Town of Springfield, Vermont
Phase 2 Stream Geomorphic Assessment
Unnamed Tributary to Black River Along Valley Street

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Prepared by:
Bear Creek Environmental, LLC
149 State Street, Suite 3
Montpelier, Vermont 05602

Bear Creek Environmental

Prepared under contract to:
Town of Springfield
96 Main Street
Springfield, Vermont 05156

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Bear Creek Environmental, LLC
149 State Street, Suite 3 / Montpelier, VT 05602
Phone: (802) 223-5140 / **Web:** www.BearCreekEnvironmental.com

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1.0 EXECUTIVE SUMMARY

A stream geomorphic assessment of an unnamed tributary to the Black River in downtown Springfield, Vermont was conducted by Bear Creek Environmental, LLC (BCE) during June 2017. The project includes a modified Phase 2 Stream Geomorphic Assessment of 1.34 stream miles. A planning strategy based on fluvial geomorphic science (see glossary at end of report for associated definitions) was chosen because it provides a holistic, watershed-scale approach to identifying the stressors on stream ecosystem health. The stream geomorphic assessment data can be used by resource managers, community watershed groups, municipalities and others to identify how changes to land-use alter the physical processes and habitat of rivers. Funding for the project was provided through the State of Vermont Ecosystem Restoration Program.

The Stream Geomorphic Assessment was conducted to help identify sources of stream instability and to generate a list of potential restoration projects to reduce sedimentation and improve water quality within the Black River watershed. There are three major gullies that are contributing sediment and nutrients to the brook within the study area. Of particular concern is the large gully/mass failure that is located between the tributary and Lincoln Street. The source of the gully erosion below Lincoln Street has been identified by the Town as stormwater runoff. Efforts were made to reduce stormwater runoff in this area by installing catch basin(s). In 2012 the Vermont Youth Conservation Corps implemented a project to help stabilize this area. This work has not halted the erosion and additional actions to stabilize the area are warranted. Two other gullies on the west side of the brook were identified during the assessment. Broken stormwater pipes located along the valley walls in these locations appear to have contributed to instability.

Encroachments along the brook, such as rock retaining walls, homes and outbuildings, and the roadway has resulted in reduced floodplain access, further exacerbating bank stability issues. Where possible, encroachments should be removed to restore the channel dimensions and provide floodplain access. Planning efforts should be considered to limit future encroachments along the brook.

A total of seven potential projects are provided in this report as preliminary recommendations for improving water quality and flood resiliency in an unnamed tributary to the Black River along Valley Street. These projects include: three gully erosion remediation projects, a property acquisition and channel restoration project, road embankment stabilization, a culvert replacement project, and a dam removal project.

2.0 LOCAL PLANNING PROGRAM OVERVIEW

There are many scientific terms used in this Phase 2 report, and the reader is encouraged to refer to the glossary at the end of the document.

2.1 Overview

This project focuses on the section of an unnamed tributary to the Black River between the intersection of Brook Road and Mile Hill Road downstream to the Main Street crossing, which is near the confluence with the Black River.

2.2 Planning Team

The planning team for this modified Phase 2 stream geomorphic assessment of the Unnamed Tributary to the Black River along Valley Street is comprised of the Town of Springfield, Southern Windsor County Regional Planning Commission (SWCRPC), Bear Creek Environmental (BCE), and the Vermont Agency of Natural Resources (VANR). The Black River Action Team (BRAT) has been conducting water quality monitoring on the Unnamed Trib, and is interested in tracking improvements in water quality once water quality improvement projects are undertaken (personal communication with Kelly Stettner). The 2017 study was funded through a State of Vermont Ecosystem Restoration Program (ERP) grant under contract with the Town of Springfield.

2.3 Local Project Objectives

The stream geomorphic assessment data are useful to resource managers, community watershed groups, municipalities and others for identifying how changes to land-use alter the physical processes and *habitat* of rivers. The Town of Springfield and project partners have the opportunity to address and mitigate major watershed stressors through the design and implementation *of restoration* and protection projects outlined in this report. It is recognized that these potential projects are preliminary and resources would be needed for project design and implementation.

2.4 Goals of the Vermont River Management Program

The State of Vermont's Rivers Program has set out several goals and objectives that are supportive of the local initiative in this small watershed in Springfield, VT. The state management goal is to, "manage toward, protect, and restore the fluvial geomorphic equilibrium condition of Vermont rivers by resolving conflicts between human investments and river dynamics in the most economically and ecologically sustainable manner" (Vermont Agency of Natural Resources, 2009b). The objectives of the Program include *fluvial erosion* hazard mitigation and sediment and nutrient load reduction, as well as aquatic and riparian habitat protection and restoration. The Program seeks to conduct river corridor planning in an effort to remediate the geomorphic instability that is largely responsible for problems in a majority of

Vermont's rivers. Additionally, the Vermont River Management Program has set out to provide funding and technical assistance to facilitate an understanding of river instability and the establishment of well-developed and appropriately scaled strategies to protect and restore river equilibrium.

3.0 STUDY AREA

The project focus area includes 1.34 miles of an unnamed tributary to the Black River in Springfield, Vermont that starts upstream at the intersection of Mile Hill Road and Brook Road and continues downstream to the Main Street crossing near the mouth of the brook. The study area includes reaches M07S1.01 through M07S1.03 as shown on the site location map on page 1 of the Attachment. The stream runs parallel to Brook Road in the upper study area for about 0.3 mile and then runs parallel to Valley Street for about a mile, after which it crosses under Main Street and then flows into the Black River mainstem, just upstream of the Park Street crossing. The drainage area of the Black River at the confluence with the unnamed tributary is approximately 183 square miles. The Black River is a tributary to the Connecticut River.

4.0 METHODS

A summary of the methodology used for the stream geomorphic assessment is provided below.

4.1 Modified Phase 2 Methodology

Reaches determined during Phase 1 (the watershed delineation and remote sensing phase) were broken further into segments during the Phase 2 Assessment. Topographic maps and orthophotos were used as a first cut in delineating segment breaks. Scientists from Bear Creek Environmental walked the entire length of each study reach to break the reaches into segments based on land use, channel dimensions, and other important characteristics.

The modified Phase 2 assessment of the unnamed tributary to the Black River followed procedures specified in the Vermont Stream Geomorphic Assessment (SGA) Phase 2 Handbook (Vermont Agency of Natural Resources, 2009b), and used version 10.3.3 of the SGAT Geographic Information System (GIS) extension to index impacts within each reach. The modified Phase 2 assessment included important impact features such as bank erosion, mass failures, gully erosion, channel straightening, hard bank armoring and rock riprap, stormwater inputs and floodplain encroachments. Valley walls and impact features were mapped in the field using a MobileMapper 100 GPS unit, which has a submeter accuracy.

4.2 Bridge and Culvert Methodology

The culverts within the study area were previously assessed by Redstart Consulting in 2015. Bridge assessments were conducted by BCE on all public crossings within the selected Phase 2 reaches at the time of the stream walkover in June 2017. The Agency of Natural Resources Bridge and Culvert protocols (Vermont Agency of Natural Resources, 2009a) were followed. Latitude and Longitude at each of the structures was determined using a MobileMapper 100 GPS unit. The assessment included photo documentation of the inlet, outlet, upstream, and downstream of each of the structures.

The Vermont Culvert Geomorphic Compatibility Screening Tool (Milone and MacBroom, Inc. 2008) was used to determine geomorphic compatibility for each culvert and bridge/arch using the following categories: fully compatible, mostly compatible, partially compatible, mostly incompatible and fully incompatible. Bridges and arches were evaluated in this study for geomorphic compatibility using the screening tool that was modified to exclude the slope parameter.

All culverts were evaluated for Aquatic Organism Passage (AOP) using the Vermont Culvert Aquatic Organism Passage Screening Tool (Milone and MacBroom, 2009). The screening guide has the following four categories:

- Full AOP for all organisms
- Reduced AOP for all aquatic organisms
- No AOP for all aquatic organisms except adult salmonids
- No AOP for all aquatic organisms

5.0 RESULTS

A description of each reach walked is provided in section 5.1. The segments are listed by stream location from downstream to upstream.

5.1 Reach/Segment Descriptions

M07S1.01

The most downstream reach included in this study begins just downstream of the crossing that goes under a parking lot and Main Street. The reach has a channel length of 2,369 feet which ends at a small tributary that enters from the east at reach point M07S1.01S1.01.

M07S1.01 has been historically channelized and flows in close proximity to businesses and residences. There are two private bridges and two public crossings (Main Street and Valley Street) within this lowest reach. Due to channel encroachments and armoring the stream has been straightened and contained for much of the reach on both sides (Figure 5.1). There are a couple of major stormwater gullies that are on the west valley wall. Although Valley Street results in a reduction in the valley width, the reference and existing valley confinement is very broad.

Figure 5.1. The Stream channel has been extensively straightened in M07S1.01.

M07S1.01 Data Summary		Reference	Existing
Length: 2,369 ft Drainage Area: 2.35 sq. mi.	Confinement	Very Broad	Very Broad
Major Stressors:	**Channel Straightening, Encroachments, Revetments, Mass Failure, Erosion, Gullies**		

M07S1.02

The middle reach starts at the confluence of a small tributary (M07S1.01S1.01) and extends upstream 3,711 feet. It was split into three segments during assessment to account for changes in channel dimensions, banks/buffers, and geomorphic adjustment processes.

M07S1.02-A

This lower segment begins at the confluence of the small tributary (M07S1.01S1.01) and ends about 2460 feet upstream at a dam. Segment A has very broad valley by reference; the existing valley type has been reduced to a broad valley type due to the significant human-caused change in valley width from Valley Street. The segment is characterized as higher gradient with larger substrate and is more entrenched than segments B and C (Figure 5.2).

Glacial till was noted to be the material at the bottom of some of the eroded banks and along several of the mass failures that were mapped, indicating channel widening is taking place. There is a channel spanning bedrock grade control in approximately the middle of the reach that is acting to prevent further incision.

Figure 5.2. Mass failure with ground water seep and glacial tell on lower bank in M07S1.02-A.

M07S1.02-A Data Summary		**Reference**	**Existing**
Length: 2,460 ft Drainage Area: 1.95 sq. mi.	Confinement	Very Broad	Broad
Major Stressors:	**Channel Straightening, Encroachments, Revetments, Mass Failure, Erosion**		

M07S1.02-B

The middle segment of reach M07S1.02 begins immediately downstream of the dam and extends upstream and ends just downstream of the junction of Valley Street and Brook Road. Segment B is approximately 550 feet in length and has a very broad valley by reference; the existing valley type has been reduced to a broad valley type due to the significant human-caused change in valley width from Valley Street. The section upstream of the dam is relatively sinuous with gravel substrate on the bed (Figure 5.3). This smaller material is due to material aggrading upstream of the dam.

Glacial till was noted to be the material at the bottom of some of the eroded banks and along several of the mass failures that were mapped, indicating channel widening is taking place. There is a channel spanning bedrock grade control in approximately the middle of the reach.

Figure 5.3. Lower banks with gravel bed material and a more sinuous channel characterize M07S1.02-B.

M07S1.02-B Data Summary		**Reference**	**Existing**
Length: 550 ft Drainage Area: 1.95 sq. mi.	Confinement	Very Broad	Broad
Major Stressors:	**Channel Straightening, Encroachments, Revetments, Mass Failure, Erosion**		

M07S1.02-C

The upper segment of M07S1.02-C begins just downstream of the junction of Valley Street and Brook road and extends upstream about 700 feet. Segment C has a broad valley by reference; however, Brook Road runs parallel to the small stream, converting the valley type to narrow. Segment C has a wooded riparian zone (Figure 5.4). The channel is entrenched and is trapped between the valley wall and Brook Road.

A couple of stormwater inputs from Brook Road were mapped within this segment. At the upper end of the segment is a 100 foot long section with bank erosion on both sides of the channel.

Figure 5.4. Channel upstream of Valley Street arch crossing in segment M07S1.02-C.

M07S1.02-C Data Summary		**Reference**	**Existing**
Length: 701 ft Drainage Area: 1.95 sq. mi.	Confinement	Broad	Narrow
Major Stressors:	**Historic Channel Straightening, Encroachments, Erosion**		

M07S1.03

The upper most reach has a channel length of 1,031 feet. The reach was segmented due to a change in reference valley width and existing channel dimensions.

M07S1.03-A

The lower segment of reach M07S1.03 is 320 feet long. Similar to segment M07S1.02-C, M07S1.03-A is entrenched (Figure 5.5) and is trapped between the valley wall and Brook Road. The reference valley width is broad. The close proximity of Brook Road to the western side of the channel converts the valley type to narrow. Segment M07S1.03-A ends at the upstream end of the Brook Road Bridge. The land use immediately adjacent to both sides of the channel is wooded.

Figure 5.5. The Stream channel has been extensively straightened in M07S1.03.

M07S1.03-A Data Summary		Reference	Existing
Length: 320 ft Drainage Area: 1.71 sq. mi.	Confinement	Broad	Narrow
Major Stressors:	**Encroachments**		

M07S1.03-B

The channel length of the upper segment of reach M07S1.03 is approximately 710 feet. The upper part of the segment has a low width to depth ratio, but then transitions to a wider channel with good floodplain access. This lower section of stream appears to be going through an aggradation process (buildup of sediment), as shown in Figure 5.6.

Figure 5.6. The channel has filled in with material at the lower end of M07S1.03-A.

M07S1.03-B Data Summary		**Reference**	**Existing**
Length: 711 ft Drainage Area: 1.71 sq. mi.	Confinement	Very Broad	Narrow
Major Stressors:	**Encroachments**		

5.2 Stream Crossings

The bridge and culvert summary reports for the study area are available on Vermont Agency of Natural Resources data Management System at the following link: https://anrweb.vt.gov/DEC/SGA/datasets/structures.aspx. The summary reports for the study area include three bridges (one on Main Street, one on Valley Street, one on Brook Road), one arch on Valley Street and two culverts on Valley Street. Table 1 below includes the geomorphic compatibility and AOP coarse screen for the culverts within the study area and Table 2 includes geomorphic compatibility for the bridges and arch. This information can be used by municipalities and the Vermont Agency of Transportation to prioritize structure replacements.

Table 1. Culvert Assessment Summary							
Reach/ Segment Number	**Road Name**	**Structure ID**	**Latitude**	**Longitude**	**Geomorphic Compatibility**	**AOP Coarse Screen**	**Notes**
M07S1.02-A	Valley Street	100000000314181	43.30567	-72.47865	Mostly Incompatible	No AOP Including Adult Salmonids	Culvert has failed wooden baffles within structure; 80% bankfull width
M07S1.02-A Project #6	Valley Street	400005000414181	43.30855	-72.47824	Mostly Incompatible	Reduced AOP	Percent bankfull width – 45%; undersized; debris at inlet

Table 2. Bridge/Arch Assessment Summary						
Reach/Segment Number	**Road Name**	**Structure ID**	**Latitude**	**Longitude**	**Geomorphic Compatibility**	**Notes**
M07S1.01	Main Street	100000000014181	43.29943	-72.48151	Partially Compatible	340 foot long bridge that passes under Main Street and parking lots; sharp approach angle; 73% bankfull width
M07S1.01	Valley Street	100000000214181	43.30178	-72.47977	Mostly Compatible	73% Bankfull width
M07S1.02	Valley Street	400005000114181	43.31165	-72.47730	Mostly Compatible	Structure is an arch; 80% bankfull width
M07S1.03	Brook Road	100000000114181	43.31390	-72.47622	Mostly Incompatible	77% bankfull width; sharp approach angle

6.0 PRELIMINARY PROJECT IDENTIFICATION

The data collected during the stream walkover on June 14, 2017 were used to identify potential projects to mitigate adverse impacts, increase geomorphic stability, and improve water quality throughout the study area. A total of seven projects were identified within the study area. These include a variety of types of projects, such gully remediation, property acquisition, stabilizing road embankments, and a culvert replacement. The projects are listed in Table 3 and described below in greater detail.

Table 3. Potential Project Locations

Project Number	Project Description	Latitude	Longitude
1	Remediate Gully Below Lincoln Street	43.302486	-72.47989
2	Remediate Gully Near Junction of Valley Street and Common Street	43.302885	-72.47953
3	Remediate Gully Near Junction of Valley Street and Common Street	43.30444	-72.478889
4	Property Acquisition and Channel Restoration	43.305084	-72.478879
5	Stabilize Road Embankment	43.305858	-72.478683
6	Replace Undersized Culvert	43.308553	-72.478237
7	Dam Removal	43.310539	-72.477982

Project #1 – Remediate Gully Below Lincoln Street

The most downstream gully that has been identified for remediation is located to the west of Valley Street between the junction of Pleasant Street to the south and Common Street to the north. The gully is located to the east of Lincoln Street, and across the brook and to the west of 83 Valley Street. The source of the gully erosion has been attributed to stormwater runoff coming from the Lincoln Street neighborhood (personal communication with Tom Yennerell, Town Manager for Springfield, VT). The gully dimensions are estimated to be approximately 10 feet deep and 150 feet long (Figure 6.1). This gully has led to destabilization of the valley wall, which has put the property of 10 Lincoln Street at risk (Figure 6.1). According to Tom Yennerell, a catch basin was installed near the base of Lincoln Street to collect stormwater and prevent it from running down the valley wall. In 2012, a slope stabilization project using erosion control matting was undertaken by the Vermont Youth Conservation Corps (VYCC). This slope stabilization project has not halted the erosion, and steps need to be taken to stabilize the slope. The erosion at the top of the valley wall is undermining the parking lot at 10 Valley Street (Figure 6.2). In addition to remediating the gully, consideration should be given to a property acquisition to purchase this at-risk property. General information about property acquisition through the Federal Emergency Management Agency (FEMA) is provided below.

FEMA Buyouts

Property acquisition, also known as buyouts, is a hazard mitigation assistance program offered through FEMA. Buyouts involve the purchase of at-risk properties by municipalities with 75% FEMA Hazard Mitigation Grant Program money and 25% municipality money. These properties are purchased for fair market (pre-disaster if disaster has occurred). The properties are required to be cleared and left in open space indefinitely. A buyout property may never be sold or developed again (FEMA, 2014).

Figure 6.1. Gully erosion on west valley wall east of Lincoln Street (Project #1).

Figure 6.2. Severe erosion on valley wall near 10 Lincoln Street (Project #1).

Project #2 – Remediate Gully Near Junction of Valley Street and Common Street

A second gully, located across the brook from 91 Valley Street and near the junction of Valley Street and Common Street, was identified during the stream walkover. The gully was estimated to be about 2 feet deep, 6 feet wide and about 44 feet in length, and appeared to be caused by a broken stormwater pipe (Figure 6.3). Field investigation is recommended to see what actions should be taken to reduce stormwater runoff in this area and/or repair the broken pipe.

Figure 6.3. Broken pipe contributing to gully erosion off of Valley Street (see project #2).

Project #3 – Remediate Gully Near Junction of Valley Street and Common Street

A third gully identified during the stream walkover is about 0.1 miles north of the junction of Valley Street and Common Street. It is located just upstream of a small tributary that enters from the east. This gully also appeared to be caused by a broken stormwater pipe (Figure 6.4). The dimensions of the gully are approximately 4 feet deep, 50 feet long and 12 feet wide (Figure 6.5). Similar to project #2, a field investigation to determine possible actions to reduce stormwater to this area and/or repair the broken pipe is recommended.

Figure 6.4 Broken stormwater pipe that is contributing to gully erosion (Project #3).

Figure 6.5. Gully erosion below broken off stormwater pipe (Project #3).

Project #4 – Property Acquisition and Channel Restoration

The goal of project #4 is to improve the safety of residents along the brook and to restore the stream channel dimensions. The encroachment from a stone retaining wall and home along the bank of the brook has narrowed the channel width width to about 12.5 feet in this location (Figure 6.6). This lack of channel width and floodprone area is resulting is excessive shear stress along the valley wall and is contributing to destabilizing the west valley wall. The house is located directly on the banks of the brook (Figure 6.7), and property acquisition should be considered to improve safety. If a buy-out is pursued, a project could be designed to increase the channel width and possibly restore some needed floodplain.

Figure 6.6. The channel width has been narrowed to 12.5 feet (project #4).

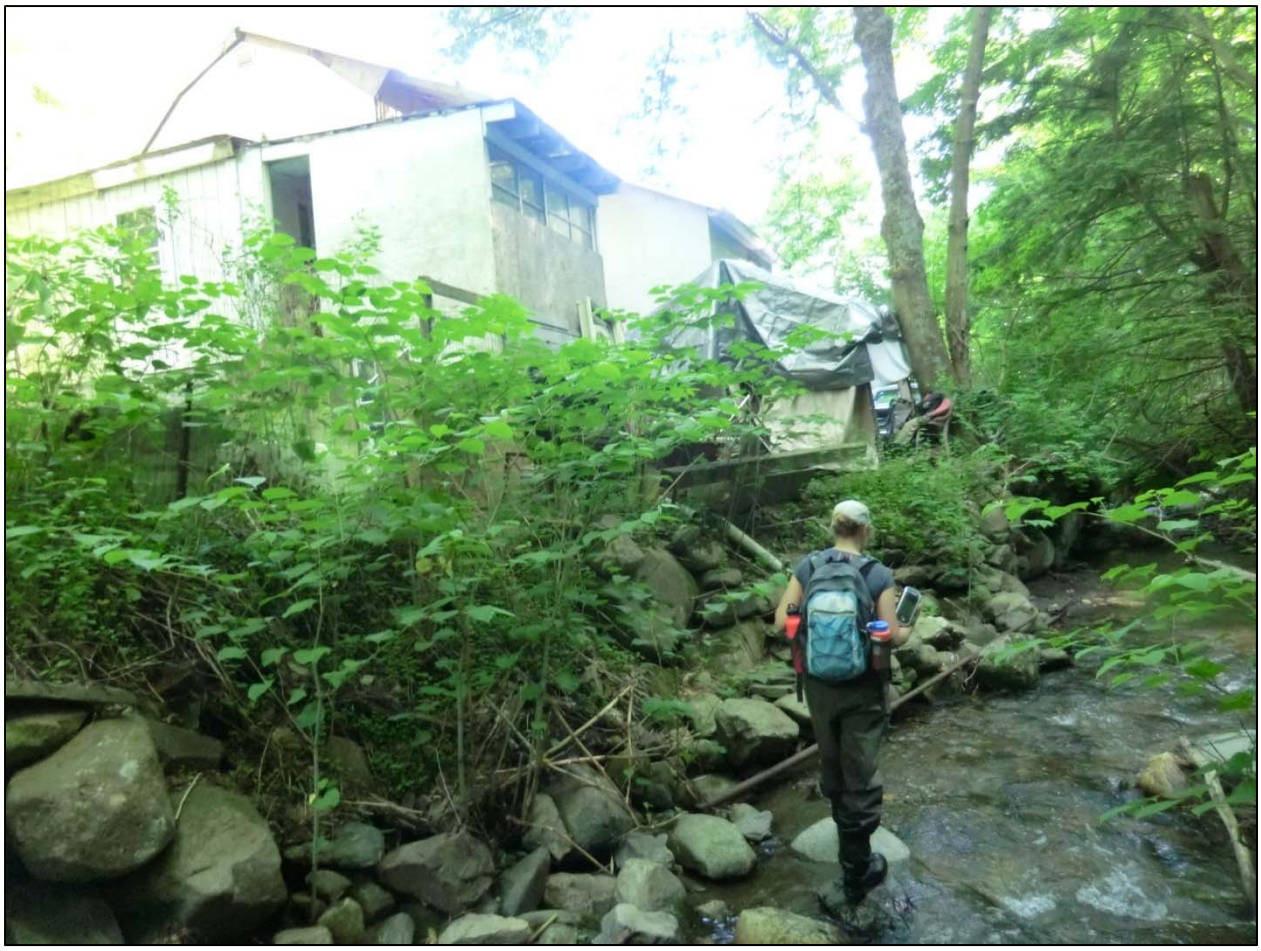

Figure 6.7. House on the banks of the brook that is susceptible to flood damage (Project #4).

Project #5 – Stabilize Road Embankment

As part of project number 5, a road stabilization project adjacent to Valley Street should be investigated (just upstream of the culvert crossing on Valley Street directly west from the intersection of Mark Street and Litchfield Street). As shown in Figure 6.8, the bank below the guard rail is not stable. A stacked toe wall design should be considered here to prevent encroachment out into the river. It is recommended that a Stream Alteration Engineer from the State of Vermont be consulted for the best course of action in this location.

Figure 6.8. Potential washout location along Valley St. adjacent to study brook (Project #5).

Project #6 – Replace Undersized Culvert

The stream crossing on Valley Street that is located approximately a quarter of a mile south of the junction of Valley Street and Litchfield Street is undersized. This steel corrugated culvert is only 45 percent of the bankfull channel width. Wood debris and sediment were noted to be obstructing the opening of the structure as shown in Figure 6.9. The height and width of the structure was measured to be 9 feet during an October 2015 stream crossing assessment, while the channel width is approximately 20 feet. A structure replacement that has dimensions that are closer to the bankfull channel width is recommended. In addition, a structure that mimics the natural system is recommended to improve water and sediment transport, flood resiliency, and habitat.

Figure 6.9. Undersized culvert on Valley St. is obstructed with sediment and debris (Project #6).

Project #7 – Dam Removal

An old dam is located on the brook adjacent to Valley Street about 500 feet south of the junction of Valley Street and Litchfield Street. The dam is approximately 10.6 feet high and is made of concrete (Figure 6.10). As shown in Figure 6.11, sediment has built up above the dam. In an effort to improve sediment transport and aquatic organism passage, a dam removal project could be considered.

Figure 6.10. Old dam made of concrete that is 10.6 feet high.

Figure 6.11. Sediment accumulation behind old dam.

7.0 LIST OF ACRONYMS AND GLOSSARY OF TERMS

List of Acronyms

BCE – Bear Creek Environmental, LLC
BRAT – Black River Action Team
ERP – Ecosystem Restoration Program
GIS – Geographic Information System
FEMA – Federal Emergency Management Agency
SGA – Stream Geomorphic Assessment
SGAT – Stream Geomorphic Assessment Tool
SWCRPC – Southern Windsor County Regional Planning Commission
VANR – Vermont Agency of Natural Resources

Glossary of Terms

Adapted from:
Restoration Terms, by Craig Fischenich, February, 2000, USAE Research and Development Center, Environmental Laboratory, 3909 Halls Ferry Rd., Vicksburg, MS 39180
And
Vermont Stream Geomorphic Assessment Handbook, Appendix Q, 2009, VT Agency of Natural Resources, Waterbury, VT.
http://www.vtwaterquality.org/rivers/docs/assessmenthandbooks/rv_apxqglossary.pdf

Adjustment Process – type of change that is underway due to natural causes or human activity that has or will result in a change to the valley, floodplain, and/or channel condition (e.g., vertical, lateral, or channel plan form adjustment processes).

Aggradation - A progressive buildup or rising of the channel bed and floodplain due to sediment deposition. The geologic process by which streambeds are raised in elevation and floodplains are formed. Aggradation indicates that the stream discharge and/or bed load characteristics are changing. Opposite of degradation.

Alluvial Fan – A fan-shaped accumulation of alluvium (alluvial soils) deposited at the mouth of a ravine or at the juncture of a tributary stream with the main stem where there is an abrupt change in slope.

Alluvial Soils – Soil deposits from rivers.

Alluvium – A general term for detrital deposits made by streams on riverbeds, floodplains, and alluvial fans.

Avulsion – A change in channel course that occurs when a stream suddenly breaks through its banks, typically bisecting an overextended meander arc.

Bank Stability – The ability of a stream bank to counteract erosion or gravity forces.

Bankfull Channel Depth - The maximum depth of a channel within a riffle segment when flowing at a bankfull discharge.

Bankfull Channel Width - The top surface width of a stream channel when flowing at a bankfull discharge.

Bankfull Discharge - The stream discharge corresponding to the water stage that overtops the natural banks. This flow occurs, on average, about once every 1 to 2 years and given its frequency and magnitude is responsible for the shaping of most stream or river channels.

Bar – An accumulation of alluvium (usually gravel or sand) caused by a decrease in sediment transport capacity on the inside of meander bends or in the center of an over wide channel.

Berms – Mounds of dirt, earth, gravel or other fill built parallel to the stream banks designed to keep flood flows from entering the adjacent floodplain.

Bifurcated Channel – a river channel that has split into two branches as a result of planform adjustment (i.e. split flow due to island).

Boundary Conditions – Factors that are acting upon a stream and preventing adjustment (e.g. bank armoring prevents channel widening).

Cascade – River bed form where the channel is very steep with narrow confinement. There are often large boulders and bedrock with waterfalls.

Channelization – The process of changing (usually straightening) the natural path of a waterway.

Confluence – The location where two streams flow together.

Culvert – A buried pipe that allows flows to pass under a road.

Degradation – (1) A progressive lowering of the channel bed due to scour. Degradation is an indicator that the stream's discharge and/or sediment load is changing. The opposite of aggradation. (2) A decrease in value for a designated use.

Delta Bar – A deposit of sediment where a tributary enters the main stem of a river.

Depositional Features – Types of sediment deposition and storage areas in a channel (e.g. mid-channel bars, point bars, side bars, diagonal bars, delta bars, and islands).

Diagonal Bar – Type of depositional feature perpendicular to the bank that is formed from excess sedimentation and within the channel and from the development of steep riffles.

Drainage Basin – The total area of land from which water drains into a specific river.

Dredging – Removing material (usually sediments) from wetlands or waterways, usually to make them deeper or wider.

Erosion – The wearing away of rock or soil by the gradual detachment of soil or rock fragments by water, wind, ice, and other mechanical, chemical, or biological forces.

Flood Resiliency – The ability to withstand and recover from flooding and associated damages.

Floodplain – Land built of sediment that is regularly covered with water as a result of the flooding of a nearby stream.

Floodprone Width – the wetted width of the channel when the water level is twice the maximum bankfull depth. For most channels this is associated with less than a 50 year return period (Rosgen, 1996).

Fluvial Erosion – Erosive forces created by flowing water.

Fluvial Geomorphology – the physics of flowing water, sediments, and other products of watersheds in relation to various land forms.

Gaging Station – A particular site in a stream, lake, reservoir, etc., where hydrologic data are obtained.

Grade Control - A fixed feature on the streambed that controls the bed elevation at that point, effectively fixing the bed elevation from potential incision; typically bedrock, dams or culverts.

Gradient – Vertical drop per unit of horizontal distance.

Habitat – The local environment in which organisms normally grow and live.
Headwater – Referring to the source of a stream or river.

Headcut – Sudden change in elevation or knickpoint on a streambed. Headcutting is the process by which a streambed lowers as headcuts migrate upstream.

Incised River – A river that erodes its channel by the process of degradation to a lower base level than existed previously or is consistent with the current hydrology.

Islands – Mid-channel bars that are above the average water level and have established woody vegetation.

Lacustrine Soils- Soil deposits from lakes.

Mass Failure – A landslide that has occurred adjacent to a stream and on its valley wall. Involves mass slumping of land down the valley wall.

Meander - The winding of a stream channel, usually in an erodible alluvial valley. A series of sine-generated curves characterized by curved flow and alternating banks and shoals.

Meander Migration – The change of course or movement of a channel. The movement of a channel over time is natural in most alluvial systems. The rate of movement may be increased if the stream is out of balance with its watershed inputs.

Meander Belt Width – The horizontal distance between the opposite outside banks of fully developed meanders determined by extending two lines (one on each side of the channel) parallel to the valley from the lateral extent of each meander bend along both sides of the channel.

Meander Wavelength - The lineal distance downvalley between two corresponding points of successive meanders of the same phase.

Meander Wavelength Ratio – The meander wavelength divided by the bankfull channel width.

Meander Width Ratio – The meander belt width divided by the bankfull channel width.

Mid-Channel Bar – Sediment deposits (bar) located in the channel away from the banks, generally found in areas where the channel runs straight. Mid-channel bars caused by recent channel instability are unvegetated.

Neck Cutoff – This is the occurrence of an avulsion on the inside of a very long and tight meander.

Planform - The channel shape as if observed from the air. Changes in planform often involve shifts in large amount of sediment, bank erosion, or the migration of the channel.

Plane Bed – Channel lacks discrete bed features (such as pools, riffles, and point bars) and may have long stretches of featureless bed.

Point Bar –The convex side of a meander bend that is built up due to sediment deposition.

Pool -- A habitat feature (section of stream) that is characterized by deep, low-velocity water and a smooth surface.

Reach - Section of river with similar characteristics such as slope, confinement (valley width), and tributary influence.

Restoration – The return of an ecosystem to a close approximation of its condition prior to disturbance.

Riffle - A habitat feature (section of stream) that is characterized by shallow, fast-moving water broken by the presence of rocks and boulders.

Riffle-pool - Channel has undulating bed that defines a sequence of riffles, runs, pools, and point bars. Occurs in moderate to low gradient and moderately sinuous channels, generally in unconfined valleys with well-established floodplains.

Riparian Buffer – The width of naturally vegetated land adjacent to the stream between the top of the bank and the edge of other land-uses. A buffer is largely undisturbed and consists of the trees, shrubs, groundcover plants, duff layer, and naturally uneven ground surface.

Riparian Corridor – Lands defined by the lateral extent of a stream's meanders necessary to maintain a stable stream dimension, pattern, profile, and sediment regime.

Segment – A relatively homogeneous section of stream contained within a reach that has the same reference stream characteristics but is distinct from other segments in the reach.

Sensitivity – The valley, floodplain and/or channel condition's likelihood to change due to natural causes and/or anticipated human activity.

Side Bar – Unvegetated sediment deposits located along the margins or the channel in locations other than the inside of channel meander bends.

Step-Pool – Characterized by longitudinal steps formed by large particles (boulder/cobbles) organized into discrete channel-spanning accumulations that separate pools, which contain smaller sized materials. Often associated with steep channels in confined valleys.

Steep Riffle – Associated with aggradation where sediment has dropped out to form a steep face of sediment on the downstream side.

Surficial Sediment/Geology – Sediment that lies on top of bedrock.

Tributary – A stream that flows into another stream, river, or lake.

Tributary Rejuvenation – As the bed of the main stem is lowered, head cuts (incision) begin at the mouth of the tributary and move upstream.

Urban Runoff – Storm water from city streets and gutters that usually carries a great deal of litter and organic and bacterial wastes into the receiving waters.

Valley Wall – The edge of a river valley where the slope of the land increases and a stream is unlikely to ever flow beyond.

Windrowing – The process of removing gravel from a streambed and piling it on the bank, creating a gravel berm.

8.0 REFERENCES

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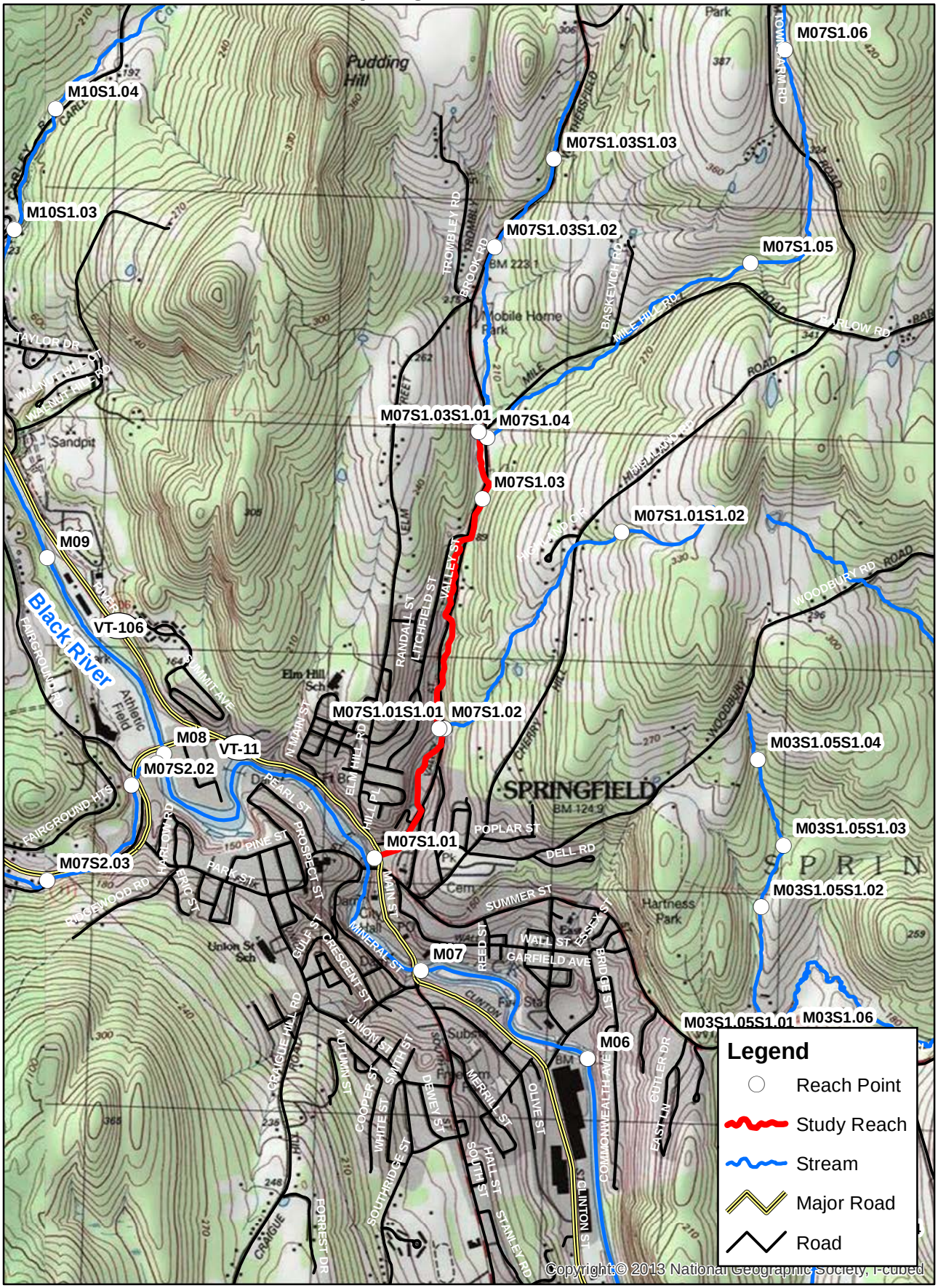
ATTACHMENT

Unnamed Tributary to the Black River along Valley Street
Reach Location Map
Springfield, Vermont



Bear Creek Environmental

N

0 1,000 2,000 Feet

Map 1: Impacts and Potential Projects
Unnamed Tributary to the Black River
Valley Street - Springfield, Vermont
M07S1.01 & M07.S1.02-A

Project #5
Project #4
Project #3
Project #2
Project #1
M07S1.02
M07S1.01S1.01
M07S1.01
SPRINGFIELD
RANDALL ST
LITCHFIELD ST
HILLTOP DR
HOOVER ST
CURTIS ST
ELM HILL RD
MARK ST
DOUGLAS ST
RITA ST
ELLIS ST
LINCOLN ST
MARY ST
HARVARD ST
HILLCREST RD
HILL PL
VT-106
RIVER ST
VT-11
Black River
ELM TER
VALLEY ST
COMMON ST
FRONT ST
ORCHARD ST
CIRCULAR ST
PLEASANT ST
PARK ST
MAIN ST
WALL ST
SUMMER ST
SUMMER HILL ST

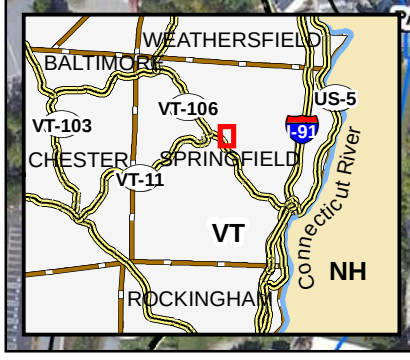
Projects:
1. Remediate Gully
2. Remediate Gully
3. Remediate Gully
4. Property Acquisition & Stream Channel Restoration
5. Stabilize Road Embankment

Legend

- Potential Project Location

Impact Point

- Bridge
- Culvert
- Debris Jam
- Dam
- Ledge Grade Control
- Gully
- Flood Chute
- Stormwater Input
- Reach/Segment Point
- Armoring
- Erosion
- Mass Failure
- Berm
- Channel Straightening
- Major Road
- Road
- Stream Centerline
- River Valley
- ANR River Corridor



Map composed on July 18, 2017. Background is Bing Imagery. Data sources include: the Vermont Center for Geographic Information, Vermont Agency of Natural Resources, and Bear Creek Environmental.

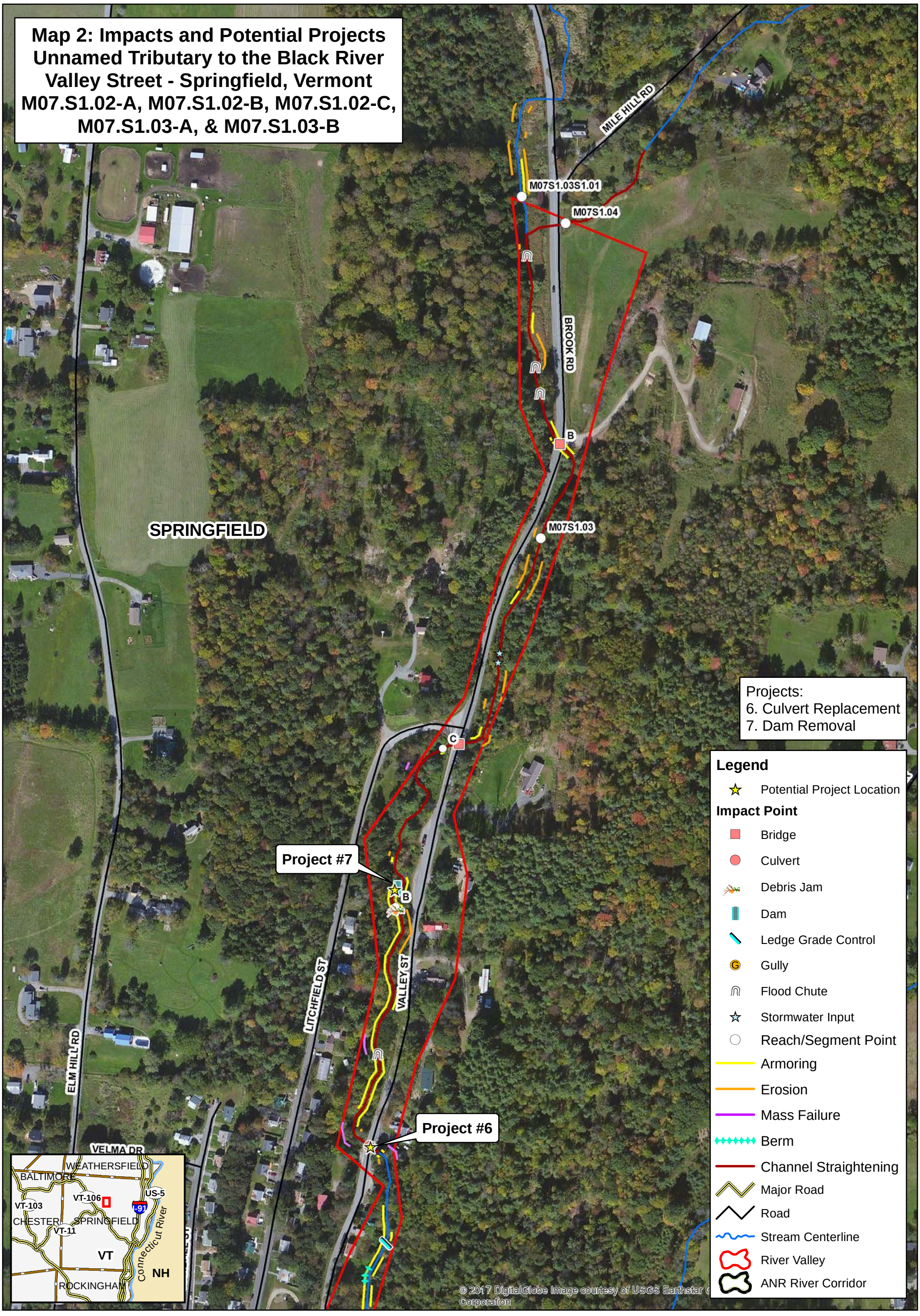
N

0 250 500 Feet

1 inch = 250 feet

Bear Creek Environmental

Map 2: Impacts and Potential Projects
Unnamed Tributary to the Black River
Valley Street - Springfield, Vermont
M07.S1.02-A, M07.S1.02-B, M07.S1.02-C, M07.S1.03-A, & M07.S1.03-B



Projects:
6. Culvert Replacement
7. Dam Removal

Legend

- Potential Project Location

Impact Point

- Bridge
- Culvert
- Debris Jam
- Dam
- Ledge Grade Control
- Gully
- Flood Chute
- Stormwater Input
- Reach/Segment Point
- Armoring
- Erosion
- Mass Failure
- Berm
- Channel Straightening
- Major Road
- Road
- Stream Centerline
- River Valley
- ANR River Corridor

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N

0 250 500 Feet

1 inch = 250 feet

Bear Creek Environmental