
<tr>
<td>M05</td>
<td>E</td>
<td>Gravel</td>
<td>Riffle-Pool</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td>0.57</td>
<td>Fair</td>
<td>0.64</td>
<td>Good</td>
<td>High</td>
<td>F IV</td>
</tr>
<tr>
<td>M06-A</td>
<td>C</td>
<td>Gravel</td>
<td>Riffle-Pool</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td>0.71</td>
<td>Good</td>
<td>0.61</td>
<td>Fair</td>
<td>Very High</td>
<td>F II</td>
</tr>
<tr>
<td>M06-B</td>
<td>B</td>
<td>Cobble</td>
<td>Step-Pool</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td>0.73</td>
<td>Good</td>
<td>0.68</td>
<td>Good</td>
<td>Moderate</td>
<td>F II</td>
</tr>
<tr>
<td>M06-C</td>
<td>C</td>
<td>Gravel</td>
<td>Riffle-Pool</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td>0.73</td>
<td>Good</td>
<td>0.66</td>
<td>Good</td>
<td>High</td>
<td>F I</td>
</tr>
<tr>
<td>T1.01</td>
<td>F</td>
<td>Gravel</td>
<td>Plane Bed</td>
<td>Yes</td>
<td>C</td>
<td>Gravel</td>
<td>Riffle-Pool</td>
<td>0.53</td>
<td>Fair</td>
<td>0.38</td>
<td>Fair</td>
<td>Extreme</td>
<td>F I</td>
</tr>
<tr>
<td>T1.02-A</td>
<td>C</td>
<td>Gravel</td>
<td>Riffle-Pool</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td>0.63</td>
<td>Fair</td>
<td>0.45</td>
<td>Fair</td>
<td>Very High</td>
<td>F II</td>
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<tr>
<td>T1.02-B</td>
<td>F</td>
<td>Gravel</td>
<td>Step-Pool</td>
<td>Yes</td>
<td>B</td>
<td>Cobble</td>
<td>Step-Pool</td>
<td>0.48</td>
<td>Fair</td>
<td>0.34</td>
<td>Poor</td>
<td>Extreme</td>
<td>F II</td>
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<tr>
<td>T1.02-C</td>
<td>A</td>
<td>Bedrock</td>
<td>Step-Pool</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td>0.86</td>
<td>Reference</td>
<td>0.85</td>
<td>Reference</td>
<td>Very Low</td>
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</tr>
<tr>
<td>T1.02-D</td>
<td>E</td>
<td>Sand</td>
<td>Riffle-Pool</td>
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<td>0.62</td>
<td>Fair</td>
<td>0.60</td>
<td>Fair</td>
<td>Very High</td>
<td>F II</td>
</tr>
<tr>
<td>T1.02-E</td>
<td>B</td>
<td>Gravel</td>
<td>Plane Bed</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td>0.72</td>
<td>Good</td>
<td>0.79</td>
<td>Good</td>
<td>Moderate</td>
<td>F I</td>
</tr>
<tr>
<td>T1.03</td>
<td>E</td>
<td>Sand</td>
<td>Dune-Ripple</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
<td>0.62</td>
<td>Fair</td>
<td>0.61</td>
<td>Fair</td>
<td>Very High</td>
<td>F II</td>
</tr>
</tbody>
</table>

* STD = Stream Type Departure
** CEM = Channel Evolution Model
† = Assessed Reference Condition Prior to Stream Type Departure

Mean: 0.62 0.58
Max: 0.86 0.85
Min: 0.34 0.33
### Phase 2 Segment Summary

**Project:** Crosby Brook  
**Stream:** Crosby Brook North Branch  
**Reach:**  
**Organization:** Windam NRCD  
**Observers:** EPF, NP  
**Segment Length (ft):** 2,060  
**Segment Location:** From mouth with Connecticut up to bend along railroad tracks upstream of second

<table>
<thead>
<tr>
<th>QC Status - Staff: Provisional Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1. Valley and Floodplain</strong></td>
</tr>
<tr>
<td><strong>1.1 Segmentation</strong></td>
</tr>
<tr>
<td>Channel Dimensions</td>
</tr>
<tr>
<td>Length (ft)</td>
</tr>
<tr>
<td>Berms</td>
</tr>
<tr>
<td>height</td>
</tr>
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<td>Roads</td>
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</tr>
<tr>
<td>Improved Paths</td>
</tr>
<tr>
<td>height</td>
</tr>
<tr>
<td>Development</td>
</tr>
<tr>
<td><strong>1.3 Corridor Encroachments</strong></td>
</tr>
<tr>
<td>Width Determination</td>
</tr>
<tr>
<td>Continuous w/</td>
</tr>
<tr>
<td>W/in 1 Bankfill</td>
</tr>
<tr>
<td>Texture</td>
</tr>
<tr>
<td><strong>1.5 Valley Features</strong></td>
</tr>
<tr>
<td>Width</td>
</tr>
<tr>
<td>Confinement Type</td>
</tr>
<tr>
<td>Rock Gorge?</td>
</tr>
<tr>
<td>Human-caused Change?</td>
</tr>
</tbody>
</table>

**Step 2. Stream Channel**

<table>
<thead>
<tr>
<th>Segment Length (ft)</th>
<th>2,060</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notes:</td>
<td>This segment is highly variable, with much of the elevation lost at large grade controls, resulting in many different types of bedforms throughout. Segment slope measured at ~3%. Channel in a confined setting throughout entire segment. One active</td>
</tr>
</tbody>
</table>

### Provisional - Step 2. (Contd.)

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>One</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedrock</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Boulder</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Cobble</td>
<td>42%</td>
<td></td>
</tr>
<tr>
<td>Coarse Gravel</td>
<td>14%</td>
<td></td>
</tr>
<tr>
<td>Fine Gravel</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Sand</td>
<td>17%</td>
<td></td>
</tr>
<tr>
<td>Silt &amp; smaller</td>
<td>21%</td>
<td></td>
</tr>
</tbody>
</table>

| Silt/Clay Present?   | No  |  
| Detritus (%)         | 5%  |  
| # Large Woody        | 42  |  

#### 2.13 Average Largest Particle on

| Bed | 8.0 inches |  
| Bar | N/A inches |  

### 2.14 Stream Type

<table>
<thead>
<tr>
<th>Stream Type</th>
<th>A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bed Material:</td>
<td>Gravel</td>
</tr>
<tr>
<td>Subclass Slope:</td>
<td>b</td>
</tr>
<tr>
<td>Bed Form:</td>
<td>Step-Pool</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Field Measured Slope:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.15 Reference Stream Type (if different from Phase 1)</td>
</tr>
<tr>
<td>A</td>
</tr>
</tbody>
</table>

| Sub-dominant | Mixed Trees | Mixed Trees |

### Step 3. Riparian Features

<table>
<thead>
<tr>
<th>3.1 Stream Banks</th>
<th>Typical Bank Slope</th>
<th>Steep</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank Texture</td>
<td>Left</td>
<td>Right</td>
</tr>
</tbody>
</table>

| 3.5 Sinuosity | Low |
| 3.4 Adjacent Side |  
| 2.10 Riffles Type | Sedimented |
| 2.11 Riffle/Step Spacing (ft) | 160 |

<table>
<thead>
<tr>
<th>2.12 Substrate Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedrock</td>
</tr>
<tr>
<td>Boulder</td>
</tr>
<tr>
<td>Cobble</td>
</tr>
<tr>
<td>Coarse Gravel</td>
</tr>
<tr>
<td>Fine Gravel</td>
</tr>
<tr>
<td>Sand</td>
</tr>
<tr>
<td>Silt &amp; smaller</td>
</tr>
</tbody>
</table>

| Silt/Clay Present? | No  |  
| Detritus (%)       | 5%  |  
| # Large Woody      | 42  |  

### 3.2 Riparian Channel

<table>
<thead>
<tr>
<th>Buffer Width</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominant</td>
<td>51-100</td>
<td>&gt;100</td>
</tr>
</tbody>
</table>

| Sub-dominant | None |
| W less than 25 | 0 |
| Buffer Veg. Type | Left | Right |

### 3.3 Riparian Corridor

<table>
<thead>
<tr>
<th>Corridor Land</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominant</td>
<td>Forest</td>
<td>Forest</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sub-dominant</th>
<th>Residential</th>
<th>None</th>
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<tr>
<td>Mass Failures</td>
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<tr>
<td>Gullies</td>
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<tr>
<td>Height</td>
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</table>

### Step 4. Flow & Flow Modifiers

<table>
<thead>
<tr>
<th>4.1 Spring / Seeps</th>
<th>Abundant</th>
</tr>
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<tbody>
<tr>
<td>4.2 Adjacent Wetlands</td>
<td>Minimal</td>
</tr>
<tr>
<td>4.3 Flow Status</td>
<td>High</td>
</tr>
<tr>
<td>4.4 # of Debris Jams</td>
<td>5</td>
</tr>
<tr>
<td>4.5 Flow Regulation Type</td>
<td>None</td>
</tr>
<tr>
<td>Flow Regulation Use</td>
<td></td>
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<tr>
<td>Impoundments</td>
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</tr>
<tr>
<td>Impoundmnt. Location</td>
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</tr>
<tr>
<td>4.6 Up/Down strm flow reg</td>
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<tr>
<td>(old) Upstrm Flow Reg</td>
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#### 4.7 Stormwater Inputs

<table>
<thead>
<tr>
<th>Field Ditch</th>
<th>Road Ditch</th>
<th>Other</th>
<th>Tile Drain</th>
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<tr>
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#### 4.9 # of Beaver Dams

<table>
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<th>Affected Length (ft)</th>
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### Step 5. Channel Bed and Planform Changes

<table>
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<tr>
<th>5.1 Bar Types</th>
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<tr>
<td>Mid</td>
</tr>
<tr>
<td>0</td>
</tr>
<tr>
<td>Diagonal</td>
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### 5.2 Other Features

<table>
<thead>
<tr>
<th>Flood</th>
<th>Neck Cutoff</th>
<th>Avulsion</th>
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<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
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<p>| 5.3 Steep Riffles and Head Cuts |</p>
<table>
<thead>
<tr>
<th>Steep Riffles</th>
<th>Head Cuts</th>
<th>Trib Rejuv.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
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<table>
<thead>
<tr>
<th>5.4 Stream Ford or Animal</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.5 Straightening</td>
<td>Straightening Length: 214</td>
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</table>

### Note:

The segment is highly variable, with much of the elevation lost at large grade controls, resulting in many different types of bedforms throughout. Segment slope measured at ~3%. Channel in a confined setting throughout entire segment. One active.
Narrative:
Reach stable due to vertical controls. High sedimentation of fines impacting bed substrate and habitat conditions. See step 5 for further narrative.
### QC Status - Staff: Provisional Cons

<table>
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<tr>
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#### Step 1. Valley and Floodplain

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<th>Both Berms</th>
<th>Height (ft)</th>
<th>One</th>
<th>Both</th>
<th>Roads (ft)</th>
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<th>Both</th>
<th>Height (ft)</th>
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<th>Both</th>
<th>Railroads (ft)</th>
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<th>Both</th>
<th>Height (ft)</th>
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<th>Both</th>
<th>Height (ft)</th>
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#### Step 2. Stream Channel

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<th>Max Depth (ft)</th>
<th>Mean Depth (ft)</th>
<th>Floodplain Width (ft)</th>
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<td>Human-caused</td>
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#### Step 3. Riparian Features

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<th>Aband. Floodpln</th>
<th>Width/Depth Ratio</th>
<th>Entrenchment Ratio</th>
<th>Incision Ratio</th>
<th>Elevated Inc Rat</th>
<th>Sinuosity</th>
<th>Riffl Type</th>
<th>Step Spacing (ft)</th>
<th>Substrate Composition</th>
<th>Bank Erosion Length (ft)</th>
<th>Erosion Height (ft)</th>
<th>Revetmnt. Type</th>
<th>Revetmnt. Length (ft)</th>
<th>Near Bank Veg. Type</th>
<th>Dominant</th>
<th>Sub-dominant</th>
<th>Bank Canopy</th>
<th>Canopy %</th>
<th>Mid-Channel Canopy</th>
<th>Bank Type</th>
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<tbody>
<tr>
<td></td>
<td>2.5</td>
<td>4.80 ft.</td>
<td>0.00 ft.</td>
<td>10.53</td>
<td>2.75</td>
<td>1.55</td>
<td>Sedimented</td>
<td>150</td>
<td>0.00</td>
<td>30</td>
<td>2.00</td>
<td>Rip-Rap</td>
<td>160</td>
<td>Left</td>
<td>26-50</td>
<td>Open</td>
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#### Step 4. Flow & Flow Modifiers

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<th>Flow Status</th>
<th>Debris Jams</th>
<th>Flow Regulation</th>
<th>Flow Regulation Use</th>
<th>Impoundments</th>
<th>Impoundmnt. Location</th>
<th>Up/Down Flow Reg</th>
<th>Old Upstrm Flow Reg</th>
<th>Stormwater Inputs</th>
<th>Field Ditch</th>
<th>Road Ditch</th>
<th>Other</th>
<th>Tile Drain</th>
<th>Overland Flow</th>
<th>Urb Strm Wtr Pipe</th>
<th>Other Features</th>
<th>Steep Riffles and Head Cuts</th>
<th>Trib Rejuv.</th>
<th>Other Features</th>
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<th>Braiding</th>
<th>Neck Cutoff</th>
<th>Avulsion</th>
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<th>5.3 Steep Necks and Head Cuts</th>
<th>Head Cuts</th>
<th>5.5 Straightening</th>
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<td>4.5</td>
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<td>None</td>
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<td>None</td>
<td>None</td>
<td>Kind</td>
<td>Field Ditch</td>
<td>Road Ditch</td>
<td>Other</td>
<td>Tile Drain</td>
<td>Overland Flow</td>
<td>Urb Strm Wtr Pipe</td>
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<td>Trib Rejuv.</td>
<td>Other Features</td>
<td>Island</td>
<td>Braiding</td>
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<td>Avulsion</td>
<td>5.2 Other Features</td>
<td>5.3 Steep Necks and Head Cuts</td>
<td>Head Cuts</td>
<td>5.5 Straightening</td>
<td>Straightening Length</td>
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#### Step 5. Channel Bed and Planform Changes

<table>
<thead>
<tr>
<th>Feature</th>
<th>Bar Types</th>
<th>Main Point</th>
<th>Side</th>
<th>Main</th>
<th>Diagonal</th>
<th>Delta</th>
<th>Island</th>
<th>Flood</th>
<th>Neck Cutoff</th>
<th>Avulsion</th>
<th>Steep Riffles and Head Cuts</th>
<th>Trib Rejuv.</th>
<th>5.4 Stream or Animal</th>
<th>5.5 Straightening</th>
<th>Straightening Length</th>
<th>5.5 Dredging</th>
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<td>Steep Riffles and Head Cuts</td>
<td>Trib Rejuv.</td>
<td>5.4 Stream or Animal</td>
<td>5.5 Straightening</td>
<td>Straightening Length</td>
<td>5.5 Dredging</td>
<td>None</td>
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#### Notes

- Channel has encroachment from railroad in lower section, and development in middle and upper sections. Valley has become confined due to encroachment, and channel incision has resulted. Narrow floodplain not filled by adjacent development is not accessible to...
### Step 7. Rapid Geomorphic Assessment Data

<table>
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<tr>
<th>Confinement Type</th>
<th>Unconfined</th>
<th>Score</th>
<th>STD</th>
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<td>7.1 Channel Degradation</td>
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<td>7.2 Channel Aggradation</td>
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<td>7.3 Widening Channel</td>
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<td>7.4 Change in Planform</td>
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<tr>
<td>Total Score</td>
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<tr>
<td>Geomorphic Rating</td>
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| Channel Evolution Model | F |
| Stream Sensitivity | Very High |

### Step 6. Rapid Habitat Assessment Data

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<th>GPS Taken?</th>
<th>Channel Constriction?</th>
<th>Floodprone Constriction?</th>
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<tr>
<td>Bridge</td>
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<td>No</td>
<td>Yes</td>
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<tr>
<td>Bridge</td>
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<td>Deposition Above</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
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</tbody>
</table>

### Narrative:
Channel incision resulting from reduced floodplain access. See step 5 for further narrative.
### Step 1. Valley and Floodplain

**1.1 Segmentation** | **None**
---|---
**1.2 Alluvial Fan** | **None**
**1.3 Corridor Encroachments** | **None**

#### Length (ft):
- **Berms:** 0
- **Roads:** 1,369
- **Railroads:** 0
- **Improved Paths:** 0
- **Development:** 956

#### Hillside Slope:
- **Hilly**

#### Continuous w/:
- **Sometimes**

#### W/in 1 Bankfill:
- **Always**

#### Texture:
- **Sand**
- **Not Evalua**

#### Valley Width (ft): 90

#### Width Determination:
- **Measured**

#### Confinement Type:
- **Semi-confined**

#### Rock Gorge?:
- **No**

#### Human-caused Change?: **Yes**

### Step 2. Stream Channel

#### Length (ft):
- **2.1 Bankfull Width:** 23
- **2.2 Max Depth (ft):** 2.10
- **2.3 Mean Depth (ft):** 1.39
- **2.4 Floodpronde Width (ft):** 34

#### Notes:
- Approx. 90% of reach affected by channel straightening from construction of I-91 in the 1950’s. Corridor encroachment and floodplain filling within left corridor in lower reach has caused a stream type departure. Despite higher channel slope, sediment supply from higher channel slope, sediment supply from

### QC Status - Staff: Provisional Cons

** QC Status - Staff: Provisional Cons

### Step 3. Riparian Features

#### 3.1 Stream Banks
- **Typical Bank Slope:** *Steep*
- **Bank Texture:** *Left*
- **Erosion Length:** 255 ft
- **Erosion Height:** 4.29 ft
- **Revetmt. Type:** *None*
- **Canopy %:** 51-75%
- **Bank Erosion:** *Left*
- **Canopy:** 48
- **Revetmt. Length (ft):** 2.00
- **Revetmt. Type:** *None*
- **Dominant Sub-dominant**
- **Shrubs/Saplin:** *Shrubs/Saplin*
- **Deciduous:** *Deciduous*
- **Coniferous:** *Coniferous*

#### 3.2 Riparian Buffer
- **Buffer Width:** 51-100 ft
- **Dominant:** 51-100 ft
- **Sub-dominant:** 0-25 ft
- **W less than 25:** 234 ft
- **Buffer Veg. Type:** *Left*
- **Canopy %:** 51-75%
- **Mid-channel Canopy:** *Closed*
- **Canopy:** 48

### Step 4. Flow & Flow Modifiers

- **4.1 Springs / Seeps:** *Minimal*
- **4.2 Adjacent Wetlands:** *Minimal*
- **4.3 Flow Status:** *Moderate*
- **4.4 # of Debris Jams:** 3
- **4.5 Flow Regulation Type:** *None*
- **4.6 Up/Down strm flow reg:** *None*
- **4.7 Stormwater Inputs:** *None*

### Step 5. Channel Bed and Planform Changes

#### 5.1 Bar Types
- **Mid:** 2
- **Point:** 4
- **Side:** 8
- **Diagonal:** 0
- **Delta:** 3
- **Island:** 0

#### 5.2 Other Features
- **Flood:** 0
- **Neck Cutoff:** 0
- **Avulsion:** 0
- **Braiding:** 0

### Step 6. Flow & Flow Modifiers

- **Overland Flow:** *None*
- **Urb Strm Wtr Pipe:** 7
- **4.9 # of Beaver Dams:** 0
- **Affected Length (ft):** 0

### Phase 2 Segment Summary

- **Completion Date:** April 17, 2008
- **Project:** Crosby Brook
- **Reach:** Crosby Brook North Branch
- **Organization:** Windam NRCD
- **Segment Length (ft):** 2,871
- **Segment Location:** From I-91 Exit 3 ramp crossing up to confluence with T2.
- **Observers:** EPF, NP
- **EPF, NP**
- **Why Not assessed:**
- **Rain:** Yes
- **June 13, 2008**
- **SGAT Version:** 4.56
### Narrative:
Channel is redeveloping a new, narrow floodplain at a lower elevation, but has not redeveloped a sinuous planform. Channel may reach equilibrium profile upstream of Interstate 91 crossing within 10-20 years.
### Phase 2 Segment Summary

**Project:** Crosby Brook  
**Stream:** Crosby Brook North Branch  
**Reach:**  
**Observers:** EPF, NP  
**Organizations:** Windam NRCD  
**Completion Date:** June 13, 2008  
**Rain:** Yes  
**Segment Location:** From confluence with T2 up to Ryan Rd crossing.

<table>
<thead>
<tr>
<th>QC Status - Staff: Provisional Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1. Valley and Floodplain</strong></td>
</tr>
<tr>
<td>1.1 Segmentation</td>
</tr>
<tr>
<td>1.2 Alluvial Fan</td>
</tr>
<tr>
<td>1.3 Corridor Encroachments</td>
</tr>
<tr>
<td>Length (ft)</td>
</tr>
<tr>
<td>357</td>
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<tr>
<td>Height</td>
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<td>Roads</td>
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<tr>
<td>Improved Paths</td>
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<tr>
<td>Height</td>
</tr>
<tr>
<td>Development</td>
</tr>
<tr>
<td>1.4 Adjacent Side</td>
</tr>
<tr>
<td>Hillside Slope</td>
</tr>
<tr>
<td>Continuous w/ W/in 1 Bankfill</td>
</tr>
<tr>
<td>Bankfill</td>
</tr>
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<td>Texture</td>
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<td>1.5 Valley Features</td>
</tr>
<tr>
<td>Width Determination</td>
</tr>
<tr>
<td>Confinement Type</td>
</tr>
<tr>
<td>Rock Gorge?</td>
</tr>
<tr>
<td>Human-caused Change?</td>
</tr>
</tbody>
</table>

**Step 2. Stream Channel**

| Notes: Below grade control mid-reach the channel is in stage III of channel evolution and is aggrading sediment and widening. Large gully delivering large amount of fine sediment to channel has altered the bed substrate distribution below the confluence. |
| 2.1 Bankfull Width | 24 |
| 2.2 Max Depth (ft) | 2.10 |
| 2.3 Mean Depth (ft) | 1.66 |
| 2.4 Floodprone Width (ft) | 200 |

| 2.13 Average Largest Particle on |
| Bed | 7.0 inches |
| Bar | 3.0 inches |

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

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

### Step 3. Riparian Features

#### 3.1 Stream Banks

| Typical Bank Slope | Undercut |
| Bank Texture | Left | Right |
| Material Type | Gravel |
| Consistency | Non-cohesive |
| 2.9 Sinuosity | Moderate |
| 2.10 Riffles Type | Sedimented |
| 2.11 Riffle/Step Spacing (ft) | 0 |
| 2.12 Substrate Composition |
| Bedrock | 14% |
| Boulder | 0% |
| Cobble | 17% |
| Coarse Gravel | 28% |
| Fine Gravel | 7% |
| Sand | 23% |
| Silt and smaller | 11% |
| Silt/Clay Present? | Yes |
| Detritus | 15% |
| # Large Woody | 63 |

### Step 4. Flow & Flow Modifiers

| 4.1 Springs / Seeps | Minimal |
| 4.2 Adjacent Wetlands | Minimal |
| 4.3 Flow Status | Moderate |
| 4.4 # of Debris Jams | 8 |
| 4.5 Flow Regulation Type | None |
| 4.6 Up/Down strm flow reg | None |

### Step 5. Channel Bed and Planform Changes

| 5.1 Bar Types |
| Mid | Point | Side |
| 3 | 5 | 1 |
| Diagonal | Delta | Island |

### Step 6. Other Features

| 5.2 Other Features |
| Flood | Neck Cutoff | Avulsion |
| 1 | 0 | 0 |

| 5.3 Steep Riffles and Head Cuts |
| Steep Riffles | Head Cuts | Trib Rejuv. |
| 0 | 1 | Yes |

| 5.4 Stream Ford or Animal |
| 0 | 1 | Yes |

| 5.5 Straightening |
| Straightening Length: | 624 |

| 5.5 Dredging |
| Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constructions are on The second page of this report - with Steps 6 through 7. | None |
Aggradation of fine sands and gravel downstream of grade control and gully is causing channel widening and planform adjustment. Historical headcut from I-91 crossing likely migrated up to grade control mid-reach.
### QC Status - Staff: Provisional Cons

#### Step 1. Valley and Floodplain

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<th>Length (ft)</th>
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<th>Both</th>
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#### 1.4 Adjacent Side

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### 1.5 Valley Features

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#### Width Determination

<table>
<thead>
<tr>
<th>Measured</th>
</tr>
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<tbody>
<tr>
<td>Yes</td>
</tr>
</tbody>
</table>

#### Confinement Type

<table>
<thead>
<tr>
<th>Narrow</th>
</tr>
</thead>
</table>

#### Rock Gorge?

<table>
<thead>
<tr>
<th>No</th>
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</thead>
</table>

#### Human-caused Change?

<table>
<thead>
<tr>
<th>Yes</th>
</tr>
</thead>
</table>

### Step 2. Stream Channel

#### 2.1 Bankfull Width

| 21 |

#### 2.2 Max Depth (ft)

| 2.20 |

#### 2.3 Mean Depth (ft)

| 1.52 |

#### 2.4 Floodprone Width (ft)

| 92  |

### Notes:

Channel has higher degree of sinuosity in lower reach than indicated by VHD. Some floodplain accessible in narrow valley between Rt 5 berm and right valley wall. Two cross sections indicate C-type geometry with little to no incision.

### Step 3. Riparian Features

#### 3.1 Stream Banks

<table>
<thead>
<tr>
<th>Typical Bank Slope</th>
<th>Undercut</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Bank Texture</th>
<th>Left</th>
<th>Right</th>
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</thead>
<tbody>
<tr>
<td>Upper</td>
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<td></td>
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<table>
<thead>
<tr>
<th>Material Type</th>
<th>Gravel</th>
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<table>
<thead>
<tr>
<th>Consistency</th>
<th>Non-cohesive</th>
<th>Non-cohesive</th>
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</table>

<table>
<thead>
<tr>
<th>Lower</th>
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</table>

<table>
<thead>
<tr>
<th>Material Type</th>
<th>Sand</th>
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<tbody>
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<td>Sand</td>
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<table>
<thead>
<tr>
<th>Consistency</th>
<th>Non-cohesive</th>
<th>Non-cohesive</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>Bank Erosion</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
</table>

| Erosion Length (ft) | 54 | 0 |

| Erosion Height (ft) | 1.96 | 0.00 |

<table>
<thead>
<tr>
<th>Revetmt. Type</th>
<th>Multiple Rip-Rap</th>
</tr>
</thead>
</table>

| Revetmt. Length (ft) | 474 | 103 |

<table>
<thead>
<tr>
<th>Near Bank Veg. Type</th>
<th>Left</th>
<th>Right</th>
</tr>
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<tbody>
<tr>
<td>Dominant</td>
<td>Herbaceous Deciduous</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Sub-dominant</th>
<th>Coniferous</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Bank Canopy</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
</table>

| Canopy % | 26-50 | 51-75 |

<table>
<thead>
<tr>
<th>Mid-Channel Canopy</th>
<th>Open</th>
</tr>
</thead>
</table>

### Step 4. Flow & Flow Modifiers

#### 4.1 Springs / Seeps

<table>
<thead>
<tr>
<th>Abundant</th>
</tr>
</thead>
</table>

#### 4.2 Adjacent Wetlands

<table>
<thead>
<tr>
<th>Abundant</th>
</tr>
</thead>
</table>

#### 4.3 Flow Status

<table>
<thead>
<tr>
<th>Moderate</th>
</tr>
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</table>

#### 4.4 # of Debris Jams

| 15 |

#### 4.5 Flow Regulation Type

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</table>

<table>
<thead>
<tr>
<th>Flow Regulation Use</th>
<th>Impoundments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Impoundmnt. Location</th>
<th>None</th>
</tr>
</thead>
</table>

| 4.6 Up/Down strm flow reg | None |
| (old) Upstrm Flow Reg | None |

#### 4.7 Stormwater Inputs

<table>
<thead>
<tr>
<th>Field Ditch</th>
<th>0</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Road Ditch</th>
<th>0</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Other</th>
<th>0</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Tile Drain</th>
<th>0</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Overland Flow</th>
<th>0</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Urb Strm Wtr Pipe</th>
<th>0</th>
</tr>
</thead>
</table>

#### 4.9 # of Beaver Dams

| 1 |

| Affected Length (ft) | 300 |

### Step 5. Channel Bed and Planform Changes

#### 5.1 Bar Types

<table>
<thead>
<tr>
<th>Mid</th>
<th>Point</th>
<th>Side</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6</td>
<td>3</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Diagonal</th>
<th>Delta</th>
<th>Island</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

#### 5.2 Other Features

<table>
<thead>
<tr>
<th>Flood</th>
<th>Neck Cutoff</th>
<th>Avulsion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Braiding</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

#### 5.3 Steep Riffles and Head Cuts

<table>
<thead>
<tr>
<th>Steep Riffles</th>
<th>Head Cuts</th>
<th>Trib Rejuv.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>No</td>
</tr>
</tbody>
</table>

#### 5.4 Stream Ford or Animal

<table>
<thead>
<tr>
<th>No</th>
</tr>
</thead>
</table>

#### 5.5 Straightening

<table>
<thead>
<tr>
<th>Straightening Length</th>
<th>1,545</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>Straightening</th>
<th>None</th>
</tr>
</thead>
</table>

### 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.
Narrative:
Channel is stable with moderate-good floodplain availability. Normal distribution of bed substrate - supply of fines limited since reach is upstream of gully. See step 5 for further narrative.
Phase 2 Segment Summary

From just upstream of first Middle Road crossing up to second Middle Rd crossing.

<table>
<thead>
<tr>
<th>QC Status - Staff: Provisional Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1. Valley and Floodplain</strong></td>
</tr>
<tr>
<td><strong>1.1 Segmentation</strong> None</td>
</tr>
<tr>
<td><strong>1.2 Alluvial Fan</strong> None</td>
</tr>
<tr>
<td><strong>1.3 Corridor Encroachments</strong></td>
</tr>
<tr>
<td>Length (ft)</td>
</tr>
<tr>
<td>Berms</td>
</tr>
<tr>
<td>height</td>
</tr>
<tr>
<td>Roads</td>
</tr>
<tr>
<td>height</td>
</tr>
<tr>
<td>Railroads</td>
</tr>
<tr>
<td>height</td>
</tr>
<tr>
<td>Improved Paths</td>
</tr>
<tr>
<td>Development</td>
</tr>
<tr>
<td><strong>1.4 Adjacent Side</strong> Left Right</td>
</tr>
<tr>
<td>Hillside Slope Very Steep Hilly</td>
</tr>
<tr>
<td>Continuous w/</td>
</tr>
<tr>
<td>W/in 1 Bankfill</td>
</tr>
<tr>
<td><strong>Texture</strong> Sand Not Evalua</td>
</tr>
<tr>
<td><strong>1.5 Valley Features</strong></td>
</tr>
<tr>
<td>Valley Width (ft) 400</td>
</tr>
<tr>
<td>Width Determination Estimated</td>
</tr>
<tr>
<td>Confinement Type Very Broad</td>
</tr>
<tr>
<td>Rock Gorge? No</td>
</tr>
<tr>
<td>Human-caused change? No</td>
</tr>
</tbody>
</table>

**Step 2. Stream Channel**

| 2.1 Bankfull Width | 16 |
| 2.2 Max Depth (ft) | 2.20 |
| 2.3 Mean Depth (ft) | 1.64 |
| 2.4 Floodprone Width (ft) | 350 |

**Notes:** Channel historically straightened against valley wall, and likely went through a downcutting process over time. Some evidence of terraces noted in middle and upper reach - not present in lower reach where cross-section was taken. Channel has

<table>
<thead>
<tr>
<th>Provisional</th>
<th>Step 2. (Cont'd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5 Aband. Floodpln</td>
<td>2.50 ft.</td>
</tr>
<tr>
<td>Human Elev Floodpln</td>
<td>0.00 ft.</td>
</tr>
<tr>
<td>2.6 Width/Depth Ratio</td>
<td>9.45</td>
</tr>
<tr>
<td>2.7 Entrainment Ratio</td>
<td>22.58</td>
</tr>
<tr>
<td>2.8 Incision Ratio</td>
<td>1.14</td>
</tr>
<tr>
<td>Human Elevated Inc Rat</td>
<td>0.00</td>
</tr>
<tr>
<td>2.9 Sinuosity Moderate</td>
<td></td>
</tr>
<tr>
<td>2.10 Riffles Type Sedimented</td>
<td></td>
</tr>
<tr>
<td>2.11 Rifle/Step Spacing (ft)</td>
<td>135</td>
</tr>
<tr>
<td>2.12 Substrate Composition</td>
<td></td>
</tr>
</tbody>
</table>

**Step 3. Riparian Features**

| 3.1 Stream Banks | Typical Bank Slope | Shallow |
| Bank Texture | Left | Right |
| Upper |
| Material Type | Gravel | Gravel |
| Consistency Non-cohesive Non-cohesive |
| Lower |
| Material Type | Sand | Sand |
| Consistency Non-cohesive Non-cohesive |
| Bank Erosion | Left | Right |
| Erosion Length (ft) | 98 | 156 |
| Erosion Height (ft) | 3.09 | 2.00 |
| Revetmt. Type None | None |
| Revetmt. Length (ft) | 0 | 0 |
| Near Bank Veg. Type Left | Right |
| Dominant Coniferous Shrubs/Saplin |
| Sub-dominant Shrubs/Saplin Herbaceous |
| Bank Canopy Left | Right |
| Canopy % 51-75 | 26-50 |
| Mid-Channel Canopy Closed |

**3.2 Riparian Buffer**

| Buffer Width | Left | Right |
| Dominant >100 | 0-25 |
| Sub-dominant 26-50 | 26-50 |
| W less than 25 | 0 | 2,214 |
| Buffer Veg. Type Left | Right |
| Dominant Coniferous Herbaceous |
| Sub-dominant Shrubs/Saplin Shrubs/Saplin |

**3.3 Riparian Corridor**

| Corridor Land | Left | Right |
| Dominant Forest Hay |
| Sub-dominant Shrubs/Saplin Shrubs/Saplin |
| Mass Failures | 38 | 0 |
| Height | 7 | 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 | Moderate |
| 4.4 # of Debris Jams | 7 |
| 4.5 Flow Regulation Type | None |
| Flow Regulation Use | None |
| Impoundments | None |
| Impoundmnt. Location | None |
| 4.6 Up/Down strm flow reg | None |
| (old) Upstrm Flow Reg | None |

**4.7 StormwaterInputs**

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

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

<table>
<thead>
<tr>
<th>5.1 Bar Types</th>
<th>Mid</th>
<th>Point</th>
<th>Side</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagonal</td>
<td>4</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Delta</td>
<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>Island</td>
<td>1</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>

**5.2 Other Features**

<table>
<thead>
<tr>
<th>Flood</th>
<th>Neck Cutoff</th>
<th>Avulsion</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**5.3 Steep Riffles and Head Cuts**

<table>
<thead>
<tr>
<th>Steep Riffles</th>
<th>Head Cuts</th>
<th>Trib Rejuv.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>Yes</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
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</table>

**5.5 Straightening**

<table>
<thead>
<tr>
<th>Straightening Length</th>
<th>2,238</th>
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</thead>
<tbody>
<tr>
<td>Straightening</td>
<td>None</td>
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</tbody>
</table>

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: Crosby Brook
Stream: Crosby Brook North Branch
Reach # M05
Organization: Windam NRCD
Observers: EP, NP, SB
Segment Length (ft): 2,393
Segment Location: Why Not assessed:
Completion Date: April 22, 2008
Rain: No

M05
Narrative:
Channel redeveloping sinuosity following historical straightening. Good floodplain access observed throughout with some evidence of old terraces.
### Phase 2 Segment Summary

#### Project: Crosby Brook  
Stream: Crosby Brook North Branch  
Reach #: M06  
Observers #: EPF, NP, SB  
Organization: Windham NRCD  
Segment Length (ft): 882  
Segment Location: From Middle Rd crossing up to change in valley confinement where channel nears

<table>
<thead>
<tr>
<th>QC Status - Staff: Provisional Cons</th>
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</thead>
<tbody>
<tr>
<td><strong>Step 1. Valley and Floodplain</strong></td>
</tr>
<tr>
<td>1. Segmentation</td>
</tr>
<tr>
<td>1.1 Valley Width</td>
</tr>
<tr>
<td>1.2 Alluvial Fan</td>
</tr>
<tr>
<td>1.3 Corridor Encroachments</td>
</tr>
<tr>
<td>Length (ft)</td>
</tr>
<tr>
<td>Berms</td>
</tr>
<tr>
<td>height</td>
</tr>
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<td>Roads</td>
</tr>
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<td>height</td>
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<td>Railroads</td>
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<tr>
<td>height</td>
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<tr>
<td>Improved Paths</td>
</tr>
<tr>
<td>height</td>
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<tr>
<td>Development</td>
</tr>
<tr>
<td>1.4 Adjacent Side</td>
</tr>
<tr>
<td>Left</td>
</tr>
<tr>
<td>Hillside Slope</td>
</tr>
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<td>Continuous w/</td>
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<td>W/in 1 Bankfill</td>
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<tr>
<td>Texture</td>
</tr>
<tr>
<td>1.5 Valley Features</td>
</tr>
<tr>
<td>Valley Width (ft)</td>
</tr>
<tr>
<td>Width Determination</td>
</tr>
<tr>
<td>Confinement Type</td>
</tr>
<tr>
<td>Rock Gorge?</td>
</tr>
<tr>
<td>Human-caused Change?</td>
</tr>
<tr>
<td>2. Stream Channel</td>
</tr>
<tr>
<td>2.1 Bankfull Width</td>
</tr>
<tr>
<td>2.2 Max Depth (ft)</td>
</tr>
<tr>
<td>2.3 Mean Depth (ft)</td>
</tr>
<tr>
<td>2.4 Floodprone Width (ft)</td>
</tr>
<tr>
<td>Notes:</td>
</tr>
<tr>
<td>Short segment with large mass failure along right bank. Channel does not flow through pond as indicated on VHD - channel flows around pond to south.</td>
</tr>
</tbody>
</table>

Small cistern located in channel to divert

### Provisional Step 2. (Continued)

| 2.5 Aband. Floodpln | 3.80 ft. |  
| Human Elev Floodpln | 0.00 ft. |  
| 2.6 Width/Depth Ratio | 14.34 |  
| 2.7 Entrenchment Ratio | 4.22 |  
| 2.8 Incision Ratio | 1.90 |  
| Human Elevated Inc Rat | 0.00 |  
| 2.9 Sinuosity | Moderate |  
| 2.10 Riffles Type | Complete |  
| 2.11 Riffle/Step Spacing (ft) | 150 |  
| 2.12 Substrate Composition |  

| Bedrock | 0% |  
| Boulder | 0% |  
| Cobble | 5% |  
| Coarse Gravel | 44% |  
| Fine Gravel | 23% |  
| Sand | 23% |  
| Silt and smaller | 5% |  
| Silt/Clay Present? | No |  
| Detritus | 10% |  
| # Large Woody | 12 |  
| 2.13 Average Largest Particle on |  
| Bed | 9.0 inches |  
| Bar | 3.0 inches |  

#### Step 3. Riparian Features

| 3.1 Stream Banks |  
| Typical Bank Slope | Steep |  
| Bank Texture | Left | Right |  
| Upper |  
| Material Type | Boulder/Cobble | Boulder/Cobble |  
| Consistency | Non-cohesive | Non-cohesive |  
| Lower |  
| Material Type | Gravel | Gravel |  
| Consistency | Non-cohesive | Non-cohesive |  
| Bank Erosion | Left | Right |  
| Erosion Length (ft) | 25 | 23 |  
| Erosion Height (ft) | 3.00 | 3.00 |  
| Revetmt. Type | Rip-Rap | Rip-Rap |  
| Revetmt. Length (ft) | 70 | 50 |  
| Near Bank Veg. Type | Left | Right |  
| Dominant | Deciduous | Deciduous |  
| Sub-dominant | Coniferous | Coniferous |  
| 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 | 0-25 |  
| W less than 25 | 0 | 63 |  
| Buffer Veg. Type | Left | Right |  
| Dominant | Deciduous | Mixed Trees |  
| Sub-dominant | Herbaceous | Coniferous |  

#### 3.3 Riparian Corridor

| Corridor Land | Left | Right |  
| Dominant | Forest | Forest |  
| Sub-dominant | Commercial | None |  

#### Step 4. Flow & Flow Modifiers

| 4.1 Springs / Seeps | None |  
| 4.2 Adjacent Wetlands | Minimal |  
| 4.3 Flow Status | Moderate |  
| 4.4 # of Debris Jams | 2 |  
| 4.5 Flow Regulation Type | None |  
| Flow Regulation Use |  
| Impoundments | None |  
| Impoundmt. Location |  
| 4.6 Up/Down strm flow reg | None |  
| (old) Upstrm Flow Reg | None |  

#### 4.7 Stormwater Inputs

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

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

| 5.1 Bar Types |  
| Mid | Point | Side |  
| 0 | 3 | 3 |  
| 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

| 5.5 Straightening |  
| Straightening Length: | 176 |  
| 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.
Phase 2 Reach Summary

Project: Crosby Brook
Stream: Crosby Brook North Branch
Organization: Windam NRCD
Segment Length (ft): 882
Reach #: M06
Observers: EPF, NP, SB
Segment Location: From Middle Rd crossing up to change in valley confinement where channel nears

1.6 Grade Controls

| Type   | Location | Total | Total Height Above Water | Photo Taken? | GPSTaken
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.8 Channel Constrictions

<table>
<thead>
<tr>
<th>Type</th>
<th>Width</th>
<th>Problem</th>
<th>Location</th>
<th>Photo Taken?</th>
<th>GPS Taken?</th>
<th>Channel Constriction?</th>
<th>Floodprone Constriction?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridge</td>
<td>17.5</td>
<td>Problem</td>
<td>Scour Above</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Culvert</td>
<td>7.00</td>
<td>Problem</td>
<td>Deposition Above, Scour Below</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
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4.9 Channel Degradation

| Type   | Location | Total | Total Height Above Water | Photo Taken? | GPSTaken
<table>
<thead>
<tr>
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4.10 Bank Stability

| Type   | Location | Total | Total Height Above Water | Photo Taken? | GPSTaken
<table>
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<tr>
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6.1 Epifaunal Substrate - Available Cover

| Type   | Location | Total | Total Height Above Water | Photo Taken? | GPSTaken
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4.11 Bank Vegetation Protection

| Type   | Location | Total | Total Height Above Water | Photo Taken? | GPSTaken
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4.12 Riparian Vegetation Zone Width

| Type   | Location | Total | Total Height Above Water | Photo Taken? | GPSTaken
<table>
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Narrative:
Channel incision in vicinity of small diversion to pond where dredging was noted. See step 5 for further narrative.
1.3 Corridor Encroachments
1.2 Alluvial Fan
1.1 Segmentation

QC Status - Staff: Provisional Cons

Step 1. Valley and Floodplain

1.1 Segmentation
Valley Width

1.2 Alluvial Fan

1.3 Corridor Encroachments

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>Berms</th>
<th>height</th>
<th>Roads</th>
<th>Improved Paths</th>
<th>Development</th>
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<tr>
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</table>

1.4 Adjacent Side
Left | Right

Hillside Slope
Extremely Steep

Continuous w/ Bankfill
Always | Sometimes

W/in 1 Bankfill
Always | Always

Texture
Mixed | Boulder

1.5 Valley Features

Valley Width (ft) 30
Width Determination Measured
Confinement Type Narrowly
Rock Gorge? No

Human-caused Change? Yes

Step 2. Stream Channel

2.1 Bankfull Width 16
2.2 Max Depth (ft) 1.90
2.3 Mean Depth (ft) 1.34
2.4 Floodplain Width (ft) 26

Notes:
Houghton Road embankment occupies approx. half of valley width, resulting in a lower entrenchment ratio than under reference conditions. Channel has adequate vertical control and appears stable with good step-pool formation.

Step 3. Riparian Features

3.1 Stream Banks
Typical Bank Slope Steep
Bank Texture Left | Right

Upper
Material Type Boulder/Cobble Boulder/Cobble

Consistency Non-cohesive Non-cohesive

Lower
Material Type Boulder/Cobble Boulder/Cobble

Consistency Non-cohesive Non-cohesive

Bank Erosion Length (ft) 46 | 0
Erosion Height (ft) 4.00 | 0.00
Revetment Type None | None

Near Bank Veg. Type Left | Right
Dominant Coniferous Coniferous

Sub-dominant Deciduous Deciduous

Bank Canopy Left | Right
Canopy % 76-100 | 76-100

Mid-Channel Canopy Closed

3.2 Riparian Canopy

Buffet Width Left | Right
Dominant 0-25 | >100
Sub-dominant 26-50 | None

W less than 25 998 | 0

Buffer Veg. Type Left | Right
Dominant Coniferous Invasives Coniferous

Sub-dominant Shrub/Saplin Mixed Trees

3.3 Riparian Corridor

Corridor Land Left | Right
Dominant Commercial Forest

Sub-dominant Shrub/Saplin Mixed Trees

3.4 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)

B 3 Step-Pool

3.3 old Amount Mean Height
Failures None | 0.00
Gullies None | 0.00

4.1 Flow & Flow Modifiers

4.2 Adjacent Wetlands

4.3 Flow Status

4.4 # of Debris Jams 4

4.5 Flow Regulation Type None

4.6 Up/Down strm flow reg None

4.7 Stormwater Inputs

Field Ditch 0 | Road Ditch 0
Other 0 | Tile Drain 0

5.1 Bar Types

Mid Point Side
0 | 0 | 1

5.2 Other Features

Flood Diagonal Delta Island
Neck Cutoff 0 | Avulsion 0

5.3 Steep Riffles and Head Cuts

Steep Riffles Head Cuts Trib Rejuv.

5.4 Stream Ford or Animal

5.5 Straightening

5.6 Dredging

Note: Step 1.6 - Grade Controls and Step 4.8 - Channel Constructions are on the second page of this report - with Steps 6 through 7.
Narrative:
Stable channel with many vertical controls. Road building encroached upon channel historically and reduced floodplain width. Stage II selected to indicate reduction in floodplain width from encroachment, despite the current stable channel.
**Phase 2 Segment Summary**

**Project:** Crosby Brook  
**Stream:** Crosby Brook North Branch  
**Observers:** EPF, NP, SB  
**Organization:** Windam NRCD  
**Segment Location:** From just upstream of Houghton Rd crossing up to reach break with M07 at next Houghton  
**Completion Date:** April 22, 2008  
**Rain:** No

---

**Provisional Step 2. (Contd.)**

<table>
<thead>
<tr>
<th>Length (ft)</th>
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<tbody>
<tr>
<td>Berms</td>
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<td>Roads</td>
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<td>height</td>
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<td>Railroads</td>
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<tr>
<td>height</td>
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</table>

**Development**  
264

---

**Step 1. Valley and Floodplain**

1. **Segmentation**
   - **Valley Width**
   - **Alluvial Fan**
   - **Corridor Encroachments**

2. **Segment Location**
   - Length (ft): 1,742

3. **Stream**
   - Tucker Reed Road - appears natural.

4. **Notes:**
   - Channel has good floodplain access throughout, with dimensions corresponding to those predicted with DHG regressions. One area of debris damming and deposition below Tucker Reed Road - appears natural.

---

**Step 3. Riparian Features**

<table>
<thead>
<tr>
<th>Feature Type</th>
<th>Bank Erosion</th>
<th>Erosion Height (ft)</th>
<th>Erosion Length (ft)</th>
<th>Substrate Composition</th>
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<tbody>
<tr>
<td></td>
<td>Left</td>
<td>Right</td>
<td></td>
<td></td>
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</tbody>
</table>

---

**Step 4. Flow & Flow Modifiers**

1. **Springs / Seeps**
   - None

2. **Adjacent Wetlands**
   - Abundant

3. **Flow Status**
   - Moderate

4. **# of Debris Jams**
   - 9

5. **Flow Regulation Type**
   - None

6. **Flow Regulation Use**
   - None

---

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

1. **Bar Types**
   - Mid: 5  
   - Point: 6  
   - Side: 3

2. **Diagonal**
   - 0

3. **Delta**
   - 0

4. **Island**
   - 0

5. **Other Features**
   - Braiding

---

**Step 6. Riparian Features**

1. **Stream Banks**
   - Typical Bank Slope
   - Shallow

2. **Material Type**
   - Sand
   - Non-cohesive

3. **Consistency**
   - Non-cohesive

4. **Coniferous**
   - Coniferous

5. **Herbaceous**
   - Shrubs/Saplin

---

**Step 7. Stormwater Inputs**

1. **Field Ditch**
   - 0

2. **Road Ditch**
   - 0

3. **Other**
   - 0

4. **Tile Drain**
   - 0

5. **Urb Strm Wtr Pipe**
   - 0

---

**Step 8. Channel Constrictions**

1. **Overland Flow**
   - None

2. **Urb Storm Wtr Pipe**
   - None

---

**Step 9. Channel Constrictions**

1. **Steep Riffles and Head Cuts**

2. **Steep Riffles**

3. **Head Cuts**

---

**Step 10. Stream Ford or Animal**

1. **None**

---

**Step 11. Straightening**

1. **None**

---

**Step 12. Dredging**

1. **None**

---

**Notes:**
- Step 1.6 - Grade Controls
- Step 2.6 - With Steps 6 through 7.
- The second page of this report has been omitted.
Phase 2 Reach Summary

Project: Crosby Brook
Stream: Crosby Brook North Branch
Organization: Windam NRCD
Segment Length (ft): 1,742

Reach # M06
Observers: EPF, NP, SB
Segment Location: From just upstream of Houghton Rd crossing up to reach break with M07 at next

1.6 Grade Controls None

4.8 Channel Constrictions

<table>
<thead>
<tr>
<th>Type</th>
<th>Width</th>
<th>Photo Taken?</th>
<th>GPS Taken?</th>
<th>Channel Constriction?</th>
<th>Floodprone Constriction?</th>
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<td>6.20</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Culvert</td>
<td>6.50</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
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</tbody>
</table>

Narrative:
Stable channel with moderate sinuosity and expected channel dimensions. No evidence of terraces or abandoned floodplain.
Phase 2 Segment Summary

Project: Crosby Brook
Stream: Crosby Brook South Branch
Organization: Windam NRDC
Observers: EPF, NP, SB
Segment Length (ft): 2,722
Segment Location: From confluence with north branch up to bend in Black Mountain Road at grade control.

QC Status - Staff: Provisional Cons
Step 1. Valley and Floodplain

1.1 Segmentation None
1.2 Alluvial Fan None
1.3 Corridor Encroachments

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>One</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berms</td>
<td>0</td>
<td>0</td>
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<tr>
<td>height</td>
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<tr>
<td>Roads</td>
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<td>Railroads</td>
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<td>height</td>
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<td>0</td>
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<tr>
<td>Improved Paths</td>
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<td>height</td>
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<td>Development</td>
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1.4 Adjacent Side Left Right

<table>
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<tr>
<th>Hillside Slope</th>
<th>Hilly</th>
<th>Very Steep</th>
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<tr>
<td>Continuous w/</td>
<td>Never</td>
<td>Sometimes</td>
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<tr>
<td>W/in 1 Bankfill</td>
<td>Sometimes</td>
<td>Sometimes</td>
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1.5 Valley Features

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<tr>
<th>Valley Width (ft)</th>
<th>90</th>
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<td>Width Determination</td>
<td>Estimated</td>
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<td>Confinement Type</td>
<td>Narrow</td>
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<tr>
<td>Rock Gorge?</td>
<td>No</td>
</tr>
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</table>

Human-caused Change? Yes

Step 2. Stream Channel

2.1 Bankfull Width 17
2.2 Max Depth (ft) 1.65
2.3 Mean Depth (ft) 1.27
2.4 Floodprone Width (ft) 26

Notes:
Valley width altered by I-91 berm (left bank) below the first crossing, and then by Black Mountain Rd. above the first crossing.
Floodplain filled by road berms and beds, constricting channel and reducing meander development. Riffle-pool features replaced by narrow, steep riffles and head cuts.

Provisional Step 2. (Contuned)

2.5 Aband. Floodpln
2.6 Width/Depth Ratio 13.39
2.7 Entrenchment Ratio 1.53
2.8 Incision Ratio 0.00
Human Elevated Inc Rat 2.03
2.9 Sinuosity Low
2.10 Riffles Type Sedimented
2.11 Riffle/Step Spacing (ft) 150
2.12 Substrate Composition

Bedrock 0%
Boulder 1%
Cobble 6%
Coarse Gravel 49%
Fine Gravel 19%
Sand 23%
Silt and smaller 2%
Silt/Clay Present? Yes
Detritus 15%
# Large Woody 24

2.13 Average Largest Particle on

Bed 5.0 inches
Bar 3.0 inches

2.14 Stream Type

<table>
<thead>
<tr>
<th>Stream Type</th>
<th>F</th>
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<tr>
<td>Bed Material</td>
<td>Gravel</td>
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<tr>
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<td>Bed Form</td>
<td>Plane Bed</td>
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<td>Field Measured Slope:</td>
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2.15 Reference Stream Type

(If different from Phase 1)

3.3 old Amount Mean Height
Failures None 0.00
Gullies None 0.00

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 Gravel Gravel
Consistency Non-cohesive Non-cohesive

Bank Erosion Left Right
Erosion Length (ft) 405 28
Erosion Height (ft) 1.33 3.00
Revetmt. Type Rip-Rap Rip-Rap
Revetmt. Length (ft) 654 766
Near Bank Veg. Type Left Right
Dominant Herbaceous Coniferous
Sub-dominant Deciduous Deciduous
Bank Canopy Left Right
Canopy % 26-50 76-100
Mid-Channel Canopy Closed

3.2 Riparian Buffer

Buffer Width Left Right
Dominant 0-25 >100
Sub-dominant 26-50 26-50
W less than 25 1,007 0
Buffer Veg. Type Left Right
Dominant Herbaceous Coniferous
Sub-dominant Deciduous Deciduous

3.3 Riparian Corridor

Corridor Land Left Right
Dominant Residential Forest
Sub-dominant Forest Shrubs/Saplin
Mass Failures 0 83
Height 0 7
Gullies 0 0
Height 0 0

3.4 Stream Ford or Animal

Steep Riffles and Head Cuts

5.5 Straightening

Straightening Length: 1,431

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.
Crosby Brook South Branch  
Windam NRCD  
Project: Crosby Brook  
Stream: Crosby Brook South Branch  
Organization: Windam NRCD  
Segment Length (ft): 2,722  
Observers: EPF, NP, SB  
Reach # T1.01  
Segment: 0  
Segment Location: From confluence with north branch up to bend in Black Mountain Road at grade

1.6 Grade Controls  
None

4.8 Channel Constrictions

Culvert 4.00  
Width 4.00  
Type Culvert  
Problem Photo Taken? Yes  
GPS Taken? No  
Channel Constriction? Yes  
Floodprone Constriction? Yes

Culvert 11.0  
Width 11.0

Step 7. Rapid Geomorphic Assessment Data

Confinement Type Unconfined

<table>
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<th>Score</th>
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<td>C to F</td>
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Total Score 30  
Geomorphic Rating 0.375

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

Step 6. Rapid Habitat Assessment Data

Stream Gradient Type High

<table>
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<tr>
<td>6.1 Epifaunal Substrate - Available Cover 12</td>
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<tr>
<td>6.2 Embeddedness 10</td>
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<td>6.3 Velocity/Depth Patterns 9</td>
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<td>6.4 Sediment Deposition 9</td>
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<td>6.5 Channel Flow Status 10</td>
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<td>6.6 Channel Alteration 6</td>
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<tr>
<td>6.7 Frequency of Riffles/Steps 11</td>
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<tr>
<td>6.8 Bank Stability Left: 7 Right: 7</td>
</tr>
<tr>
<td>6.9 Bank Vegetation Protection Left: 5 Right: 8</td>
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<tr>
<td>6.10 Riparian Vegetation Zone Width Left: 4 Right: 8</td>
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</table>

Total Score 106  
Habitat Rating 0.53

Habitat Stream Condition Fair

Narrative:
C to F stream type departure due to floodplain filling along I-91 and Black Mountain Road. See step 5 for further narrative.
### Project: Crosby Brook
### Stream: Crosby Brook South Branch
### Organization: Windam NRCD
### Segment Length (ft): 998

#### Phase 2 Segment Summary

- **Segment Location:** From grade control at sharp bend in Black Mtn Road up to 50m upstream of large mass
- **Completion Date:** April 23, 2008
- **Rain:** No

#### Phase 2 Segment Summary

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<tbody>
<tr>
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<td><strong>Step 2. (Contd)</strong></td>
<td><strong>Step 3. Riparian Features</strong></td>
<td><strong>Step 4. Flow &amp; Flow Modifiers</strong></td>
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<tr>
<td>2.5 Aband. Floodpln</td>
<td>3.90 ft.</td>
<td>3.1 Stream Banks</td>
<td>4.1 Springs / Seeps</td>
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<td>Human Elev Floodpln</td>
<td>0.00 ft.</td>
<td>Typical Bank Slope</td>
<td>4.2 Adjacent Wetlands</td>
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<tr>
<td>2.6 Width/Depth Ratio</td>
<td>13.79</td>
<td>Undercut</td>
<td>4.3 Flow Status</td>
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<td>2.7 Entrenchment Ratio</td>
<td>2.60</td>
<td>Bank Texture</td>
<td>4.4 # of Debris Jams</td>
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<tr>
<td>2.8 Incision Ratio</td>
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<td>Left</td>
<td>4.5 Flow Regulation Type</td>
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<td>Human Elevated Inc Rat</td>
<td>0.00</td>
<td>Right</td>
<td>4.6 Flow Regulation Use</td>
</tr>
<tr>
<td>2.9 Sinuosity</td>
<td>Moderate</td>
<td>Upper</td>
<td>Impoundments</td>
</tr>
<tr>
<td>2.10 Riffles Type</td>
<td>Eroded</td>
<td>Material Type</td>
<td>Never</td>
</tr>
<tr>
<td>2.11 Riffle/Step Spacing (ft)</td>
<td>90</td>
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</tr>
<tr>
<td>2.12 Substrate Composition</td>
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<td>Consistency</td>
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</tr>
<tr>
<td>Bedrock</td>
<td>0%</td>
<td>Non-cohesive</td>
<td>None</td>
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<td>Boulder</td>
<td>3%</td>
<td>Non-cohesive</td>
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<td>18%</td>
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<td>34%</td>
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</tr>
<tr>
<td>Fine Gravel</td>
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<td>Sub-dominant</td>
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<td>Sand</td>
<td>10%</td>
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<td>Silt/Clay Present?</td>
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<td>Detritus</td>
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<td># Large Woody</td>
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<td>Rip-Rap</td>
<td>None</td>
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<td>2.13 Average Largest Particle</td>
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<td>None</td>
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<tr>
<td>Bed</td>
<td>6.0 inches</td>
<td>2.55</td>
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<td>Bar</td>
<td>4.0 inches</td>
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<td>2.14 Stream Type</td>
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<td>Bed Form:</td>
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<td>Field Measured Slope:</td>
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<td>2.15 Reference Stream Type</td>
<td>(if different from Phase 1)</td>
<td>3.50</td>
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<tr>
<td>C</td>
<td>4</td>
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<tr>
<td>b</td>
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#### QC Status - Staff: Provisional Cons

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<tr>
<th>Step 1. Segmentation</th>
<th>Valley Width</th>
<th>Alluvial Fan</th>
<th>Corridor Encroachments</th>
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<tr>
<td>1.1</td>
<td></td>
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#### 1.5 Valley Features

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<td>Width Determination</td>
<td>Measured</td>
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<tr>
<td>Confine Type</td>
<td>Broad</td>
</tr>
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<td>Rock Gorge?</td>
<td>No</td>
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</table>

#### Human-caused change? Yes

**Notes:**
Severe incision occurring around 2 nick points in segment, one in lower segment and another up near large mass failure. A short section of channel with floodplain connectivity was noted in between 2 nickpoints. Cross section at that location indicates less incision.
Phase 2 Reach Summary

Project: Crosby Brook
Stream: Crosby Brook South Branch
Organization: Windam NRCD
Segment Length (ft): 998

From grade control at sharp bend in Black Mtn Road up to 50m upstream of large mass

1.6 Grade Controls

<table>
<thead>
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<th>Type</th>
<th>Location</th>
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<th>Total Height Above Water</th>
<th>Photo Taken</th>
<th>GPS Taken</th>
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<td>Waterfall</td>
<td>Mid-segment</td>
<td>6.00</td>
<td>6.00</td>
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4.8 Channel Constrictions

<table>
<thead>
<tr>
<th>Type</th>
<th>Width</th>
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<th>GPS Taken?</th>
<th>Channel Constriction?</th>
<th>Floodprone Constriction?</th>
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<tbody>
<tr>
<td></td>
<td>None</td>
<td></td>
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6.1 Epifaunal Substrate - Available Cover

6.2 Embeddedness

6.3 Velocity/Depth Patterns

6.4 Sediment Deposition

6.5 Channel Flow Status

6.6 Channel Alteration

6.7 Frequency of Riffles/Steps

6.8 Bank Stability

6.9 Bank Vegetation Protection

6.10 Riparian Vegetation Zone Width

Total Score: 126
Habitat Rating: 0.63

Habitat Stream Condition: Fair

Narrative:
Channel actively incising with 2 nickpoints present. See step 5 for further narrative.
**Project:** Crosby Brook  
**Stream:** Crosby Brook South Branch  
**Organization:** Windam NRCD  
**Seg Length (ft):** 1,426  
**Segment Location:** From change in confinement at intersection of Black Mountain Rd and Kipling Road up to

### QC Status - Staff: Provisional Cons

#### Step 1. Valley and Floodplain

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>Berms</th>
<th>Height</th>
<th>Roads</th>
<th>height</th>
<th>Railroads</th>
<th>height</th>
<th>Improved Paths</th>
<th>height</th>
<th>Development</th>
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<tbody>
<tr>
<td>One</td>
<td>0</td>
<td>0</td>
<td>1,355</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Both</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 1.3 Alluvial Fan

- Alluvial Fan: None

#### 1.2 Corridor Encroachments

- Length (ft): One
- Berms: 0
- Height: 0
- Roads: 1,355
- Height: 0
- Railroads: 0
- Height: 0
- Improved Paths: 0
- Height: 0
- Development: 0

#### 1.4 Adjacent Side

- Hillside Slope: Very Steep
- Continuous w/ Sub-dominant
- W/1 Bankfill: Never
- Texture: Silt/Clay

#### 1.5 Valley Features

- Width Determination: Measured
- Confinement Type: Narrowly
- Rock Gorge?: No
- Human-caused Change?: Yes

### Step 2. Stream Channel

#### 2.1 Bankfull Width

- 18

#### 2.2 Max Depth (ft)

- 2.00

#### 2.3 Mean Depth (ft)

- 1.33

#### 2.4 Floodprone Width (ft)

- 23

**Notes:** Segment broken out to characterize impacts from Black Mtn Rd occupying 1/2 of valley. Historically, channel likely had a small floodplain developed within the semi-confined valley. Currently the lack of floodplain is causing excess stream power during rainfall.

### Step 3. Riparian Features

#### 3.1 Stream Banks

- Typical Bank Slope: Steep
  - Bank Textures: Left, Right
  - Upper:
    - Material Type: Clay, Clay
    - Consistency: Cohesive, Cohesive
  - Lower:
    - Material Type: Boulder/Cobble
    - Consistency: Non-cohesive, Non-cohesive

#### 3.2 Substrate Composition

- Bedrock: 0%
- Boulder: 23%
- Cobble: 21%
- Coarse Gravel: 29%
- Fine Gravel: 13%
- Sand: 13%
- Silt and smaller: 1%
- Silt/Clay Present: Yes
- Detritus: 8%
- # Large Woody: 16

#### 3.3 Old Stream

- Average Largest Particle on Bed: 12.0 inches
- Bar: N/A inches

#### 3.4 Stream Type

- Stream Type: F
  - Bed Material: Gravel
  - Subclass Slope: a
  - Bed Form: Step-Pool

**Field Measured Slope:**

#### 3.5 Reference Stream Type

<table>
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<tr>
<th>3.5</th>
<th>Amount</th>
<th>Mean Height</th>
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<tr>
<td>New</td>
<td>None</td>
<td>0.00</td>
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### Step 4. Flow & Flow Modifiers

#### 4.1 Flow Regulation

- Minimal

#### 4.2 Flow Status

- None

#### 4.3 Flow Regulation Use

- None

#### 4.4 # of Debris Jams

- 1

#### 4.5 Flow Regulation Type

- None

#### 4.6 Up/Down Stream flow reg

- None

#### 4.7 Stormwater Inputs

- Field Ditch: 0
- Road Ditch: 3
- Other: 0
- Tile Drain: 0
- Overland Flow: 0

#### 4.8 Channel Constrictions

- None

### Step 5. Channel Bed and Planform Changes

#### 5.1 Bar Types

<table>
<thead>
<tr>
<th>Mid</th>
<th>Point</th>
<th>Side</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

#### 5.2 Other Features

- Braiding: 0

#### 5.3 Steep Riffles and Head Cuts

- Steep Riffles: Head Cuts: Trib Rejuv: 0

#### 5.4 Stream Ford or Animal

- None

#### 5.5 Straightening

- None

#### 5.6 Straightening Length

- 1,420

### Observers

- Crosby Brook South Branch  
- EPF, NP, SB  
- Why Not assessed:
  - June 13, 2008
  - SGAT Version: 4.56

**Completion Date:** April 23, 2008
1.6 Grade Controls

<table>
<thead>
<tr>
<th>Type</th>
<th>Location</th>
<th>Total</th>
<th>Total Height Above Water</th>
<th>Photo Taken?</th>
<th>GPS Taken?</th>
</tr>
</thead>
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<tr>
<td>Ledge</td>
<td>Mid-segment</td>
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<td>2.00</td>
<td>No</td>
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<tr>
<td>Ledge</td>
<td>Mid-segment</td>
<td>4.00</td>
<td>2.00</td>
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4.8 Channel Constrictions

<table>
<thead>
<tr>
<th>Type</th>
<th>Width</th>
<th>Photo Taken?</th>
<th>GPS Taken?</th>
<th>Channel Constriction?</th>
<th>Floodprone Constriction?</th>
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<tr>
<td>Bridge</td>
<td>7.00</td>
<td>Yes</td>
<td>None</td>
<td>Yes</td>
<td>Yes</td>
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</tbody>
</table>

Narrative:
Complete loss of floodplain access resulting in degradation and bank erosion. Grade controls in segment reach control vertical stability some, resulting in less slope failure in upper segment. See step 5 for further narrative.
## Phase 2 Segment Summary

### Location
From Black Mountain Road crossing up to change in slope immediately below Dickinson

### Date
June 13, 2008

### Revision
SGAT Version: 4.56

### Completion Date
April 23, 2008

### Rain
No

### Stream
Crosby Brook South Branch

### Project
Crosby Brook

### Segment
C

### Observers
EPF, NP, SB

### Organization
Windam NRCD

### Segment Length (ft): 477

### Notes
Steep channel with bedrock armoring on bed and banks downstream. Homeowners (Sullivan) on upper right bank (487 Black Mtn Rd) are concerned about potential bank erosion downstream of old mill/diversion site. Met with Pat Sullivan on 4/23/08 and listened.

---

## QC Status - Staff: Provisional Cons

### 1.1 Segmentation
Grade Controls

#### Length (ft):
- Berms: 0
- Height: 0
- Roads: 0
- Railroads: 0
- Improved Paths: 0
- Development: 0

#### Adjacent Side
- Left: 166
- Right: 0

### 1.2 Alluvial Fan
None

### 1.3 Corridor Encroachments

#### Width Determination
- Bed Form: N/A
- Bar: N/A

#### Confined Type
Semi-confined

#### Rock Gorge?
Yes

#### Valley Features
- Width (ft): 35
- Hillside Slope: Extremely
- Continuous w/ W/in 1 Bankfill: Always
- Texture: Bedrock

### 1.4 Adjacent Side
- Left: 0
- Right: 0

### 1.5 Valley Features
- Width Determination: Measured
- Confinement Type: Semi-confined
- Human-caused Change?: No

---

### 2.1 Bankfull Width (ft): 13

### 2.2 Max Depth (ft): 1.70

### 2.3 Mean Depth (ft): 1.17

### 2.4 Floodplain Width (ft): 20

### Notes:
Steep channel with bedrock armoring on bed and banks downstream. Homeowners (Sullivan) on upper right bank (487 Black Mtn Rd) are concerned about potential bank erosion downstream of old mill/diversion site. Met with Pat Sullivan on 4/23/08 and listened.

---

### Step 2. Stream Channel

#### 2.1 Bankfull Width
13

#### 2.2 Max Depth
1.70

#### 2.3 Mean Depth
1.17

#### 2.4 Floodplain Width
20

### Notes:
Steep channel with bedrock armoring on bed and banks downstream. Homeowners (Sullivan) on upper right bank (487 Black Mtn Rd) are concerned about potential bank erosion downstream of old mill/diversion site. Met with Pat Sullivan on 4/23/08 and listened.

---

### Provisional Step 2. (Contd.)

#### 2.5 Aband. Floodpln
1.70

#### 2.6 Width/Depth Ratio
10.85

#### 2.7 Entrenchment Ratio
1.54

#### 2.8 Incision Ratio
1.00

#### 2.9 Sinuosity
Low

#### 2.10 Riffles Type
Complete

#### 2.11 Riffle/Step Spacing (ft)
35

#### 2.12 Substrate Composition
- Bedrock: 51%
- Boulder: 6%
- Cobble: 5%
- Coarse Gravel: 16%
- Fine Gravel: 11%
- Sand: 3%
- Silt and smaller: 8%

#### 2.13 Average Largest Particle on Bed
- N/A

#### 2.14 Stream Type
- Stream Type: A
- Bed Material: Bedrock
- Subclass Slope: None
- Bed Form: Step-Pool
- Field Measured Slope: 2

#### 2.15 Reference Stream Type
- (if different from Phase 1)
- MA 1
- Non Step-Pool

#### 2.17 Average Largest Particle on Bar
- N/A

#### 3.1 Stream Banks
- Typical Bank Slope: Steep
- Bank Texture: Left

#### 3.2 Riparian Buffer
- Buffer Width: Left
- Dominant: >100
- Sub-dominant: 51-100
- W less than 25: 0
- Buffer Veg. Type: Left
- Dominant: Mixed Trees
- Sub-dominant: None

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

### Step 3. Riparian Features

#### 3.1 Stream Banks
- Typical Bank Slope: Steep
- Bank Texture: Left

#### 3.2 Riparian Buffer
- Buffer Width: Left
- Dominant: >100
- Sub-dominant: 51-100
- W less than 25: 0
- Buffer Veg. Type: Left
- Dominant: Mixed Trees
- Sub-dominant: None

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

### Step 4. Flow & Flow Modifiers

#### 4.1 Springs / Seeps
None

#### 4.2 Adjacent Wetlands
None

#### 4.3 Flow Status
Moderate

#### 4.4 # of Debris Jams
0

#### 4.5 Flow Regulation Type
None

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

#### 4.7 Stormwater Inputs
- Field Ditch: 0
- Road Ditch: 0
- Other: 0
- Tile Drain: 0
- Overland Flow: 0
- Urb Strm Wtr Pipe: 0

### Step 5. Channel Bed and Planform Changes

#### 5.1 Bar Types
- Mid: 0
- Point: 0
- Side: 1
- Diagonal: 0
- Delta: 0
- Island: 0

#### 5.2 Other Features
- Flood: 0
- Neck Cutoff: 0
- Avulsion: 0

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

#### 5.4 Stream Ford or Animal
None

#### 5.5 Straightening
- Straightening Length: 22

### Step 4.8 - Channel Constrictions
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: Crosby Brook
Stream: Crosby Brook South Branch
Organization: Windam NRCD
Segment Length (ft): 477

Phase 2 Reach Summary

Reach #: T1.02
Observers: EPF, NP, SB
Segment Location: From Black Mountain Road crossing up to change in slope immediately below

Score
6.1 Epifaunal Substrate - Available Cover 13
6.2 Embeddedness 11
6.3 Velocity/Depth Patterns 15
6.4 Sediment Deposition 18
6.5 Channel Flow Status 20
6.6 Channel Alteration 20
6.7 Frequency of Riffles/Steps 18
6.8 Bank Stability Left: 10 Right: 10
6.9 Bank Vegetation Protection Left: 10 Right: 10
6.10 Riparian Vegetation Zone Width Left: 8 Right: 8

Total Score 171
Habitat Rating 0.855

Narrative:
Stable bedrock-lined channel with good buffer and limited direct impacts. See step 5 for further narrative.

Step 7. Rapid Geomorphic Assessment Data

Score STD Historic
7.1 Channel Degradation 19 None No
7.2 Channel Aggradation 16 None No
7.3 Widening Channel 16 No
7.4 Change in Planform 17 No

Total Score 68
Geomorphic Rating 0.85

Step 6. Rapid Habitat Assessment Data

Score
6.1 Epifaunal Substrate - Available Cover 13
6.2 Embeddedness 11
6.3 Velocity/Depth Patterns 15
6.4 Sediment Deposition 18
6.5 Channel Flow Status 20
6.6 Channel Alteration 20
6.7 Frequency of Riffles/Steps 18
6.8 Bank Stability Left: 10 Right: 10
6.9 Bank Vegetation Protection Left: 10 Right: 10
6.10 Riparian Vegetation Zone Width Left: 8 Right: 8

Total Score 171
Habitat Rating 0.855

Habitat Stream Condition Referen
## Phase 2 Segment Summary

**Project:** Crosby Brook  
**Stream:** Crosby Brook South Branch  
**Reach:** T1.02  
**Organization:** Windam NRCD  
**Observers:** EPF, NP, MC  
**Completion Date:** April 23, 2008  
**Rain:** No

### QC Status - Staff: Provisional Cons

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<th>Step 1. Valley and Floodplain</th>
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<td>Railroads</td>
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<td>2.7 Entrenchment Ratio</td>
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<td>2.8 Incision Ratio</td>
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<tr>
<td>Human Elevated Inc Rat</td>
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<tr>
<td>2.9 Sinuosity</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>2.10 Riffles Type</td>
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<tr>
<td>2.11 Riffle/Step Spacing (ft)</td>
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<tr>
<td>2.12 Substrate Composition</td>
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</tr>
<tr>
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<tr>
<td>Boulder</td>
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<tr>
<td>Cobble</td>
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<tr>
<td>Coarse Gravel</td>
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<tr>
<td>Fine Gravel</td>
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<td>Sand</td>
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<td># Large Woody</td>
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</tr>
<tr>
<td><strong>Bar</strong></td>
<td><strong>N/A</strong></td>
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<td><strong>Stream Type</strong></td>
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<td><strong>Subclass Slope:</strong></td>
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<tr>
<td><strong>Bed Form:</strong></td>
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<td><strong>Field Measured Slope:</strong></td>
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<td><strong>Reference Stream Type</strong></td>
<td><strong>(if different from Phase 1)</strong></td>
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<tr>
<td><strong>E</strong></td>
<td><strong>5</strong></td>
<td><strong>Non Ripple-Pool</strong></td>
</tr>
<tr>
<td><strong>3.3 old</strong></td>
<td><strong>Amount</strong></td>
<td><strong>Mean Height</strong></td>
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<tr>
<td>Failures</td>
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<td>0.00</td>
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<tr>
<td>Gullies</td>
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### Step 3. Riparian Features

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<th>3.1 Stream Banks</th>
<th>Typical Bank Slope</th>
<th>Undercut</th>
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<tbody>
<tr>
<td>Bank Texture</td>
<td>Left</td>
<td>Right</td>
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<td><strong>Upper</strong></td>
<td>Material Type</td>
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<td><strong>Lower</strong></td>
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<td>Erosion Length (ft)</td>
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</tr>
<tr>
<td>Erosion Height (ft)</td>
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<td>Revetmt. Type</td>
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<td>Revetmt. Length (ft)</td>
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</tr>
<tr>
<td>Near Bank Veg. Type</td>
<td>Left</td>
<td>Right</td>
</tr>
<tr>
<td><strong>Dominant</strong></td>
<td>Invasives</td>
<td>Invasives</td>
</tr>
<tr>
<td>Sub-dominant</td>
<td>Deciduous</td>
<td>Herbaceous</td>
</tr>
<tr>
<td>Bank Canopy</td>
<td>Left</td>
<td>Right</td>
</tr>
<tr>
<td>Canopy %</td>
<td>26-50</td>
<td>1-25</td>
</tr>
<tr>
<td><strong>Mid-Channel Canopy</strong></td>
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</table>

### Step 4. Flow & Flow Modifiers

<table>
<thead>
<tr>
<th>4.1 Springs / Seeps</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2 Adjacent Wetlands</td>
<td>None</td>
</tr>
<tr>
<td>4.3 Flow Status</td>
<td>Moderate</td>
</tr>
<tr>
<td>4.4 # of Debris Jams</td>
<td>0</td>
</tr>
<tr>
<td>4.5 Flow Regulation Type</td>
<td>None</td>
</tr>
<tr>
<td>Flow Regulation Use</td>
<td>Impoundments</td>
</tr>
<tr>
<td>Impoundmt. Location</td>
<td>None</td>
</tr>
<tr>
<td>4.6 Up/Down strm flow reg</td>
<td>Non</td>
</tr>
<tr>
<td>(old) Upstrm Flow Reg</td>
<td>None</td>
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</table>

### Step 5. Channel Bed and Planform Changes

<table>
<thead>
<tr>
<th>5.1 Bar Types</th>
<th><strong>Mid</strong></th>
<th><strong>Point</strong></th>
<th><strong>Side</strong></th>
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<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
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</tr>
<tr>
<td>Diagonal</td>
<td>Delta</td>
<td>Island</td>
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<table>
<thead>
<tr>
<th>5.2 Other Features</th>
<th>Flood</th>
<th>Neck Cutoff</th>
<th>Avulsion</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
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</table>

<table>
<thead>
<tr>
<th>5.3 Steep Riffles and Head Cuts</th>
<th>Steep Riffles</th>
<th>Head Cuts</th>
<th>Trib Rejuv.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5.4 Stream Ford or Animal</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.5 Straightening</td>
<td>No</td>
</tr>
<tr>
<td>Straightening Length:</td>
<td>431</td>
</tr>
</tbody>
</table>

| 5.5 Dredging | None |

### Notes:

- Short segment with mowed floodplain beyond right bank buffer. Dickinson Road culvert is severely undersized, but Brattleboro Town officials claim that is holds back large flow events and allows channel to flood into adjacent field on right bank, thus reducing...
1.6 Grade Controls **None**

<table>
<thead>
<tr>
<th>Type</th>
<th>Location</th>
<th>Total</th>
<th>Total Height Above Water</th>
<th>Photo Taken</th>
<th>GPSTaken</th>
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<tr>
<td>Culvert</td>
<td>3.00</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Old</td>
<td>3.70</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
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</tbody>
</table>

**Narrative:**
Moderate channel incision indicates stage II of CEM. Undersized culvert at Dickinson Rd has historically allowed for channel to flood, thereby slowing channel degradation process.

---

**Step 6. Rapid Habitat Assessment Data**

<table>
<thead>
<tr>
<th>Stream Gradient Type</th>
<th>Low</th>
<th>Score</th>
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<tbody>
<tr>
<td>6.1 Epifaunal Substrate - Available Cover</td>
<td>10</td>
<td></td>
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<tr>
<td>6.2 Pool Substrate</td>
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<td>6.3 Pool Variability</td>
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<tr>
<td>6.4 Sediment Deposition</td>
<td>18</td>
<td></td>
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<tr>
<td>6.5 Channel Flow Status</td>
<td>15</td>
<td></td>
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<tr>
<td>6.6 Channel Alteration</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>6.7 Channel Sinuosity</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>6.8 Bank Stability</td>
<td>Left: 8 Right: 8</td>
<td></td>
</tr>
<tr>
<td>6.9 Bank Vegetation Protection</td>
<td>Left: 8 Right: 6</td>
<td></td>
</tr>
<tr>
<td>6.10 Riparian Vegetation Zone Width</td>
<td>Left: 5 Right: 2</td>
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</tr>
<tr>
<td>Total Score</td>
<td>123</td>
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<tr>
<td>Habitat Rating</td>
<td>0.615</td>
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</tr>
</tbody>
</table>

**Habitat Stream Condition** **Fair**
### QC Status - Staff: Provisional Cons

#### Step 1. Valley and Floodplain

**1.1 Segmentation**
- Valley Width

**1.2 Alluvial Fan**
- None

**1.3 Corridor Encroachments**
- Length (ft): 1.06
- Segment Location: From change in confinement approx. 600 ft. upstream of Dickinson Road crossing up to

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>One</th>
<th>Both</th>
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</thead>
<tbody>
<tr>
<td>Berms</td>
<td>0</td>
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<tr>
<td>Height</td>
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<td>0</td>
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<tr>
<td>Roads</td>
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<tr>
<td>Railroad</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Height</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Improved Path</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Development</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**1.4 Adjacent Side**
- Left | Right

- Hillside Slope: Steep
- Continuous w/: Sometimes
- W/1 Bankfill: Always
- Subscript Slope: Not Evaluated

**1.5 Valley Features**
- Valley Width (ft): 50
- Width Determination: Measured
- Confinements Type: Semi-confined
- Rock Gorge?: No
- Human-caused Change?: No

#### Step 2. Stream Channel

**2.1 Bankfull Width**
- 17

**2.2 Max Depth (ft)**
- 1.70

**2.3 Mean Depth (ft)**
- 1.06

**2.4 Floodplain Width (ft)**
- 32

**Notes:**
- Short segment with confinement and slope that results in planform bedform (natural) for much of reach. One old impoundment with failing wall is storing fine sediment - not causing channel instability above or below.

#### Step 2. (Contd.)

**2.5 Abandoned Floodplain**
- 1.90 ft.

**2.6 Width/Depth Ratio**
- 15.57

**2.7 Entrenchment Ratio**
- 1.94

**2.8 Incision Ratio**
- 1.12

**2.9 Sinuosity**
- Low

**2.10 Riffles Type**
- Not Applicable

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

**2.12 Substrate Composition**
- Bedrock: 0%
- Boulder: 10%
- Cobble: 26%
- Coarse Gravel: 18%
- Fine Gravel: 16%
- Sand: 28%
- Silt and smaller: 2%
- Silt/Clay Present?: Yes
- Detritus: 15%
- # Large Woody: 8

**2.13 Average Largest Particle on Bed**
- 9.0 inches

**2.14 Stream Type**
- Stream Type: B
- Bed Material: Gravel
- Subclass Slope: None
- Bed Form: Plane Bed
- Field Measured Slope: 0

**2.15 Reference Stream Type**
- (if different from Phase 1)

<table>
<thead>
<tr>
<th>B</th>
<th>4</th>
<th>Non Plane Bed</th>
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</thead>
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<tr>
<td>3.3 old</td>
<td>Amount</td>
<td>Mean Height</td>
</tr>
<tr>
<td>Gullies</td>
<td>None</td>
<td>0.00</td>
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</table>

### Phase 2 Segment Summary

**Project:** Crosby Brook
**Stream:** Crosby Brook South Branch
**Reach #:** T1.02
**Observers:** EPF, NP, SB
**Organization:** Windam NRCD
**Segment Length (ft):** 947
**Segment Location:** From change in confinement approx. 600 ft. upstream of Dickinson Road crossing up to

**Completion Date:** April 23, 2008
**Completion Date:** SGAT Version: 4.56
**Why Not assessed:** Rain: No

#### Step 3. Riparian Features

**3.1 Stream Banks**
- Typical Bank Slope: Moderate
- Bank Texture: Left | Right
- Upper
- Material Type: Boulder/Cobble
- Consistency: Non-cohesive | Non-cohesive
- Lower
- Material Type: Mix | Mix
- Consistency: Non-cohesive | Non-cohesive
- Bank Erosion: Left | Right
- Erosion Length (ft): 0 | 0
- Erosion Height (ft): 0.00 | 0.00
- Revetmnt. Type: None | None
- Revetmnt. Length (ft): 0 | 0
- Near Bank Veg. Type: Left | Right
- Dominant: Coniferous | Coniferous
- Sub-dominant: Deciduous | Deciduous
- Bank Canopy: Left | Right
- Canopy %: 76-100 | 76-100
- 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: Shrubs/Saplin | None
- Mass Failures: 0 | 0
- Height: 0 | 0
- Gullies: 0 | 0
- Height: 0 | 0

#### Step 4. Flow & Flow Modifiers

**4.1 Spring / Seeps**
- None

**4.2 Adjacent Wetlands**
- None

**4.3 Flow Status**
- Moderate

**4.4 # of Debris Jams**
- 0

**4.5 Flow Regulation Type**
- None

**4.6 Flow Regulation Use**
- Impoundments
- Impoundmt. Location
- 0

**4.7 Stormwater Inputs**
- 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

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

**5.1 Bar Types**
- Mid | Point | Side
- 0 | 0 | 0

**5.2 Other Features**
- Flood: 0 | Neck Cutoff: 0 | Avulsion: 0 | Braiding: 0

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

**5.4 Stream Ford or Animal Crossing**
- Yes

**5.5 Straightening**
- None

**5.5 Straightening Length:**
- 0

**5.6 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:** Crosby Brook  
**Stream:** Crosby Brook South Branch  
**Organization:** Windam NRCD  
**Segment:** E  
**Completion Date:** April 23, 2008  
**Rain:** No  
**Segment Length (ft):** 947  
**Reach #:** T1.02  
**Observers:** EPF, NP, SB  
**Segment Location:** From change in confinement approx. 600 ft. upstream of Dickinson Road crossing up to EPF, NP, SB

### Geomorphic Rating

<table>
<thead>
<tr>
<th>Step 7. Rapid Geomorphic Assessment Data</th>
<th>Plane Bed</th>
<th>Score</th>
<th>STD</th>
<th>Historic</th>
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<tbody>
<tr>
<td>Confinement Type</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>7.1 Channel Degradation</td>
<td></td>
<td>16</td>
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<td>No</td>
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<tr>
<td>7.2 Channel Aggradation</td>
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<td>None</td>
<td>No</td>
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<tr>
<td>7.3 Widening Channel</td>
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<td>17</td>
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<td>No</td>
</tr>
<tr>
<td>7.4 Change in Planform</td>
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<td>15</td>
<td></td>
<td>No</td>
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</tbody>
</table>

**Total Score:** 63  
**Geomorphic Rating:** 0.7875

Channel Evolution Model: F  
Channel Evolution Stage: I  
Geomorphic Condition: Good  
Stream Sensitivity: Moderate

### Habitat Stream Condition

**Good**

**Narrative:** Stable channel conditions and natural plane bedform due to confinement and slope.
**QC Status - Staff: Provisional Cons**

**Step 1. Valley and Floodplain**

<table>
<thead>
<tr>
<th>Section</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Length (ft)</td>
<td>One</td>
</tr>
<tr>
<td>Berms</td>
<td>1,090</td>
</tr>
<tr>
<td>height</td>
<td>4</td>
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<tr>
<td>Roads</td>
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<tr>
<td>height</td>
<td>0</td>
</tr>
<tr>
<td>Railroads</td>
<td>0</td>
</tr>
<tr>
<td>height</td>
<td>0</td>
</tr>
<tr>
<td>Improved Paths</td>
<td>0</td>
</tr>
<tr>
<td>height</td>
<td>0</td>
</tr>
<tr>
<td>Development</td>
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</table>

<table>
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<tr>
<th>Section</th>
<th>Value</th>
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<tbody>
<tr>
<td>Hillside Slope</td>
<td>Extremely</td>
</tr>
<tr>
<td>Continuous w/</td>
<td>Never</td>
</tr>
<tr>
<td>W/ in Bankfill</td>
<td>Sometimes</td>
</tr>
<tr>
<td>Texture</td>
<td>Bedrock</td>
</tr>
<tr>
<td>Valley Width (ft)</td>
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<td>Width Determination</td>
<td>Measured</td>
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<tr>
<td>Confinement Type</td>
<td>Very Broad</td>
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<td>Rock Gorge?</td>
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<tr>
<td>Human-caused change?</td>
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</table>

**Step 2. Stream Channel**

<table>
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<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Bankfull Width</td>
<td>4</td>
</tr>
<tr>
<td>Max Depth (ft)</td>
<td>2.10</td>
</tr>
<tr>
<td>Mean Depth (ft)</td>
<td>1.34</td>
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<tr>
<td>Floodplain Width (ft)</td>
<td>340</td>
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</tbody>
</table>

**Notes:**
Channel dimensions change mid-reach for approx. 700 ft where near bank vegetation changes from herbaceous to shrub forest. Channel becomes wider and deeper but E-type channel dimensions were measured to verify no segmentation necessary. Incision in

<table>
<thead>
<tr>
<th>Section</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>2.5 Aband. Floodpln</td>
<td>2.70 ft</td>
</tr>
<tr>
<td>Human Elev Floodpln</td>
<td>0.00 ft</td>
</tr>
<tr>
<td>2.6 Width/Depth Ratio</td>
<td>3.21</td>
</tr>
<tr>
<td>2.7 Incision Ratio</td>
<td>1.29</td>
</tr>
<tr>
<td>Human Elevated Inc Rat</td>
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</tr>
<tr>
<td>2.9 Sinuosity</td>
<td>Low</td>
</tr>
</tbody>
</table>

**Step 3. Riparian Features**

<table>
<thead>
<tr>
<th>Section</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 Stream Banks</td>
<td>Undcrut</td>
</tr>
<tr>
<td>Bank Texture</td>
<td>Left</td>
</tr>
</tbody>
</table>

**4.1 Springs / Seeps** | Abundant |
**4.2 Adjacent Wetlands** | Abundant |
**4.3 Flow Status** | Moderate |
**4.4 # of Debris Jams** | 1 |
**4.5 Flow Regulation Type** | None |
**4.6 Up/Down strm flow reg** | None |
**4.7 StormwaterInputs** | None |
**4.8 Impoundments** | None |
**4.9 # of Beaver Dams** | 2 |
**4.10 Affected Length (ft)** | 325 |

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

<table>
<thead>
<tr>
<th>Section</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1 Bar Types</td>
<td>Mid</td>
</tr>
</tbody>
</table>

**5.2 Other Features** | Braiding |
**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 |
**5.6 Straightening Length** | 3,708 |
**5.7 Dredging** | None |
Historic straightening has left channel pushed against left valley wall. Channel moderately-connected to floodplain in most areas, with minor to moderate channel incision noted.
Appendix C

QA/QC Summary
Appendix D

VTDEC Biotic Sampling Summary
### Table 2: Macroinvertebrate community assessments from reaches sampled within Crosby Brook watershed. * Reach of lower gradient habitat then SHG model for these sites. As a result BPJ relied on for assessment and PMA-o, and PPCS-f.

<table>
<thead>
<tr>
<th>Location</th>
<th>Site (mi)</th>
<th>Date</th>
<th>Assessment</th>
<th>Density</th>
<th>Richness</th>
<th>Ept</th>
<th>PMA-O</th>
<th>BI 0-10</th>
<th>Oligo%</th>
<th>Ept/Ept&amp;C</th>
<th>PPCS-F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crosby Brook</td>
<td>0.3</td>
<td>9/17/2002</td>
<td>Poor</td>
<td>302</td>
<td>38.0</td>
<td>12.0</td>
<td>59.6</td>
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<td>17.6</td>
<td>0.80</td>
<td>0.57</td>
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<tr>
<td></td>
<td>0.3</td>
<td>9/18/2003</td>
<td>Poor</td>
<td>1458</td>
<td>30.0</td>
<td>9.5</td>
<td>50.8</td>
<td>5.09</td>
<td>11.3</td>
<td>0.74</td>
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<tr>
<td></td>
<td>0.3</td>
<td>9/3/2004</td>
<td>Poor</td>
<td>855</td>
<td>33.5</td>
<td>14.5</td>
<td>49.6</td>
<td>4.47</td>
<td>25.2</td>
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<td>0.44</td>
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<td></td>
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<td>9/3/2004</td>
<td>G-Fair *</td>
<td>1572</td>
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<td>22.0</td>
<td>69.5*</td>
<td>3.54</td>
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<tr>
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<td>0.7</td>
<td>9/2/2004</td>
<td>G-Fair *</td>
<td>653</td>
<td>38.0</td>
<td>16.0</td>
<td>79.2*</td>
<td>3.13</td>
<td>11.6</td>
<td>0.77</td>
<td>0.59*</td>
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<tr>
<td></td>
<td>1.5</td>
<td>9/18/2003</td>
<td>Fair</td>
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<td>13.5</td>
<td>48.0</td>
<td>5.05</td>
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<td>0.93</td>
<td>0.37</td>
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<tr>
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<td>1.5</td>
<td>9/3/2004</td>
<td>G-Fair</td>
<td>576</td>
<td>33.5</td>
<td>13.5</td>
<td>68.7</td>
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<tr>
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<td>9/3/2004</td>
<td>Ex-Vgood</td>
<td>1936</td>
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<td>23.0</td>
<td>76.9</td>
<td>3.33</td>
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<td>Ex-Vgood</td>
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<td>9/2/2004</td>
<td>VGood</td>
<td>1780</td>
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<td>19.0</td>
<td>74.7*</td>
<td>3.22</td>
<td>1.1</td>
<td>0.74</td>
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### Table 3: Fish community assessments from reaches sampled within the Crosby Brook watershed. * Reach of lower gradient dominated habitat, as a result BPJ used for assessment.

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<tr>
<th>Location</th>
<th>Station (mi)</th>
<th>Date</th>
<th>Assessment</th>
<th>CW IBI</th>
<th>Richness</th>
<th>Intol. Spp No</th>
<th>Blacknose Dace %</th>
<th>General Feed %</th>
<th>Top Carnivore %</th>
<th>Cold Water Spp %</th>
<th>BKT Density</th>
<th>BKT Age Class</th>
<th>Total /100m2</th>
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<td>Poor</td>
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<td>1</td>
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<td>Excellent</td>
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Table 4: Percent composition of the major macroinvertebrate orders from reaches sampled within the Crosby Brook watershed.

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<th>Location</th>
<th>Site (mi)</th>
<th>Date</th>
<th>Coleoptera %</th>
<th>Diptera %</th>
<th>Ephemeroptera %</th>
<th>Plecoptera %</th>
<th>Trichoptera %</th>
<th>Oligochaeta %</th>
<th>Other %</th>
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<td>7.3</td>
<td>20.9</td>
<td>1.3</td>
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<td>11.3</td>
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<td>9/3/2004</td>
<td>4.3</td>
<td>8.8</td>
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<td>8.0</td>
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<td>3.5</td>
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<td>9/2/2004</td>
<td>16.9</td>
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<td>7.4</td>
<td>11.2</td>
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Table 5: Percent composition of the macroinvertebrate major functional feeding grps from reaches sampled within the Crosby Brook watershed.

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<th>Location</th>
<th>Site (mi)</th>
<th>Date</th>
<th>CGath%</th>
<th>CFilt%</th>
<th>Predator%</th>
<th>ShrdDet%</th>
<th>ShrdHerb%</th>
<th>Scraper%</th>
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<td>32.5</td>
<td>38.4</td>
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<td>3.6</td>
<td>1.0</td>
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<td>9/18/2003</td>
<td>36.8</td>
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<td>31.6</td>
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<td>1.2</td>
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<td>11.9</td>
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<td>4.0</td>
<td>0.2</td>
<td>9.4</td>
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<td>9/2/2004</td>
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<td>35.3</td>
<td>10.8</td>
<td>13.7</td>
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<td>17.3</td>
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Table 6: Habitat measures of Substrate composition (pebble ct method), Embeddedness, and Silt rating (0-5), from Crosby Brook biomonitoring sites. *Observational substrate composition only.

<table>
<thead>
<tr>
<th>Location</th>
<th>Site</th>
<th>Date</th>
<th>Clay %</th>
<th>Silt %</th>
<th>Sand %</th>
<th>Gravel %</th>
<th>CGravel %</th>
<th>Cobble %</th>
<th>Boulder %</th>
<th>Ledge %</th>
<th>Embeddness %</th>
<th>SiltR 0-5</th>
<th>Snags</th>
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<td>0</td>
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Table 7: Canopy cover, and standardized periphyton (pebble ct w alga density categories) assessments from Crosby Brook watershed biomonitoring sites. Reported as Weighted Averages (range 0-10), for three alga types Moss, Macro, Micro.

<table>
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<tr>
<th>Location</th>
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<th>Date</th>
<th>% Canopy</th>
<th>Moss</th>
<th>Macro Algae</th>
<th>Micro Algae</th>
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<td>9/18/2003</td>
<td>80</td>
<td>0.4</td>
<td>1.3</td>
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<td>&lt; 0.1</td>
</tr>
<tr>
<td>Crosby Brook</td>
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<td>9/18/2003</td>
<td>60</td>
<td>0.7</td>
<td>&lt; 0.1</td>
<td>0.4</td>
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<tr>
<td></td>
<td>0.5</td>
<td>9/2/2004</td>
<td>70</td>
<td>0.4</td>
<td>0.0</td>
<td>0.2</td>
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<tr>
<td></td>
<td>1.3</td>
<td>9/2/2004</td>
<td>90</td>
<td>2.14</td>
<td>0</td>
<td>0.08</td>
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</table>
Summary of the biological condition of Crosby Brook

Crosby Brook and the South Branch Crosby Brook have been sampled for fish and or macroinvertebrates at a total of nine sites over three years. These assessments have allowed for an evaluation of the spatial and temporal extent of the biological condition of CB, and SBCB. Figure 2: illustrates the biological condition of the macroinvertebrate and fish communities longitudinally within the watershed by site and over multiple years. It is evident that the upper reaches on both CB and SBC are generally of high (Very Good to Excellent) biological condition. The exception being the CB 1.5 site where the macroinvertebrate community only rated fair to good over two consecutive years. Based on the assemblage characteristics, and habitat observations this site maybe stressed by temperature, fine particulate organic matter and channel straightening.

Figure 2: Biological Condition of both the Macroinvertebrate and Fish Assemblages at several sites on Crosby Brook and S.B Crosby Brook. Data points represent the macroinvertebrate or fish assemblage for a single sampling event from 2002-2004. Reach locations are relative miles up from confluence with the Connecticut River. SB Crosby brook data points are associated with tabular data from sites 0.1, 0.5 and 1.3. At river mile 1.0 land use changes from “rural residential” to more “urban”.

The lower part of the watershed starting from CB 0.7 down to CB 0.3, and SBC 0.1 are generally degraded compared to the upper watershed sites. Based on the assemblage characteristics, and habitat observations temperature, sediment/silt, and stream channel straightening appear to be the most likely stressors to various degrees at each individual site. Finally, it is clear that the lowest site 0.3 has been consistently assessed as fair to poor by both assemblages for three consecutive years. The assemblage characteristics and habitat observations at this site point strongly toward temperature and sediment/silt, as the primary stressors.
Appendix E

Bed Substrate Histograms (CD-ROM)
Crosby Brook Histogram Plots of Bed Substrate

<table>
<thead>
<tr>
<th>Substrate Class</th>
<th>M01-A</th>
<th>M01-B</th>
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<tbody>
<tr>
<td>Silt &lt; 0.06 mm</td>
<td>20%</td>
<td>10%</td>
</tr>
<tr>
<td>Sand 0.06 - 2 mm</td>
<td>10%</td>
<td>20%</td>
</tr>
<tr>
<td>F. Gravel 2 - 16 mm</td>
<td>5%</td>
<td>30%</td>
</tr>
<tr>
<td>C. Gravel 16 - 64 mm</td>
<td>15%</td>
<td>10%</td>
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<tr>
<td>Cobble 64 - 256 mm</td>
<td>60%</td>
<td>40%</td>
</tr>
<tr>
<td>Boulder 256 - 4096 mm</td>
<td>5%</td>
<td>10%</td>
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<tr>
<td>Bedrock &gt; 4096 mm</td>
<td>5%</td>
<td>5%</td>
</tr>
</tbody>
</table>

**Substrate Class**

- Silt
- Sand
- F. Gravel
- C. Gravel
- Cobble
- Boulder
- Bedrock
Appendix F

Cross Section Plots (CD-ROM)
Appendix G

Photos and Log (CD-ROM)