Sucker Brook Watershed Report: Phase 1 and 2
Stream Geomorphic Assessment Summary

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DRAFT

Introduction:

Sucker Brook was identified for assessment during 2005 as part of a joint UVM-ANR research project to assess the impacts of stormwater runoff on geomorphic stability in small watersheds in Chittenden County (Fitzgerald, 2007). Due to its rural setting and limited urbanization, Sucker Brook reaches were chosen as reference sites for reaches in stormwater impaired watersheds in the Burlington area. The assessments for the Sucker Brook mainstem, which included a total of 10 Phase 1 reaches and 7 Phase 2 reaches/segments, were carried out by Evan Fitzgerald and the UVM field crew in August 2005. Reaches M01 and M07 were not assessed during the Phase 2 surveys due to reach impoundment from beaver activity. Reaches M09 and M10 were not assessed because their small channel dimensions were not suitable for scope of the UVM research project. Fitzgerald Environmental Associates, LLC. (FEA) was retained by the ANR River Management Program in 2007 to: 1) carry out Phase 1 and 2 analyses for 5 reaches on the north branch tributary, and 2) organize and review the data and produce a summary report of the Phase 1 and 2 assessments for the entire watershed.

The following is a documentation of the key geomorphic processes and adjustments occurring in the Sucker Brook watershed at the reach scale. The intent of this documentation is twofold: 1) concisely summarize Sucker Brook watershed zones and geomorphic processes; 2) highlight for those using the data the key steps containing important or extraordinary information. When used in conjunction with the Phase 1 and 2 data in ANR's web-based Data Management System (DMS), and the SGA watershed mapping, this documentation also provides explanation for questions that may arise concerning discrepancies in the data. At the end of each reach or watershed zone summary is a discussion of potential projects that could protect, sustain, or restore fluvial geomorphic equilibrium conditions, through the implementation of either passive or active stream corridor management strategies. Following the discussion text is Appendix 1, which summarizes QA/QC notes and other relevant information for the Phase 1 and 2 databases. Plots for each channel cross-section measured during the Phase 2 analysis are provided in Appendix 2. Reach summary statistics and maps are found respectively in Appendices 3 and 4.

Sucker Brook Watershed Setting:

Sucker Brook is drained by western flowing watershed which spans the towns of Williston and St. George. The overall slope of the mainstem channel network from headwaters to outlet at Muddy Brook is 2.8%, reflecting the high gradient nature of many of the watershed's reaches. The drainage area of the basin is approximately 7.4 square miles, and land cover is predominately second-growth forest and agriculture with some areas of low density residential development.

Like many of the small basins in Chittenden County which were historically affected by Lake Vermont and the Champlain Sea (Wright, 2003), the parent material in the Sucker Brook basin is composed of a mixture of alluvial, till, and lacustrine substrates. In the lower reaches of the watershed up to the channel crossing with Route 2A, clay soils are associated with the lacustrine substrates. Above the Route 2A crossing in the upper areas of the watershed, alluvial and till soils are found. In addition to the alluvial valley associated with the Muddy Brook floodplain in reach M01, two wide alluvial valley with depositional channels are found along the channel network: 1) Reaches M05, M06, M07 and T1.01 are found in a wide alluvial valley in the vicinity of Route 2A; 2) Reach T1.05 is situated in an alluvial valley along Old Creamery Road. Above the alluvial valley on the mainstem, a series of sediment transport channels are found within confined valley settings. Similarly, in between the two alluvial valleys on the north branch tributary, sediment transport channels are also found within confined valley settings (T1.02 through T1.04). These zones are characterized by steep valley side slopes composed of glacial till and occasionally bedrock substrate.

During the Phase II field assessments of the Sucker Brook watershed, six distinct zones were observed with respect to natural topographic and geologic characteristics, as well as human impacts and the presence of beaver activity. Below is a summary of the reaches assessed for Phase II data during 2005 and 2007 within each of these watershed zones. Stream type departure (STD) information is found within each reach summary, and a project identification discussion is included for those reaches which STD was observed.

Lower Watershed Zone (M01 & M02):

Reaches M01 and M02 are found within a wide valley associated with the Muddy Brook floodplain, which is characterized by alluvial soils and frequent flooding. These reaches have been impacted by historic agricultural land use, including minor historic channel straightening and disturbances to the buffer and bank vegetation from the outlet up to the reach break with M03. Due to the low-gradient channel characteristics in this zone (channel slopes less than 1.0%), depositional reaches with E-type geometry are found with sand substrate. During the field assessments in 2005, there was significant beaver activity resulting in ponding throughout much of reach M01. As a result, this reach has not been evaluated for channel stability and habitat to date. Below is a brief description of the reach evaluated during the field assessments.

Reach Description:

Reach M02 is found from the confluence with a minor tributary entering from the south up to a change in valley slope and confinement approximately 500 feet upstream from the South Brownell Road crossing. This reach has E-type geometry (Rosgen, 1994; Figure 1) with sand substrate, dune-ripple bedform (Montgomery and Buffington, 1997) and a channel slope of 0.2 %. Some ponding was noted in the lower section of the reach due to a large beaver dam in downstream reach M01. The current channel conditions of this reach are relatively stable, with limited evidence of incision from the historic straightening (stage I of channel evolution). Rapid Geomorphic Assessment (RGA) and Rapid Habitat Assessment (RHA) scores were in the good range for this reach. The culvert beneath South Brownell Road (18 feet diameter) represents only a minor constriction of the channel (width of 21 feet), with no aggradation or

scour noted in the vicinity of the structure. Due to the limited impacts and channel adjustments observed in this watershed zone, no project identification summaries have been included.

Figure 1. Cross-section for Reach M02

Brownell Mountain Zone (M03):

A change in slope is found at the M02-M03 reach break immediately north of Brownell Mountain. From this point east up to a second alluvial valley beginning at Reach M04, the Sucker Brook channel is found in a narrow valley setting and has a well connected floodplain. Due to the variability in channel slope in this area (range from 1.3 to 3%), some sections of the channel exhibit sediment transport processes while other sections exhibit depositional processes. The stream buffer and corridor conditions in this zone are excellent (surrounding parcel owned and protected by the Town of Williston) and provide shading and organic inputs for the macroinvertebrate community found in these reaches.

Reach Description:

Reach M03 is found from the break in slope up to a change in buffer conditions from forested to herbaceous and shrub-sapling. This reach has a length of 2275 feet with an overall channel slope of 1.3% which supports a stable riffle-pool and planebed system with cobble and gravel substrate (Figure 3). Significant aggradation was noted in the lower section of the reach where a large mid-channel bar has formed prior to a 90 degree bend in the channel. This feature is causing minor widening and bank erosion in this area, but it is isolated to a 200 foot section of the channel. Upstream of this feature, stable riffle-pool and planebed features were observed. Rapid Geomorphic Assessment (RGA) and Rapid Habitat Assessment (RHA) scores were in the good range for this reach, and channel evolution stage was assessed at stage III due to the minor aggradation and widening observed in the lower reach. Due to the limited impacts and channel adjustments observed for this reach, no project identification summaries

have been included.

Figure 2. Stable plane bed features in Reach M03

Figure 3. Mid-channel bar in lower Reach M03

Route 2A Valley (M04 to M07; T1.01):

A sharp change in slope occurs at the reach break between M03 and M04, and the valley widens significantly in reach M04 east of Brownell Mountain. Here the Sucker Brook channel is found in a wide alluvial valley where historic agricultural land use impacts, such as channel straightening and buffer removal, are pervasive. The average channel slope throughout this valley is 0.6%, resulting in low-gradient channels with E-type geometry and depositional processes. Below are narrative descriptions of the reaches found in this watershed zone.

Reach Descriptions:

Reach M04 is found from the break in slope at the downstream reach break up to where the north branch tributary (T1) enters from the northeast and has a channel length of 3725 feet. In M04 the valley slope lessens to approximately 0.6%, with the alluvial setting and wide valley having supported a channel with meandering planform and riffle-pool bedform under reference conditions. Historic agricultural encroachment and straightening has resulted in a channel with reduced sinuosity. This reach was segmented at a break in buffer conditions (see map in Appendix 4) due to a change in channel dimensions. Lower segment M04-A has C-type channel geometry with riffle-pool bedform and gravel substrate (Figure 4). Some aggradation and channel widening were noted in this segment, and the channel evolution processes have been assessed at stage III. Upper segment M04-B has E-type geometry with sand substrate. Ponding due to a large beaver dam was occurring in segment B at the time of the field assessments in 2005 (Figure 5). Some redevelopment of sinuosity was noted throughout this reach, and the channel evolution processes have been assessed at stage IV. Rapid Geomorphic Assessment (RGA) and Rapid Habitat Assessment (RHA) scores were in the good range for both segments.

Figure 4. Riffle-pool bed features in Segment M04-A

Figure 5. Large beaver dam in Segment M04-B

Reach M05 is found from approximately 1000 feet downstream of the mainstem crossing of Route 2A up to where a minor tributary enters from the north. This reach has E-type geometry (Figure 6) with sand substrate, dune-ripple bedform and a channel slope of 0.3%. Some ponding was noted in the lower section of the reach due to a large beaver dam in downstream reach M01. The current channel conditions of this reach are relatively stable, with limited evidence of incision from the historic straightening. These conditions have resulted from an evolution of channel planform and slope, and much of the lower reach is now stable (stage V of channel evolution). Rapid Geomorphic Assessment (RGA) and Rapid Habitat Assessment (RHA) scores for this reach were good and fair, respectively. The culvert beneath South Brownell Road (7 feet diameter) represents only a minor constriction of the channel (width of 8 feet), with only limited scour noted in the vicinity of the structure.

Figure 6. Cross section in M05

Figure 7. Culvert beneath Route 2A

Reach M06 is found from approximately 300 feet downstream of the mainstem crossing of Butternut Road up to where a minor tributary enters from the east. This reach has E-type geometry with sand substrate, dune-ripple bedform and a channel slope of 0.2%. This reach has been extensively straightened throughout, and remains in a state of incision (incision ratio = 1.4) with some bank erosion observed in 2005. Very few areas of the channel have redeveloped the degree of sinuosity that is typical of this channel type and setting, indicating that the channel may have been straightened within the last 10 to 20 years. Rapid Geomorphic Assessment (RGA) and Rapid Habitat Assessment (RHA) scores for this reach

were in the fair range, and channel evolution was assessed at stage II.

Reach M07 is found from the confluence with a minor tributary entering from the east up to a sharp break in slope at the reach break with M08. This reach has E-type geometry with sand substrate, dune-ripple bedform and a channel slope of 1.2%. During the field assessments in 2005, there was significant beaver activity resulting in ponding throughout much of reach M07. As a result, this reach has not been evaluated for channel stability and habitat to date.

Reach T1.01, the first reach on the north branch tributary, is found from the north branch confluence with the mainstem up to a driveway approximately 1300 ft north of Ridge Rd. This reach has E-type geometry with gravel substrate, riffle-pool bedform and a channel slope of 0.7% (Figure 8). Significant incision was observed in two areas in the reach: 1) in the lower section below the Route 2A crossing where the channel; 2) approximately 500 feet upstream of the Ridge Road crossing. The incision (incision ratio > 1.5) below Route 2A is resulting from an undersized culvert (8.5 feet diameter; channel width = 13 feet) which is restricting the transport of fine gravel through the structure. Upstream of Ridge Rd the channel is downcutting through previously aggraded material (Figure 9) delivered from the avulsion in upstream segment T1.02-B. In between these two areas of incision the channel is in fair condition with limited adjustments, but the overall reach geomorphic stability and habitat conditions have been assessed as fair (channel evolution stage is II).

Figure 8. Cross section in lower T1.01

Figure 9. Channel incision in upper T1.01

Preliminary Project Identification:

In this depositional zone of the watershed the primary issue of concern should be (in the absence of current encroachment on the corridor) the protection of the corridor from future encroachment. Areas of straightened channel through this alluvial valley are beginning to redevelop a sinuous planform, and are predicted to continue their lateral adjustments for decades to come. Currently there is limited encroachment on the stream corridor, despite suitable land for development (e.g., flat with moderately suitable soils for on-site septic systems). Corridor protection efforts for this zone of Sucker Brook should define an adequate width for the stream corridor and ensure that no development is permitted within this zone.

Mainstem Headwaters Zone (M08 to M10):

At the reach break of M07 and M08, the valley slope changes drastically and the mainstem channel enters a more confined setting north of Ayer Road. From this point south along the channel, the slope steepens (slopes range from 3.8 to 8.5%) and numerous sediment transport zones are found. A and B-type channel geometry with a wide range of bedforms were observed during the field assessments. Within this zone, only reach M08 was evaluated during the 2005 field assessments. Below is a brief description of this reach.

Reach Description:

Reach M08 is found from the break in slope up to where a minor tributary enters from the south. This reach has a length of 2530 feet with an overall channel slope of 7.0%, supporting a step-pool system with cobble and gravel substrate. Significant aggradation was noted throughout the reach, and in many areas the wetted perimeter of the channel only occupied approximately 25% of the streambed. It was not clear where the sediment causing this aggradation was originating from (and upslope reaches M09 and M10 were not evaluated). Rapid Geomorphic Assessment (RGA) and Rapid Habitat Assessment (RHA) scores for this reach were fair and good, respectively. The channel evolution stage was assessed at stage IIb due to the aggradation and widening observed throughout the reach. Due to limited channel encroachment along this reach, no project identification summaries have been included.

North Branch Middle Zone (T1.02 to T1.04-A)

North of the alluvial valley in the vicinity of the Route 2A crossing, the north branch channel is found in an area with variable topography and mixture of valley and stream types. This area of the watershed contains a major channel avulsion (Reach T1.02) that has been the focus of a large- scale channel restoration effort by the Town of Williston. Above the channel restoration site, the north branch is found in an area with limited residential and agricultural land use in the stream corridor. This area is associated with a parcel protected by a conservation easement, and stable channel conditions are found in a wide, unconfined alluvial valley. Above this valley, the channel enters a confined valley west of Lyman Road, and a large waterfall is found downstream of the McJay Road crossing. Below are narrative descriptions of the reaches found in this watershed zone.

Reach Descriptions:

Reach T1.02 was delineated during the Phase 1 analysis to encompass the site of the channel avulsion and subsequent restoration effort. This reach is found from a driveway crossing at the reach break with T1.01 up to approximately 250 feet above LaClair Road. This channel position has shifted to the west by 150 feet in some locations, as seen in Figures 10 and 11. Under reference conditions, this reach had a channel slope of 4.4%, which likely supported a B-type channel with step-pool morphology and cobble substrate. In the 1980's an extreme flood event moved the channel into a new location through an old gravel pit underlain with sands and clays. Since the avulsion, the channel has deepened to form a 40 foot gully, delivering approximately 72,000 cubic yards of material to the downstream reaches. VTANR

considers this one of the worst channel avulsions known to Vermont (Dubois and King, 2007). Today, the gully is the site of an extensive restoration effort to stabilize the channel through the installation of rock weirs and large substrate to control the vertical adjustments.

During the Phase 2 assessment of this reach in 2007 by FEA, only the area downstream of the restoration site was accessible for evaluation. The reach was segmented to capture the current channel dimensions below the restoration site, which have undergone a change from B-type channel geometry to C-type geometry due to the aggradation of sediment from above and the redevelopment of a narrow floodplain within the confined valley setting. Segment A is located from the downstream reach break at the driveway crossing up 675 feet to the site of the historic waterfall. This segment is characterized by a C-type stream with riffle-pool bedform and gravel substrate. RGA and RHA scores indicate a reach in fair conditions, with the channel evolution processes reflecting the aggradation and redevelopment of sinuosity (stage IV). Large amounts of coarse material are periodically removed from the channel at the downstream area to avoid flooding at a 48 inch culvert beneath a driveway (Figure 12). Within the channel restoration site, numerous rock weirs are being installed to return the channel to its stable dimensions with B-type geometry and step-pool bedform (Figure 13).

Figure 10 & 11. Aerial photographs of the channel avulsion site from 1937 (left) and 2003 (right). The current channel location is shown in solid blue, and the 1937 channel location in dashed blue.

Figure 12. Above 48 inch culvert in lower Reach T1.02

Figure 13. Channel restoration site in upper T1.02

Reach T1.03 is found from the upstream end of the channel restoration site up to a break in slope approximately 600 feet west of the end of Lyman Road. This reach has a channel length of 3170 feet and a slope of 0.95%. It is found in an unconfined valley with limited local impacts from development, and exhibits a stable riffle-pool form with C-type geometry and a sinuous planform (Figure 14). One area of straightening and buffer encroachment in the lower reach has impacted habitat conditions. However, overall the reach has good to excellent stability and geomorphic habitat conditions (channel evolution stage of I).

Figure 14. Cross section in Reach T1.03

Figure 15. Cross section in lower Segment T1.04-A

Segment T1.04-A is found from a break in slope approximately 600 feet west of the end of Lyman Road up to another break in slope 500 feet downstream of the McJay Road crossing. This segment has a channel length of 1500 feet and an approximate slope of 3.5%. Much of the elevation loss, however, is located at a waterfall in the upper segment. The segment is found in a confined valley setting with limited impacts to the corridor, and exhibits a stable plane bed morphology with C-type geometry (Figure 15). The large waterfall is located in the upper segment just downstream of the confluence with an incised tributary entering from the north. The geomorphic stability and habitat conditions have been assessed as good, with stable channel processes (stage I of channel evolution).

Preliminary Project Identification:

An incised tributary entering from the north was noted in Segment T1.04-A. This tributary enters the north branch channel west of Lyman Road and originates from an area of recent residential development on the north side of Old Creamery Road. Recently built housing on Highlands Drive and Overlake View, and an increase in upslope impervious cover, may be resulting in excess hydraulic loading and channel incision. Any future assessments or corridor planning efforts in the Sucker Brook watershed should consider this impact.

Old Creamery Road Zone (T1.04-B to T1.05-C)

Upstream of the waterfall in Segment T1.04-A there is a significant change in valley slope where the north branch is found in an alluvial valley along Old Creamery Road. C and E-type channel morphologies are found within this zone where the overall channel slope is 0.4%. There are significant impacts to the channel and corridor in this zone. Medium and low-density residential land use has encroached on the corridor, especially to the north of Old Creamery Road upstream of the first crossing. Below are narrative descriptions of the segments found in this watershed zone.

Segment Descriptions:

Segment T1.04-B is found from the McJay Road crossing upstream to the first crossing of Old Creamery Road. This segment has a channel length of 1880 feet and an approximate slope of 2.1%. It is found in an unconfined valley with and has C-type geometry with plane bedform. Some of the recently built homes on Lyman Road have encroached on the corridor, and in some cases, have placed rock weirs in the channel which are causing significant aggradation upstream resulting in an impact on habitat conditions (Figure 16). The depositional features created by these structures are causing widening in the upslope areas, resulting in fair geomorphic stability and habitat conditions. Channel evolution processes have been assessed in stage III.

Figure 16. Rock weir in lower Segment T1.04-B

Figure 17. Corridor encroachment in T1.05-A

Segment T1.05-A is found from the crossing at Old Creamery Road up to a change in channel slope 200 feet downstream of the Nob Hill Road crossing. This segment has a length of 1160 feet and C-type channel geometry. The stream channel and corridor have been highly impacted along this segment where the residential land use has altered the buffer and channel boundary conditions (Figure 17). Many areas along this segment lack a woody vegetative

buffer greater than 25 feet, and numerous rock weirs have been placed in the stream for aesthetics, resulting in aggradation above these structures. The depositional features are causing widening upslope, resulting in fair geomorphic stability and habitat conditions. Channel evolution processes have also been assessed in stage III for this segment.

Segment T1.05-B is found from the crossing at Nob Hill Road up to the second Old Creamery Road crossing. This segment has a length of 1955 feet and E-type channel geometry (Figure 18). The stream corridor has also been impacted along this segment where the residential land use has altered the buffer conditions, resulting in a lack a woody vegetative buffer greater than 25 feet. In addition, 28% of the channel length was historically straightened, which has severely impacted the habitat conditions. Despite these impacts, the channel remains relatively stable in stage II of channel evolution due to limited discharge from the upslope watershed, which is likely moderated by the beaver ponding in the upslope segment. The geomorphic stability and habitat conditions have been assessed as fair for this segment.

Figure 18. E-type channel in Segment T1.05-B

Figure 19. E-type channel in Segment T1.05-C

Segment T1.05-C is found from the crossing at Old Creamery Road up to the north branch source in the vicinity of Oak Hill Road. This segment has a length of 5175 feet and E-type channel geometry throughout (Figure 19). In the lower section of the segment, a large beaver impoundment is found which affects the channel upstream for approximately 1700 feet. Upstream of this area, the channel is unaffected by local-scale residential or agricultural land uses, and maintains a very sinuous planform. Very good habitat conditions for the low-gradient setting were noted in the middle and upper sections of the segment, with excellent buffer conditions and abundant wood debris throughout. The geomorphic stability and habitat conditions have been assessed as good, with stable channel evolution processes (stage I).

Preliminary Project Identification:

The two segments in between the Old Creamery Road crossings have been highly impacted by historic straightening, residential encroachment on the corridor and unnatural structures placed in the channel. Both have undergone a departure from reference bedform (see Appendix 3), due mainly to a loss of sinuosity. The channel and watershed characteristics in this upper zone are such that little future lateral channel migration is expected; channel straightening combined with bank armoring will hold the channel in place indefinitely. Potential projects in this area include the removal of the in-stream structures causing

aggradation and habitat impacts, as well the revegetation of the buffers with native woody vegetation. Future efforts to identify specific projects in this watershed zone would involve extensive public outreach, given the large number of residential properties found along the channel, especially in segment T1.05-A.

Conclusions:

The Sucker Brook watershed supports many stream reaches in good to reference conditions, particularly in areas where the topography is steep enough to have limited historic impacts to the channel boundary conditions (e.g., straightening). Upper Reach M03 is an excellent site for comparison with other riffle-pool and planebed reaches in larger stormwater impaired watersheds in Chittenden County. Similarly, Reach T1.03 is could be used as a reference reach for gravel-bottomed riffle-pool reaches in smaller stormwater impaired watersheds. In both reaches, impacts from encroachments (e.g., houses in the corridor) are minimal and the large scale stressors of altered hydrology are nearly absent. Therefore, these reaches are recommended for comparison with high-gradient stormwater impaired reaches with drainage areas greater than five square miles.

Historic impacts to the Sucker Brook channel conditions from agricultural land uses are still pervasive in many reaches. These impacts are severe in reaches M04, M05, M06 and T1.05. Although there have been limited alterations to hydrology upslope of these areas, buffer removal and channel straightening has had the effect of initiating channel evolution processes that are similar to those observed in stormwater impaired reaches in the Burlington area. Incision, followed by widening and a redevelopment of sinuosity are the processes occurring in these reaches. Due to their altered conditions, these reaches are not recommended for comparison (as reference channels) with stormwater impaired reaches in Chittenden County.

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