STORMWATER MANAGEMENT PLAN FOR SWANTON TOWN AND VILLAGE

FINAL REPORT

Stone Project ID 112475-W

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1. INTRODUCTION

Water knows no political boundaries. As such, evaluations of water quality tend to be undertaken along watershed boundaries and involve land areas in multiple towns. From a strict water quality perspective, it would be ideal to manage water resources along watershed lines—but the reality is that many decisions, particularly those about land use, are made at the site or local levels.

A Stormwater Management Plan ensures that issues related to land use, surface water quality, and stormwater management are not viewed independently. Rather, localized stormwater problems are examined at a larger scale (e.g., town-wide) to determine their relative contribution. A Town-wide Stormwater Management Plan is responsive to existing landscape characteristics, connecting land use, stormwater management, floodplain management, river management, and public infrastructure needs to more effectively address all of the issues which contribute to water quality impairment or improvement. Furthermore, as adjoining towns also take increasingly comprehensive views of stormwater management issues and planning, these plans are one-stop resources that can improve coordination and increase opportunities for collaboration in meeting watershed-related needs across political boundaries.

1.1. Project Background

As precipitation falls on an undisturbed, natural landscape and moves through the hydrologic cycle, it flows through a complex system of vegetation, soil, groundwater, and surface waters. Natural events have shaped these components over time to create a system that can efficiently handle stormwater through evaporation, transpiration, infiltration, and runoff. Alterations to the landscape change the way it responds to precipitation events. Management of land use, rainfall, storm runoff, and surface water (streams and lakes) are interrelated, and the management practices chosen all influence water quality and stream health.

What is a watershed?

A **watershed** is any area of land in which all water runoff from its surface flows to the same drainage point. Watersheds are sometimes referred to as drainage areas.

Watersheds are important because they are the basic unit of analysis for all surface water management. They come in all shapes and sizes, and are defined based on the intended study area.

Watersheds are interconnected networks in which a change at any location can carry throughout the system. There are many factors that influence exactly how stormwater runoff from a particular site will affect other areas of the watershed. The degree and type of impact varies from location to location, but it can be significant relative to other sources of pollution. Stormwater runoff affects water quality, water quantity, habitat and biological resources, public health, and the aesthetic appearance of the receiving water. Stormwater controls, in contrast, are typically conceived and implemented on a project-by-project basis. These projects are analyzed for their individual stormwater impacts, not in the context of their impact on an interconnected hydrologic and hydraulic system. It is well documented, however, that the cumulative effects of individual land surface changes dramatically influence flooding conditions and contribute to degradation of water quality (NRC 2009).

Watershed management practices have direct impacts on water quality in local creeks and streams (e.g., Hungerford Brook, Missisquoi River), as well as downstream waterbodies (e.g., Lake Champlain). Any decisions that affect land use have stormwater management ramifications and, in turn, impact all downstream water resources. The findings of one recent study (Troy et al. 2007) suggest that “land-use changes in the

Basin have increased phosphorus levels in Lake Champlain, especially conversion of agricultural areas and forests to developed uses."

Vermont's streams, rivers, and Lake Champlain are vital economic resources. As such, the quality of local receiving waters affects both economic interests and quality of life in the surrounding areas. Throughout the Champlain Valley, the local economy depends, in part, on the revenue gained from outdoor activities enjoyed in and on the water. Protecting the quality of surface waters is one of the most important commitments communities can make to protect the economic interests of residents.

Taken together, these elements emphasize the need for a holistic planning effort that considers the interconnected nature of land use, stormwater management, and river management in order to achieve overall watershed goals.

1.2. Goals of this Project

The Swanton Town and Village Municipal Plan states: *It is vital that the water quality of Lake Champlain be protected and that public access be maintained and enhanced. The Town is interested in identifying ways to mitigate the effects of failed septic systems and non-point source pollution on the water quality of Lake Champlain. The Town will continue to work with the State of Vermont, Missisquoi River Basin Association, Friends of Northern Lake Champlain, and other organizations to plan and implement water quality improvements.* (Swanton, 2010).

The ultimate goal of this project is to provide Swanton Town and Village with a list of high priority water resource concerns, including conceptual solutions, which will support the development and implementation of restoration projects in an efficient and targeted manner. The Stormwater Management Plan first, however, incorporates information from existing plans and datasets to create a single, town-specific resource to guide future stormwater management activities. This Stormwater Management Planning Library, included as Appendix B, is a valuable resource for the future regarding any water quality-related work in Swanton.

This Stormwater Management Plan also:

- Identifies stormwater-related areas of active erosion or other sources of sediment that are being delivered directly to water bodies in Swanton Town and Village;
- Develops recommendations to address stormwater problems, including:
    - A list of problem areas that can assist stakeholders in directing resources to high priority projects; and
    - Conceptual solutions for high-priority problem areas (Section 4.3 and Appendix E), and
    - Potential revisions to town ordinances needed to encourage location-specific management activities.

2. GENERAL DESCRIPTION OF THE STUDY AREAS

The Town of Swanton is located in Franklin County in northwest Vermont with a total area of 61.7 square miles, including more than 20 miles of Lake Champlain shoreline. Swanton Village has an area of 0.8 square

miles and is located wholly within the Town of Swanton. The total population of the Town was 6,427 as of the 2010 census; approximately 2,386 of the Town's residents live within the Village boundaries (U.S. Census Bureau, 2011).

The Swanton Town and Village lie wholly within the Lake Champlain basin, and have a number of rivers, streams and lakes within its boundaries. The Swanton Town and Village includes portions of the Missisquoi River, Hungerford Brook, Jewett Brook, Stevens Brook and Fairfield Pond watersheds, in addition to a number smaller streams and brooks – such as the historic "Tinker's Ravine" in the Village. Each of the watersheds are described in more detail below, and watershed boundaries are shown on Map 1 in Appendix A.

2.1. Lake Champlain Direct Drainage

A significant portion of western and northern Swanton Town – or West Swanton – drains directly to Lake Champlain. West Swanton includes much of the 6,000-acre Missisquoi National Wildlife Refuge, as well as a significant number of seasonal homes. This area is characterized as very flat with numerous wetlands. In addition, a significant portion of West Swanton meets the State's definition of primary agricultural soils and is in active farming.

2.2. Missisquoi River and Oxbow Lake

The Missisquoi River is the largest tributary of the Missisquoi Bay. The Missisquoi runs approximately 88 miles. From its headwaters in Lowell, Vermont, the Missisquoi River flows north into Quebec where the Missisquoi Nord joins the main stem at Highwater, QC. The river then returns to Vermont at East Richford and flows west, through Swanton Town and Village, to Missisquoi Bay. There are five major subwatersheds that drain to the Missisquoi River: Hungerford Brook, Black Creek, Tyler Branch, Trout River, and Mud Creek; portions of both the Hungerford Brook and Black Creek (through its Dead Creek tributary) watersheds fall within Swanton's boundaries. The whole length of the Missisquoi River is considered by the State of Vermont to be stressed from high sediment loads, turbidity, nutrient enrichment, and increased water temperature, likely from agricultural land uses, loss of riparian vegetation, and streambank erosion.

Oxbow Lake, a true oxbow of the Missisquoi River, is located in Swanton. No water quality data are available for the pond. The most recent aerial orthophotograph shows this pond to be surrounded on all but the southern shore by active agricultural land.

2.3. Hungerford Brook

Hungerford Brook flows northward from St Albans Town to Swanton, where it ultimately empties into the Missisquoi River. The mainstem of Hungerford Brook is approximately 10 miles long, and drains a watershed area of approximately 19.5 square miles. The watershed is dominated by agricultural (53%) and forest (28%) land uses, although increasing residential and commercial development is occurring in the upper reaches of the watershed in St Albans Town. Watershed impacts such as direct cattle access to the stream, close cropping with small or absent buffers, channel alteration and direct inputs of stormwater runoff have been repeatedly observed during numerous studies of the brook.

2.4. Jewett Brook

Jewett Brook is a low-gradient stream that confluences with Stevens Brook in the Black Creek Swamp in St. Albans Town shortly before emptying into St Albans Bay; the headwaters of Jewett Brook and roughly two square miles of the brook's watershed are in Swanton. The Jewett Brook watershed is approximately 8 square

miles and is dominated by agricultural land use. Jewett Brook is considered to be an "impaired" waterbody, meaning it does not currently meet water quality standards. The state has identified the pollutants of concern as sediment, nutrient, and *E. coli* bacteria, and has attributed these pollutants primarily to agricultural runoff. Within one to three years (roughly 2014-2016), the State of Vermont will develop a TMDL for Jewett Brook (VTDEC 2012).

2.5. Stevens Brook

Stevens Brook drains an area of approximately 14.7 square miles in Swanton, St Albans Town and City, joining with Jewett Brook in the Black Creek Swamp before emptying into St Albans Bay. Stevens Brook is considered to also be an "impaired" waterbody. From its mouth to river mile 6.8, the state has identified the pollutants of concern as sediment, nutrient, and *E. coli* bacteria, and has attributed these pollutants primarily to agricultural runoff. Within one to three years (roughly 2014-2016), the State of Vermont will develop a TMDL for Stevens Brook (VTDEC 2012). A TMDL for the upper section of Stevens Brook has already been developed; from river mile 6.8 upstream to river mile 9.3, the stream is designated as impaired by stormwater runoff. In addition, a one-mile section of Stevens Brook downstream of the CV Rail Yard is listed as impaired for sediment, oil, grease, and hydrocarbons as a result of fuel spills and historic management activity at the rail yard; however, development of a TMDL for this portion of Stevens Brook is over 8 years in the future (VTDEC 2012).

2.6. Other Watersheds in Swanton

Watersheds that are located partially within the Swanton Town, but which were not the focus of this project, include Fairfield Pond and Black Creek. Both of these watersheds are described briefly below.

2.6.1. Fairfield Pond

Fairfield Pond is a large pond (>20 acres) located in Fairfield, just across the Swanton town line. Less than three square miles in the southeast corner of Swanton drains to Fairfield Pond.

2.6.2. Dead Creek

Dead Creek flows a short distance through the southeast corner of Swanton from St Albans Town, and quickly crosses into Fairfield; in Fairfield, Dead Creek confluences with Black Creek, and ultimately with the Missisquoi River in Sheldon. The State of Vermont has identified Black Creek as a "water in need of further assessment" because of concerns over sediment, nutrient, and *E. coli* bacteria levels in the creek, and has attributed these pollutants primarily to agricultural runoff. In Swanton, Dead Creek is part of and then flows out of Fairfield Swamp, and thus its water quality is good overall.

3. EXISTING PLANS AND DATA

Numerous and varied groups and individuals have invested considerable effort in evaluating different components of Swanton's water resources, and the important interface between water resources and local land use decisions. Some evaluations have followed watershed boundaries, while others have followed political boundaries. The following sections identify evaluations completed over the past ten years, with emphasis on work most relevant to Swanton Town and Village and to future efforts to develop a list of strategic, prioritized

projects that could be undertaken to improve water quality in and around Swanton. A detailed review of each assessment is included as Appendix B of this report.

3.1. Watershed-Based Assessments

The assessments described below are generally led by the Agency of Natural Resources. These include:

- Basin planning, completed primarily to guide VTANR in its own work and in collaborative projects with the public, municipalities, and other State and federal agencies. The basin plans have a five-year scope. The draft *Missisquoi River Basin Water Quality Management Plan* (VTANR, 2013) covers more than three-quarters of Swanton's land area; the remainder is covered by the *Water Quality Management Plan for the Northern Lake Champlain Direct Drainages* (VTANR, 2009). In addition, in 2008, USDA's Natural Resource Conservation Service (NRCS) completed the *Missisquoi Areawide Plan*, a watershed-based plan specifically structured to inform and help guide the conservation efforts of partner agencies and cooperating farmers.
- Critical source area (CSA) evaluation, to identify areas of the landscape that absent proper management are likely to produce disproportionate amount of phosphorus loading to adjacent waterways. In 2011, detailed data about the distribution of potential CSAs of phosphorus pollution in the Missisquoi watershed were developed using a Soil and Water Assessment (SWAT) model.
- Stream geomorphic assessments (SGA), undertaken to understand the natural tendencies of a particular reach of stream or river, its current condition, and what changes may be anticipated in the future. Stream geomorphic assessments have been completed for Stevens Brook, Jewett Brook and Hungerford Brook within Swanton.
- Water quality monitoring, including biological assessments. At least one year of assessment data has been collected at two different locations on Hungerford Brook in Swanton. In addition, as part of the Lake Champlain Long-Term Water Quality Monitoring Program a USGS gaging station is being operated on the Lower Missisquoi River in Swanton.
- TMDL development, to establish the maximum amount of a pollutant (e.g., bacteria, nutrients, excess stormwater flows) that a waterbody can assimilate and still meet the state-established water quality standards. They are based on the relationship between pollution sources and in-stream water quality conditions. A TMDL addresses a single pollutant or stressor for each waterbody. The previously approved Lake Champlain phosphorus TMDL is currently under review by EPA Region 1.
- Stormwater infrastructure mapping and illicit discharge detection and elimination work was completed with the support of VTDEC for six communities in the Missisquoi River watershed, including Swanton, in 2009-2010

3.2. Town-Wide Assessments and Programs

In addition to the watershed-based assessments, a number of pieces of data are developed on a municipality-by-municipality basis that are important to any effort to develop a list of strategic, prioritized projects that could be undertaken to improve local water quality. These include direct feedback from the Town, work by the Vermont Agency of Transportation (VTrans), and past and current planning initiatives, specifically:

- During meetings a series of meeting that included the now-retired Town Administrator, his replacement, the Village Manager and the Town Road Foreman, a list of potential problem areas was identified. These include both areas where there are current concerns, such as localized flooding or erosion, and areas of future concerns particularly where new development may be concentrated. These areas were investigated at potential problem areas and documented, as appropriate, in Appendix C.
- VTrans-sponsored programs, including routine inspections of bridges and culverts and grant opportunities provided by the Better Backroads Program, have identified a number of potential projects to protect existing infrastructure whose implementation would also improve stormwater management.
- Swanton's Town Plan both recognizes the important role that the Missisquoi River has and continues to play in the development of Swanton and also makes specific recommendations for actions needed to ensure that "the water quality of Lake Champlain and its tributaries are protected for the enjoyment of present and future generations."
- Swanton's zoning regulations include stormwater management standards that directly reference the VT ANR Stormwater Management Manual; the regulations do not currently include specific support for low impact development (LID) stormwater management strategies. There are provisions of Swanton's regulations that may unintentionally create unnecessary impervious surface (and therefore stormwater runoff), including requirements for 16-foot minimum driveway widths and 20-foot minimum lengths for parking spaces.

4. STORMWATER PROBLEM AREAS

One of the goals of this Plan is to "develop a comprehensive list of stormwater problems". To achieve this goal, a thorough effort was made to identify existing problem areas, and then to evaluate existing conditions and potential solutions.

4.1. Identification of Problem Areas

The first task was to identify the location and nature of existing drainage problems, and where appropriate, to gather field data for further analysis. The approach to identifying potential problem areas included the following elements:

- Reviewing existing plans and data, as described in Section 3 above, and noting the location of any concerns related to stormwater
- Engagement with local officials, including:
  - March 7, 2012 kick-off meeting with the Town Administrator (now retired) and the Village Manager
  - March and April 2012, written responses from the Town Administrator and the Village Manager in reply to our questions about problem areas
  - May 22, 2012 meetings with the new Town Administrator and with the Road Foreman

- June 15, 2012 meeting with the Village Manager

- Targeted site visits to verify problems areas (May and June 2012)
- Documentation (with photos) of existing problem areas

A "problem area data sheet" was developed and used as a guide to ensure consistent information was collected as site visits were completed. More than 33 potential problem areas were identified and geo-located. The data sheets for all of the problem areas identified in Swanton Town and Village are provided in Appendix C of this report.

4.2. Evaluation of Problem Areas

Working from the list of potential problem areas, the Consultant Team visited each potential problem area to directly observe the site. Where an unresolved problem was found, photos were taken of any areas of active erosion, as well as any observations about the source or cause.

Each problem area was given a score, with the intent of generally assessing the severity of existing problems, removing low priority problem areas from the dataset, and providing general guidance on the relative order in which the problems should be addressed when considered town-wide. Scores were assigned as follows:

Level	Classification
1	Outside of project scope.
2a	Stable, no urgency.
2b	Stable, but problem could escalate with future change in surrounding land use.
3	Small to moderate erosion and/or drainage problems are present; issues could be readily addressed.
4	Significant erosion and/or drainage problems are present; issues may be readily addressed.

4.3. Conceptual Solutions to High Priority Problem Areas

The 15 problem areas that were assigned a Level 3 or 4 classification were subject to more detailed investigation. The first phase of the detailed investigation involved desktop analysis to determine:

- Drainage area contributing to the known problem,
- Underlying soils, with particular attention to the presence of highly erodible soils (e.g., $k > 0.17$),
- Location of any existing stormwater infrastructure,
- Proximity to the nearest surface water feature,
- Whether the Town or Village identified the area for planned future growth, and
- Potential location or locations most suitable for stormwater treatment practices, taking into account topography and existing development (if any).

A map of each high-priority problem area including all of these features was prepared (Appendix D). These sites were revisited to further investigate treatment potential and gather information for conceptual solutions, including more detailed information on the contributing drainage area, soil conditions, and traffic and

pedestrian flow. These data were collected in order to better evaluate anticipated water quality benefits and constructability. In some locations, several areas were grouped together because of the inter-related nature of the stormwater management needs. In other locations, conceptual solutions were not developed for one of the following reasons:

- The stormwater concerns involve issues where it would be not be appropriate for the Village or Town to assume a leadership role (e.g., private property);
- The stormwater concern did not rise to the level of demanding immediate action.

In total, eight conceptual solutions were developed. Each of the conceptual solutions is described in the report sections that follow, while the complete analyses are presented in Appendix E.

4.3.1. Swanton Village Municipal Complex

Stormwater from three acres of impervious surface at the Swanton Village Municipal Complex could be routed to potential stormwater treatment practices (STPs) located as shown yellow in Figure 1. Areas of impervious surface that are considered to be treatable are highligted in blue in Figure 1. Predominant soil types are Windsor loamy fine sand (HSG A) with a deep water table, meaning there is potential to soak away a large amount of stormwater that is currently draining from this property.

The existing swales along Elm St. could be retrofitted to provide relatively simple, yet effective infiltration-based STPs. The presence of underground utilities in the area will need to be fully and carefully investigated as part of any design.

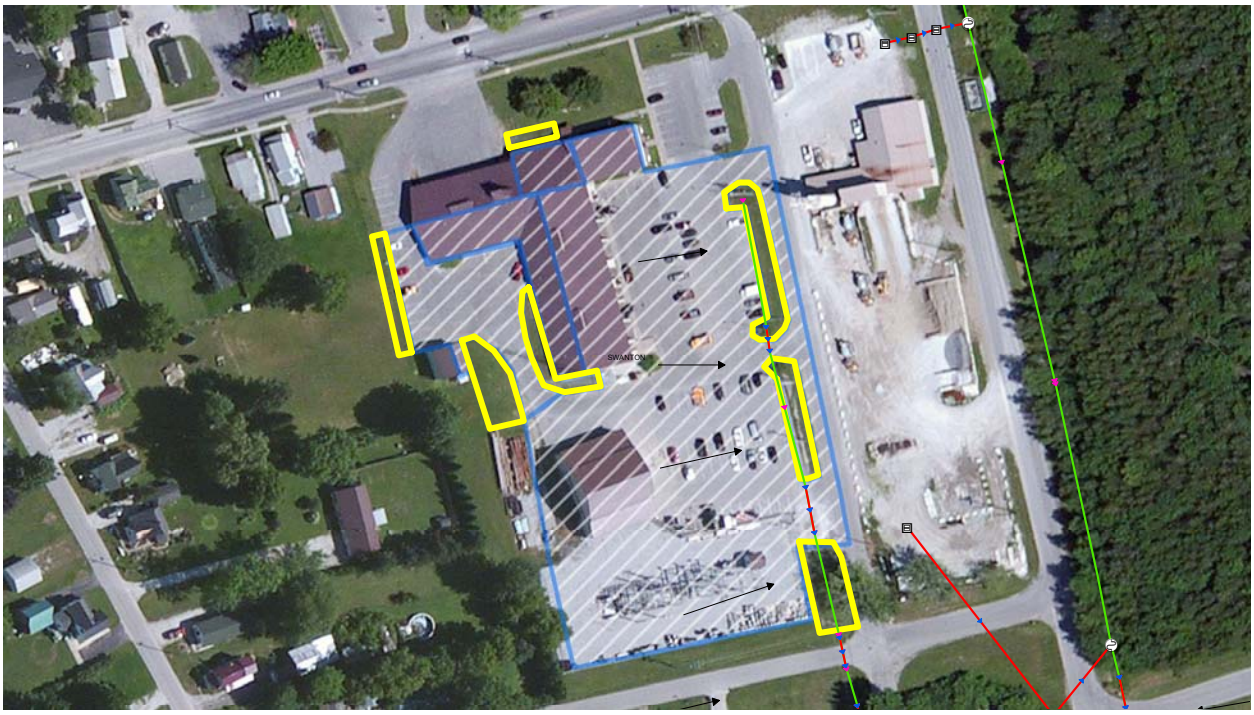

Figure 1. Swanton Village Municipal Complex: Treatable impervious areas are highlighted in blue, while locations for potential treatment practices are highlighted in yellow.

4.3.2. I-89 Exit 21 Interchange (Town)

Green space within and adjacent to the I-89 Exit 21 interchange could accommodate the construction of stormwater treatment practices. The diamond interchange at Exit 21 includes a stormwater conveyance system that drains the highway. The 30-acre subwatershed includes 3.8 acres of impervious surface. The large amount of open space and existing conveyance structures simplify design and construction efforts required to implement a stormwater treatment practice at this location. A storm water treatment practice similar to that which was recently constructed in the highway median at I-89 Exit 20 could be effective here.

The most suitable practices are likely to be bioretention and filtration systems that include an underdrain. Soils are reported by the USGS to be Georgia stony loam and Massena stony loam, Hydrologic Soil Group (HSG) C with high water tables. These characteristics mean that infiltration cannot be expected to be a suitable treatment practice. Additionally, roadway subsoil strength can be affected by saturated soils. The proximity of the roadway further supports the need for non-infiltration-based systems.

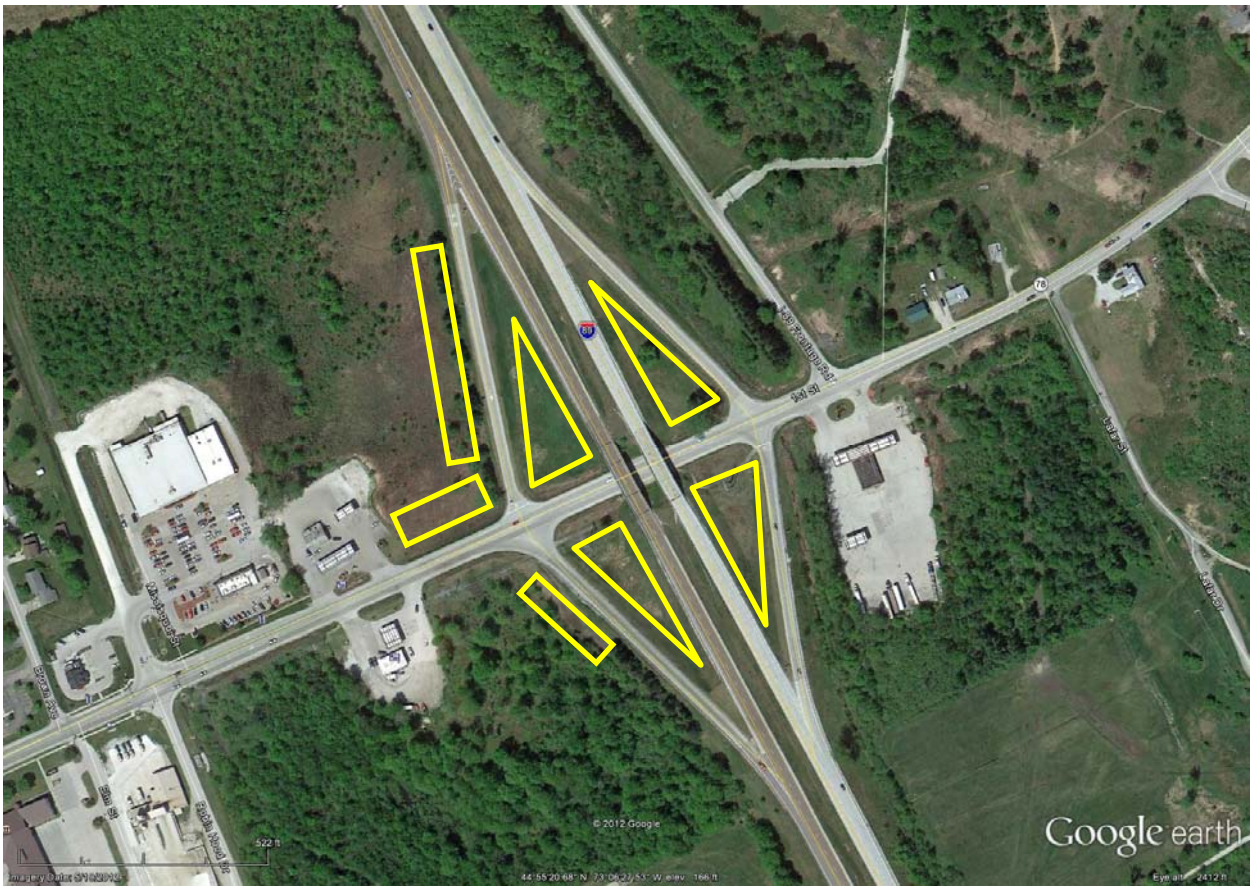

Figure 2. I-89 (Exit 21)-VT RT 78 Interchange. Potential sites for stormwater treatment practices highlighted in yellow.

4.3.3. Taylor Drive (Village)

Taylor Drive is a residential street with a large cul-de-sac that includes a median that is well-suited for stormwater treatment. Currently, water drains from the street and some of the adjacent residential lots toward the cul-de-sac where it is collected in catch basins along the existing curb.

The reported soil types in the area are Windsor loamy fine sand (HSG A) with a deep water table. This means that infiltration practices could be used to soak away a large portion of stormwater runoff from this neighborhood. Curb cuts could allow stormwater to drain to a potential stormwater treatment practice within the green space at the center of the cul de sac.

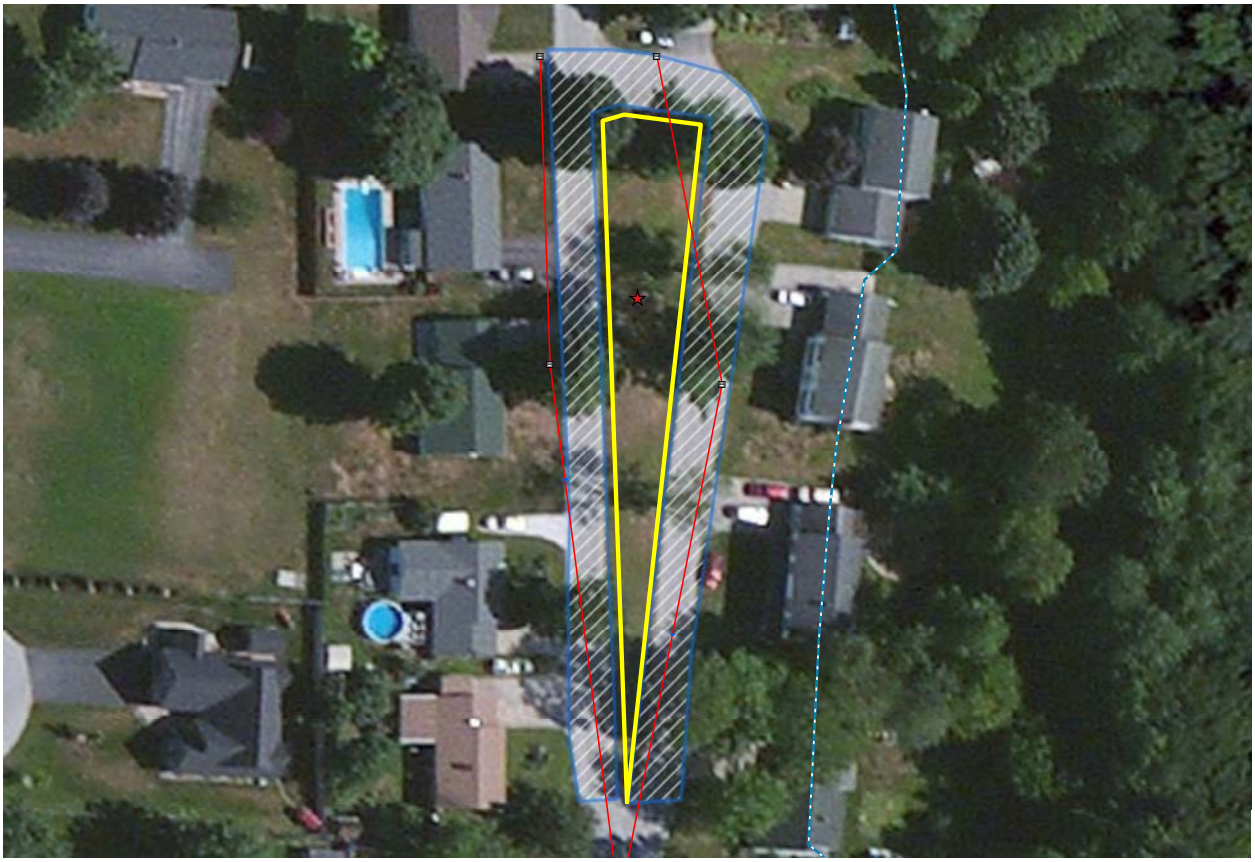

Figure 3. The Taylor Drive cul-de-sac offers ample treatment opportunity (shown in yellow). The contributing impervious area is outlined in blue.

4.3.4. Brooklyn Road at Route 78 (Town)

Stormwater runoff from approximately 22 acres drains to a culvert at the corner of Route 78 and Brooklyn Rd., where the Fournier business is located. This 22-acre subwatershed includes 7.1 acres of impervious surface (approximately 3.6 acres of roof tops and asphalt, and 3.5 acres of compacted gravel surface). Stormwater from this subwatershed appears to receive no treatment before being routed through two culverts under Route 78 and discharged to the Missisquoi River.

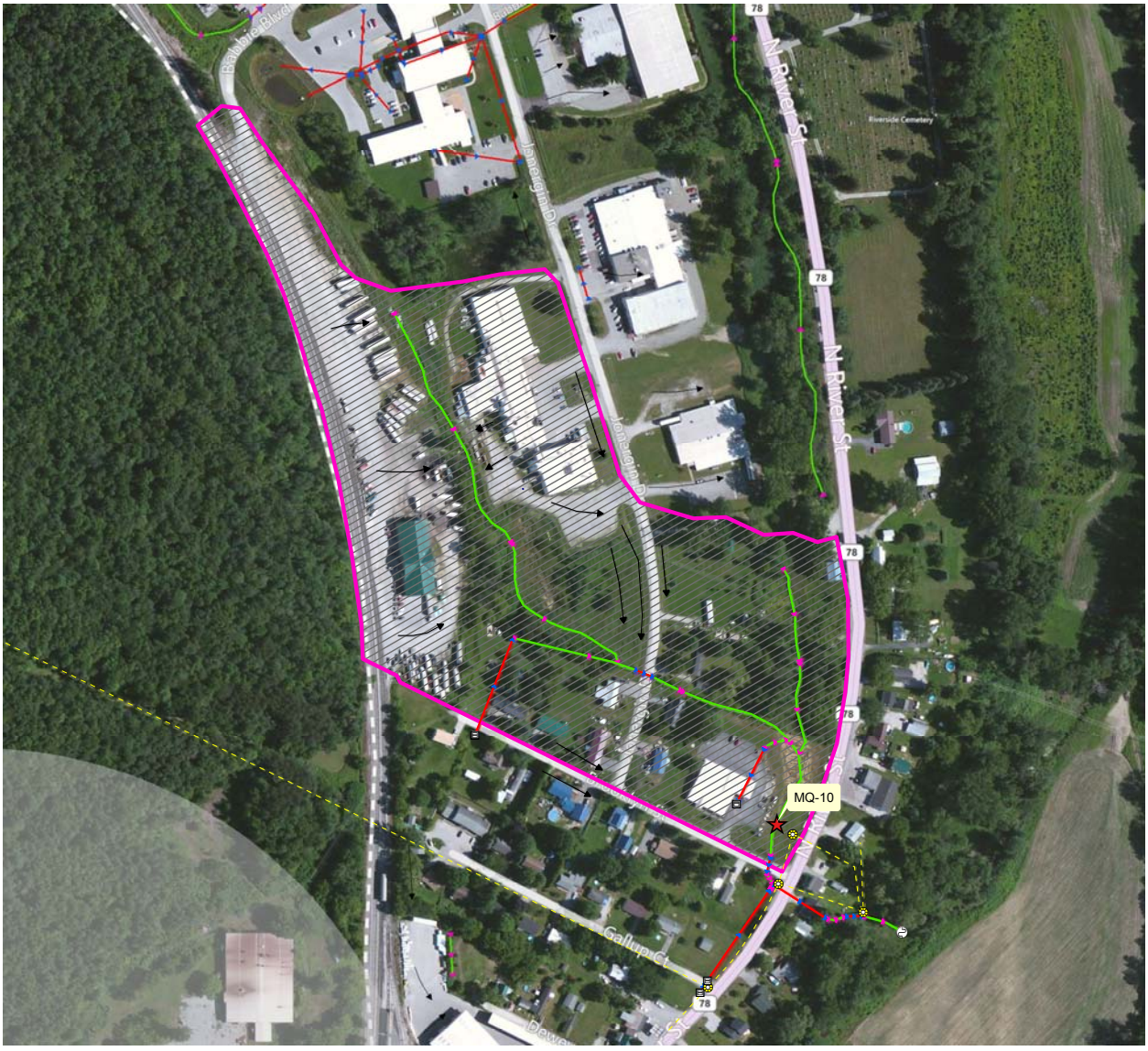

Figure 4. Subwatershed draining to a culvert at the southeast corner of the Fourniers Door and Window business at the corner of Rt. 78 and Brooklyn St.

4.3.5. Franklin Northwest Supervisory Union (Town and Village)

Potential stormwater treatment opportunities exist along the Swanton Recreation Path near Robinhood Drive. The subwatershed contains portions of the Swanton Elementary School and former Robinhood Ammunition plant property. The 10.5 acre subwatershed includes 3.2 acres of impervious surface (1.4 acres of roof tops and 1.8 acres of compacted gravel). The remainder of the subwatershed consists primarily of athletic turf on the school property. Athletic fields are often highly compacted and can have low infiltration rates. Stormwater drains north to a swale that flows to the northeast along the south side of the recreation path. From the end of this swale, stormwater flows through approximately 0.5 miles of storm sewer and open channel conveyance to the Missisquoi River.

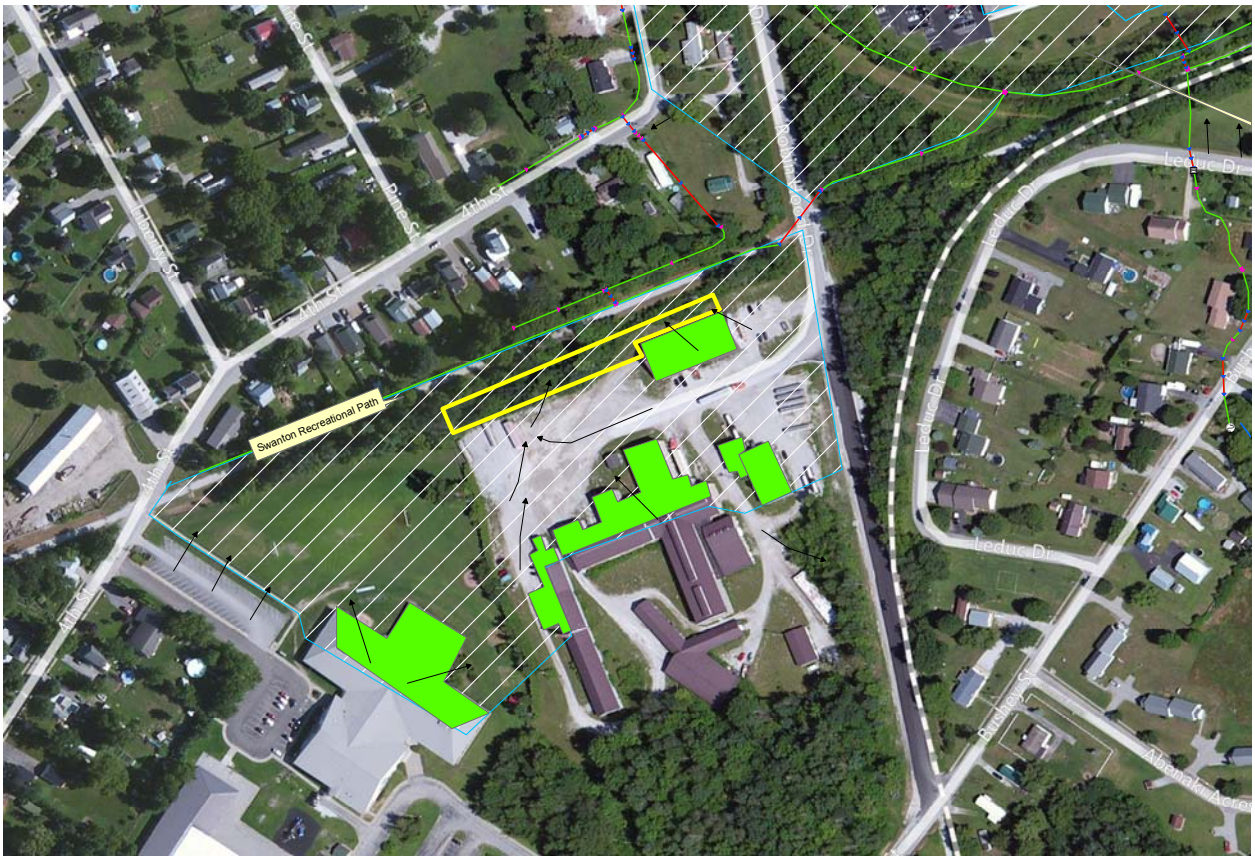

Figure 5. Drainage area at and around Swanton Elementary School: location for potential STP shown in yellow. Portions of rooftop that drain toward the potential STP are highlighted in green.

4.3.6. Jonergrin Drive Industrial Area (Town)

The industrial area along Jonegrin Dr. and Babbie Blvd. includes a significant amount of impervious area; 3.9 acres within the subwatershed have been identified as potentially treatable. Stormwater runoff from this subwatershed makes its way to the Missisquoi River with no retention and little, if any, treatment. Many options have been identified for location of STPs as shown by the yellow highlight in Figure 6. Stormwater from a large segment of the industrial development near Jonegrin Dr. and Babbie Blvd. is untreated and drains to the Missisquoi River. Massena stony loam and Raynham silt loam are the predominant soil types in this area. Both soils are reported to be HSG C with a shallow water table. Infiltration practices will not be a likely option. However, many opportunities exist for retrofitting the existing stormwater infrastructure with filtration-type treatment practices.

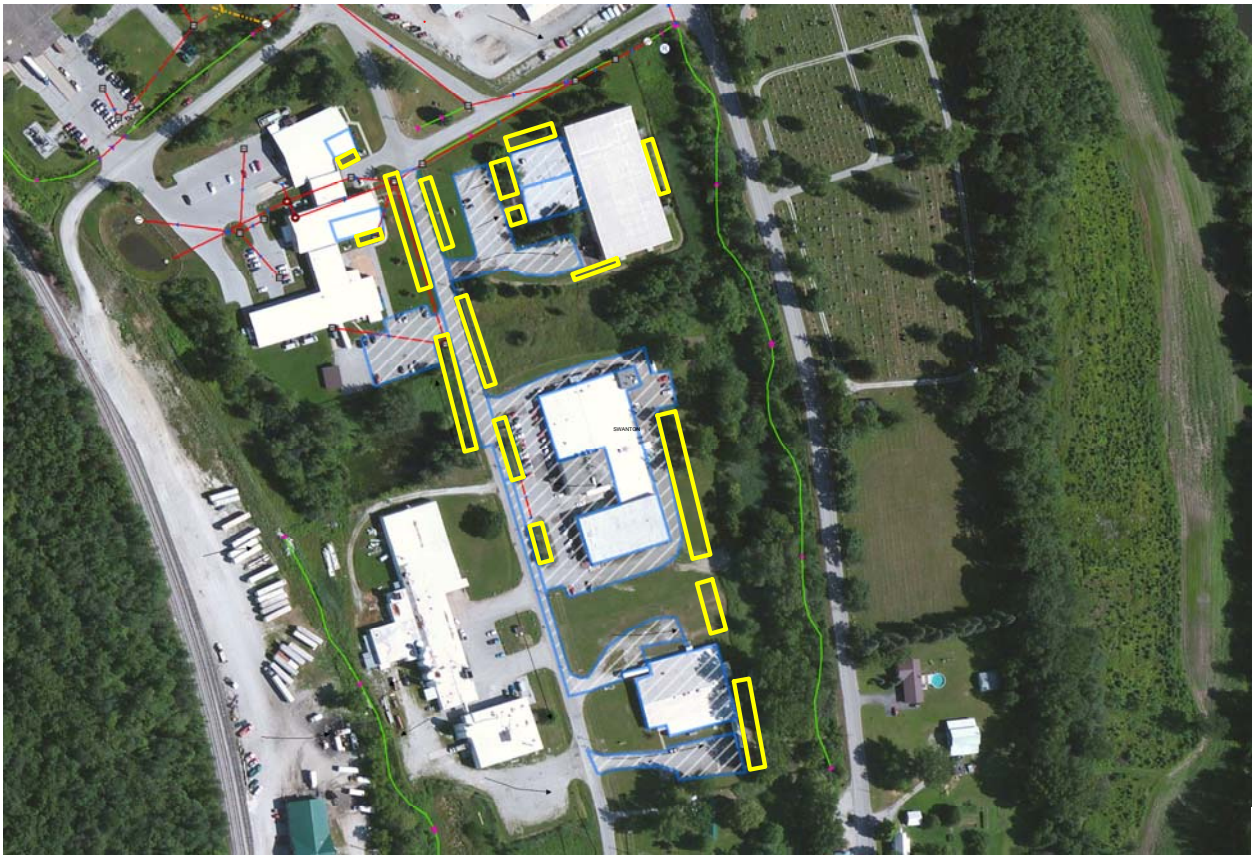

Figure 6. Stormwater from a large segment of the industrial development near Jonegrin Dr. and Babbie Blvd. is untreated and drains to the Missisquoi River.

4.3.7. Thibault Parkway (Village)

A catch basin adjacent to Thibault Parkway could be retrofitted and utilized as part of an STP, such as a simple rain garden. Site conditions, including Windsor loamy fine sand (HSG A) and a deep water table, would enable detention and infiltration of a significant portion of stormwater runoff from 0.04 acres of impervious surface draining to the existing catch basin.

Figure 7. Stormwater treatment opportunity at corner of Thibault Parkway and Spring Street

4.3.8. Greenwich Avenue (Village)

Two existing catch basins on Greenwich Avenue between 2nd St. and Platt St. are well-situated to be utilized as part of stormwater treatment practice. Approximately 0.4 acres of Greenwich Ave. drains toward the center of the block where stormwater is collected by two existing catch basins on either side of the street. The predominant soil type is reported to be Windsor loamy fine sand (HSG A) with a deep water table. This means that there is potential to soak away a large portion of the stormwater draining from this neighborhood. The existing catch basins could then act as overflow relief for an infiltration-based STP.

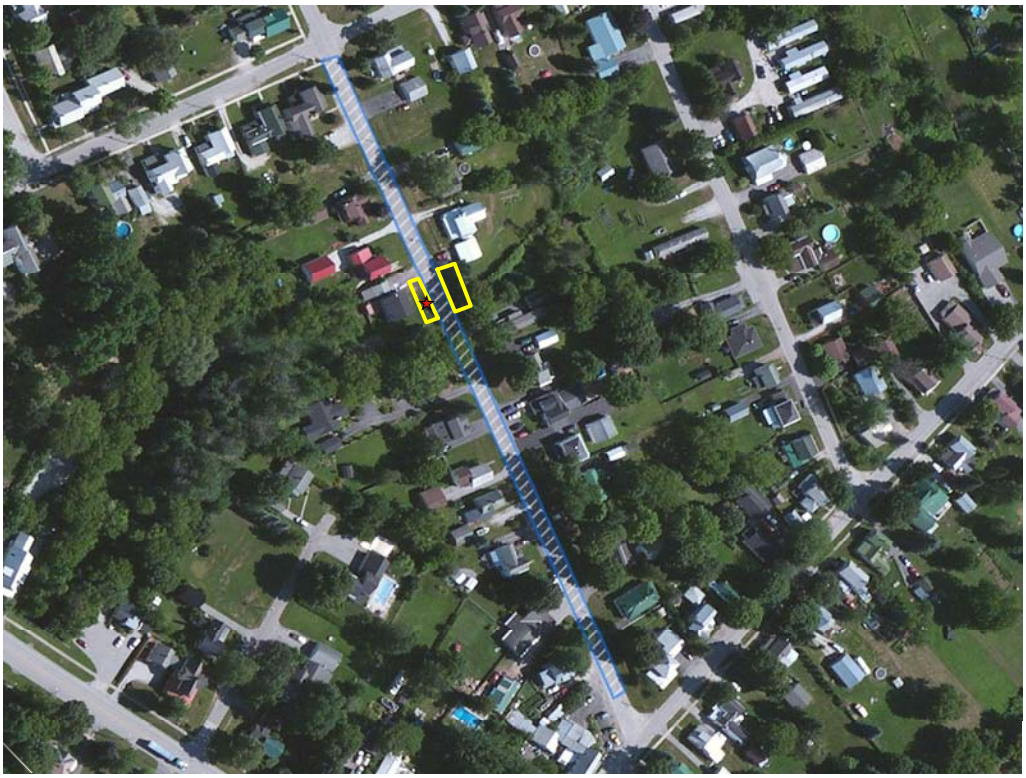

Figure 8. Greenwich Ave. drains to two existing catch basins near the middle of the block where two STPs could be located.

4.3.9. Grand Avenue (Village)

Stormwater runoff from 0.3 acres of Grand Ave., between Farrar St. and Furman Place, could be treated before draining to existing catch basin in the green strip. Stormwater drains toward the center of the block from both directions. Catch basins between the street and sidewalk collect stormwater on either side of Grand Ave. The predominant soil type is Windsor fine sand (HSG A) with a low water table. Given the well-drained soils and position of existing catch basins, stormwater from this section of Grand Ave., could be treated with an infiltration-based STP.

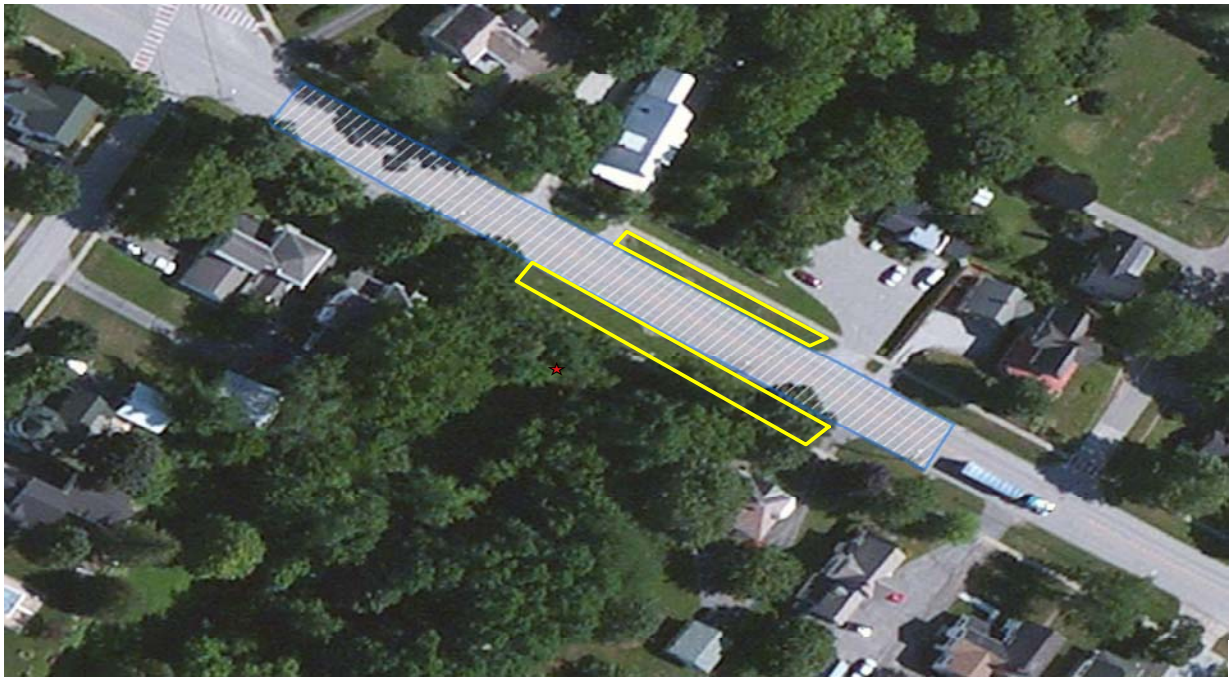

Figure 9. Grand Ave. stormwater could be treated with infiltration practices located between Farrar St. and Furnam Pl.

4.3.10. Marble Mill Park (Village)

A significant portion of the stormwater runoff from the closed drainage system in Swanton Village is piped to Marble Mill Park, where it is discharged without treatment to the Missisquoi River. The area of the park near this outfall also contributes untreated runoff to the Missisquoi, including active erosion in the road and path leading to the park, runoff from the parking lot, and a washout leading from the park to the river's edge hear the outfall. The Village previously worked with the Northwest Regional Planning Commission to obtain grant funding from VT DEC to develop a comprehensive solution for stormwater management at Marble Mill Park, and a design has been prepared. Unfortunately the Village has faced a number of challenges in seeing the design implemented, including concerns raised over any construction activity within the 100-year floodplain of the Missisquoi, and nothing has been built to date.

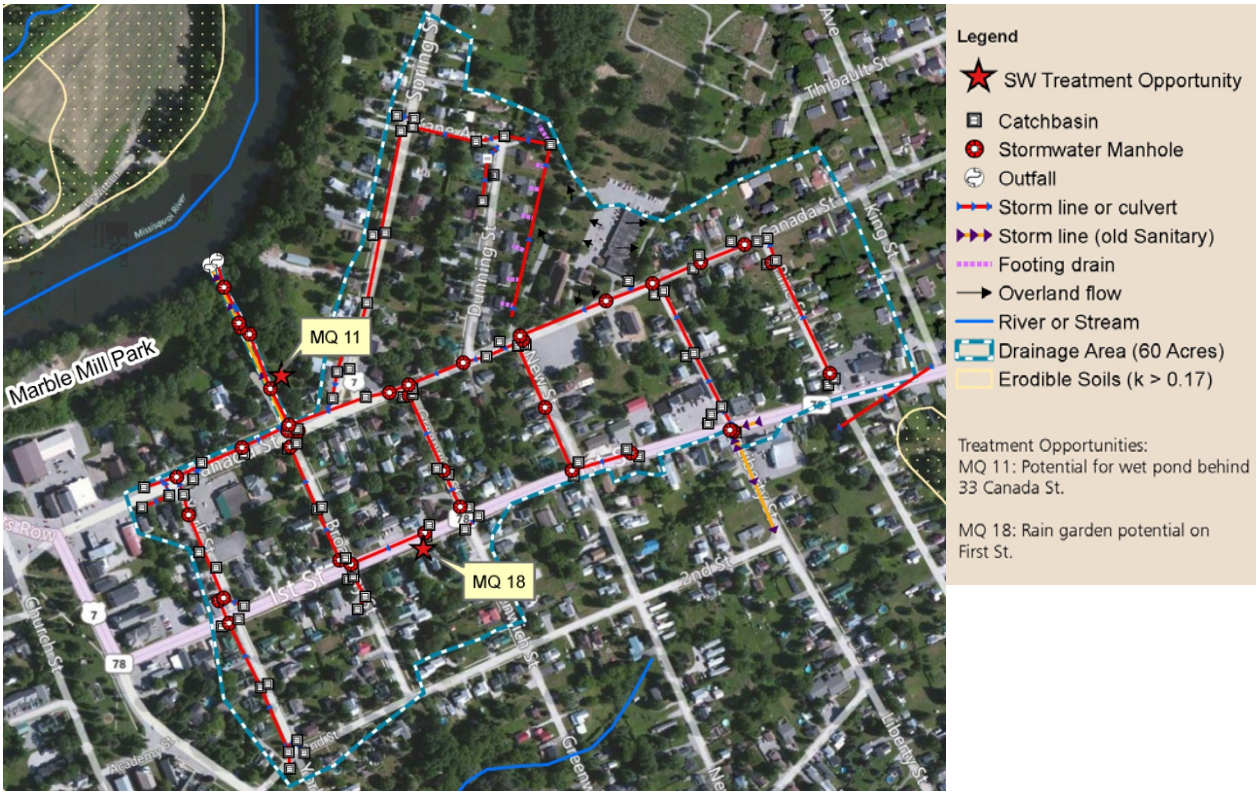

Figure 10. Marble Mill Park problem area, with areas of identified issues highlighted in red.

5. NEXT STEPS

This document represents an extensive effort to identify and evaluate potential stormwater problem areas throughout Swanton Town and Village. Several high priority potential stormwater improvement projects were identified that the Village and Town could either pursue directly, or could work with local landowners to address. Detailed information about these high priority projects can be found in Appendix E.

In addition to exploring opportunities to address current stormwater management needs, Swanton can also take steps to prevent future stormwater problems by expanding how stormwater management is addressed in zoning

regulations. Specifically, Swanton could consider incorporating one or more of the following elements into the zoning regulations:

- Require a certain amount of stormwater runoff be treated, as part of all development and redevelopment projects; and.
- Articulate a clear preference for low impact development practices that seek to infiltrate and soak away, as opposed to store and release, stormwater runoff into the land use and development regulations.

Some specific examples of how this might be accomplished include:

- Modifying access requirements to minimize impervious surfaces. Thoughtful siting and design of streets helps achieve stormwater control "at the source," which means less runoff requiring management and less impact on downstream waterbodies. Further, reducing paving lowers development and maintenance costs.
    - Swanton's current land use development regulations require "when a right-of-way serves more than one dwelling, it shall be… a minimum of 16 feet wide" and that cul-de-sacs be built with "a minimum 50 foot radius, 100 foot width, 16 foot drive width."
        - Consider reducing the minimum width for a private right-of-way serving up to four houses to 9 feet.
        - Strategies that would reduce the imperviousness of cul de sac design include reducing the required radius (to 30 or 35 feet), incorporating a landscaped island into the center of the cul-de-sac that can be used to treat stormwater, or creating a T-shaped (or hammerhead) turnaround.
- Revising parking standards to encourage minimal use of impervious surface. For example:
    - Reduce the stall length to 18 feet (or less) for a standard parking space, from the current 20 feet.
    - Recommend or require smaller stalls for compact cars, up to 30% of total number of parking spaces.
    - Re-evaluate specified parking minimums to prevent the creation of surplus amounts of parking. This could involve establishing maximum parking requirements that closely mirror or are slightly less than current minimum parking requirements, and providing a minimum parking requirement that is anywhere from 20-80% of the maximum depending on the associated use. Using a minimum and maximum effectively creates a range of acceptable parking requirements thereby providing the development community a chance to be more flexible and efficient in their design.

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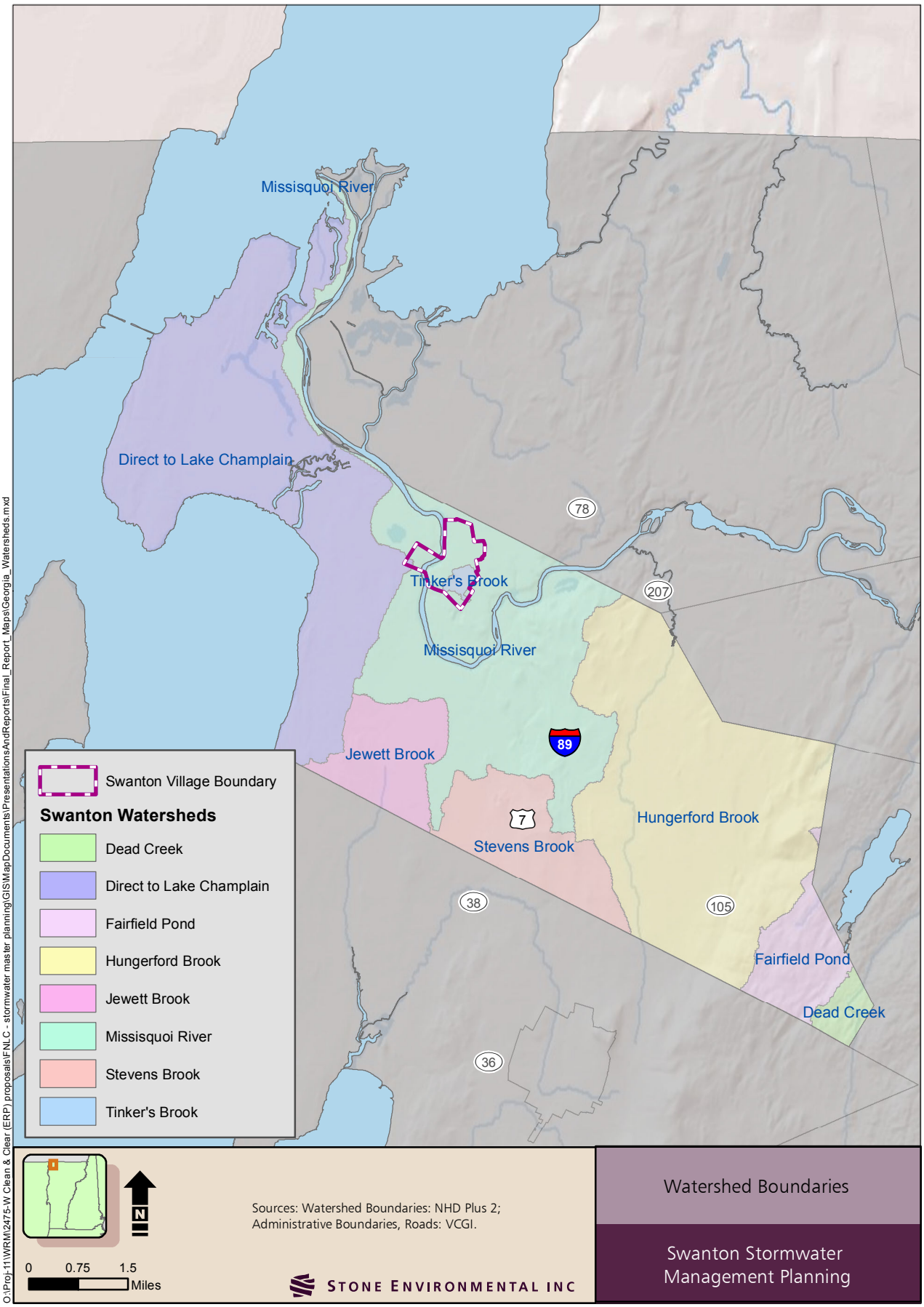
APPENDICES

APPENDIX A: WATERSHED MAP


Missisquoi River
Direct to Lake Champlain
78
Tinker's Brook
207
Missisquoi River
89
Jewett Brook
7
Hungerford Brook
Stevens Brook
38
105
Fairfield Pond
Dead Creek
36
Swanton Village Boundary
Swanton Watersheds
Dead Creek
Direct to Lake Champlain
Fairfield Pond
Hungerford Brook
Jewett Brook
Missisquoi River
Stevens Brook
Tinker's Brook
N
0
0.75
1.5
Miles
Sources: Watershed Boundaries: NHD Plus 2;
Administrative Boundaries, Roads: VCGI.
STONE ENVIRONMENTAL INC
Watershed Boundaries
Swanton Stormwater
Management Planning
O:\Proj-11\WRM\2475-W Clean & Clear (ERP) proposals\FNLC - stormwater master planning\GIS\MapDocuments\PresentationsAndReports\Final_Report_Maps\Georgia_Watersheds.mxd

APPENDIX B: STORMWATER MANAGEMENT PLANNING LIBRARY

STORMWATER MANAGEMENT PLANNING LIBRARY

TOWN AND VILLAGE OF SWANTON, VERMONT

April 13, 2012

Revised February 8, 2013

Prepared for:

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STONE ENVIRONMENTAL INC

Table of Contents

1. BACKGROUND

Water knows no political boundaries. As such, evaluations of water quality tend to be undertaken along watershed boundaries and to involve land areas in multiple municipalities, counties, and, in the case of the Missisquoi River, countries. For example, the Missisquoi River watershed area includes part or all of twenty northern Vermont communities in three counties. Although from a strict water quality perspective it would be ideal to manage our water resources along watershed lines, the reality is that many decisions, in particular decisions about land use, are made at the local level. This report is designed to summarize the information currently available from the suite of reports that speak to water quality in the various rivers, lakes, and streams that pass through or are located wholly within the Town and Village of Swanton, Vermont. Although water quality assessment data dating back to the early 1970s is available for the Missisquoi River watershed, this summary focuses on assessments and reports that have been prepared in the past twenty years. It is hoped that this report will serve as the basis for developing a Swanton-specific list of strategic, prioritized projects that could be undertaken to improve water quality.

2. INTRODUCTION

The Town of Swanton is located in Franklin County in northwest Vermont with a total area of 61.7 square miles, including more than 20 miles of Lake Champlain shoreline. Swanton Village has an area of 0.8 square miles and is located wholly within the Town of Swanton. The total population of the Town was 6,427[1] as of the 2010 census; approximately 2,386[2] of the Town's residents live within the Village boundaries. The Town and Village of Swanton have multiple rivers and streams within their boundaries which drain either to the Missisquoi River or directly to Lake Champlain.

The Missisquoi River has branches beginning in both Vermont and Canada and flows for 80 miles until it empties into Missisquoi Bay in Lake Champlain, passing through the Town and Village of Swanton. The Hungerford Brook starts in St. Albans Town, Vermont and flows north through Swanton until it reaches the Missisquoi River in Highgate, Vermont. Hungerford Brook, while not on the State of Vermont's list of impaired waters as defined by section 303(d) of the federal Clean Water Act, is a stream whose watershed sees intensive agricultural land use, which contributes to high sediment loads and streambank instability. The upper watersheds of both Jewett and Stevens Brooks also reach into the Town of Swanton and then flow south through the Town of St. Albans to St. Albans Bay. Eastern portions of Swanton drain to either Fairfield Pond or Black Creek.

[1] http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk

[2] http://censusviewer.com/city/VT/Swanton

Oxbow Lake, a true oxbow of the Missisquoi River, is located in Swanton. No water quality data are available for the pond. The most recent aerial orthophotograph shows this pond to be surrounded on all but the southern shore by active agricultural land.

The Town of Swanton also has a significant amount of frontage along Lake Champlain. Portions of northern Lake Champlain, including Missisquoi Bay, show profound effects of ongoing sediment and nutrient pollution, including recurrent algae blooms and nuisance plant growth. A 2007 basin-wide study of the sources of pollution in Lake Champlain found that stormwater runoff from developed areas and agricultural runoff are the primary sources of Lake Champlain pollution[3]. There are also several small, unnamed streams that drain portions of Swanton directly to Lake Champlain.

Numerous and varied groups and individuals have invested considerable effort in evaluating different components of Swanton's water resources and the important interface between water resources and local land use decisions. At times, these evaluations have followed watershed boundaries and at other times they have followed political boundaries. The following sections identify evaluations that have been done to date and pull out the pieces that are 1) most relevant to the Town and Village of Swanton and 2) most relevant to future efforts to develop a list of strategic, prioritized projects that could be undertaken to improve water quality.

3. WATERSHED-BASED ASSESSMENTS

The ongoing assessments described below are generally led by the State of Vermont's Agency of Natural Resources (ANR). These include:

- Basin planning efforts, whose main purpose is to guide ANR in its own work and in collaborative projects with the public, municipalities, and other state and federal agencies. The basin plans have a five-year scope. There are two basin plans that cover different areas within Swanton.
- Stream geomorphic assessment work, undertaken to understand the natural tendencies of a particular reach of stream or river, its current condition, and what changes may be anticipated in the future. Stream geomorphic assessments have been completed for two stream/river segments within Swanton: Hungerford Brook and Jewett Brook.
- In-stream water quality assessment work, including the watershed load monitoring program and biological assessments.

[3] http://www.lcbp.org/techreportPDF/54_LULC-phosphorus_2007.pdf

3.2. Missisquoi River Watershed Water Quality Management Plan[4]

The Missisquoi River Basin Water Quality Management Plan identifies water resource concerns within the more than 619 square miles of Vermont that drains to the Missisquoi River, and identifies opportunities for sustaining and improving water quality and aquatic habitat. In addition to the plan, ANR also published a draft set of preliminary strategies to address water quality and aquatic habitat concerns in the Missisquoi River Basin. The primary focus of the strategies is addressing nonpoint source pollution threats to surface waters, wetlands, lakes and ponds, and streams throughout the Missisquoi watershed.

In 2010, ANR's Watershed Management Division began revising basin plans to include more tactical strategies[5], meaning that plans will be updated to included objectives, prioritized strategies, benchmarks, and tasks in order to facilitate their implementation. Priority will be given to sub-basins for direct remediation actions where there are severe water quality problems or in areas of excellent condition that need more protection. Additional tactical strategies are likely to be incorporated into the Missisquoi Basin Plan as it is moved to completion. The Northwest Regional Planning Commission recently completed a series of edits to the draft plan.

The draft Missisquoi River Basin Plan identifies the following specific concerns for Hungerford Brook and the Lower Missisquoi River, as described below:

- Lower Missisquoi River, from the mouth upstream to Swanton dam, is considered to be impaired for fish consumption due to mercury contamination from atmospheric deposition.
- Missisquoi River (whole length), is considered to be stressed from high sediment loads, turbidity, nutrient enrichment, and increased water temperature, likely from agricultural land uses, loss of riparian vegetation, and streambank erosion.
- Hungerford Brook is considered to be stressed by nutrients, sediment, and turbidity likely caused by agricultural activities.

3.3. Northern Lake Champlain Direct Drainages Water Quality Management Plan[6]

Portions of the Town of Swanton fall outside the Missisquoi River watershed and thus are not covered by the Missisquoi River Basin Plan. These areas drain directly to Lake Champlain and are therefore included in the Northern Lake Champlain Direct Drainages Water Quality Management Plan ("Basin 5 Plan"). The Basin 5 Plan includes areas draining directly to the Lake beginning at the Ferrisburgh/Charlotte town line and ending at the Canadian border, and all Vermont surface waters that drain directly into this section of the Lake, except for

[4] http://www.vtwaterquality.org/mapp/docs/mp_basin6assessmntrpt.pdf

[5] http://www.vtwaterquality.org/wqd_mgtplan/swms_planningprocessintro.htm

[6] http://www.vtwaterquality.org/planning/docs/pl_basin5.Finalplan.pdf

three major river watersheds: the Missisquoi (including the Rock and Pike Rivers), the Winooski, and the Lamoille river watersheds. ANR approved the Basin 5 Plan in October 2009.

The Basin 5 Plan does not identify strategies specific to any particular waterway but rather outlines a series of broad-based strategies that could be considered. These include recommendations for enhancing efforts to protect stream corridors, improve stormwater management, reduce agricultural pollution, and prevent the spread of aquatic invasive species.

3.4. Links Between Geomorphic Condition, Water Quality, and Phosphorus Loading in Hungerford Brook, Vermont (Dani Newcomb)[7]

A 2007 masters thesis developed by a University of Vermont Rubenstein School student examined the links between geomorphic condition, water quality, and phosphorus loading in Hungerford Brook. Specifically, the thesis focuses on:

- The impacts of land use at the watershed and near-stream scales on total suspended solids, total phosphorus, and soluble reactive phosphorus.
- The link between geomorphic condition and phosphorus and sediments in the Hungerford Brook watershed as the spatial scale varies.
- The contribution of soil phosphorus in stream banks to the total phosphorus load in Hungerford Brook.

The results of the study found that in Hungerford Brook:

- Phosphorus and sediment transport happens mainly during storm events and that concentrations greatly exceed the state standards.
- Phosphorus concentrations are significantly lower at the mouth of Hungerford Brook than upstream in the subwatershed, indicating that deposition is occurring in the downstream subwatersheds.
- Agricultural land use is closely associated with stream instability.

3.5. Missisquoi Areawide Plan (Natural Resource Conservation Service)[8]

In 2008, the NRCS completed the Missiquoi Areawide Plan, a watershed-based plan designed to reduce the phosphorus load delivered to Missisquoi Bay. The document was structured to inform and help partner agencies and cooperating farmers. The Areawide Plan consists of a series of water quality improvement strategies that target efforts to specific priority areas. The strategies were developed in consultation with local

[7] http://www.lcbp.org/PDFs/IJC_MBBP/P_loading_Hungerford_Brook.pdf

[8] http://www.lcbp.org/PDFs/IJC_MBBP/Missisquoi_Areawide_plan.pdf

stakeholders and representatives of various state and federal agencies. The Areawide Plan was designed to help move conservation implementation actions away from a "first come, first served basis" in order to target financial and technical resources to the areas of the watershed with the greatest conservation need. The plan includes a considerable amount of geospatial data, including information on farmstead location, annual crop and hay lands, and the adjacency of cropland to areas with steep slopes.

3.6. Identification of Critical Source Areas of Phosphorus in the Vermont Sector of the Missisquoi Bay Basin[9] (Lake Champlain Basin Program, 2011)

Critical Source Areas are areas of the landscape that, absent proper management, are likely to produce disproportionate amount of phosphorus loading to adjacent waterways. Detailed data about the distribution of potential Critical Source Areas (CSAs) of phosphorus to Missisquoi Bay were developed using a Soil and Water Assessment (SWAT) model. The areas identified using this modeling approach were selected primarily by their soils, landscape features, proximity and connectivity to streams, and the land use or farm crop practices that are in place or are likely to be in place. To view this data in an interactive map, visit lcbp.stone-env.com.

From a stormwater management standpoint, phosphorous critical source areas are areas of development (including roads) with a high potential for stormwater runoff. In general, roads with steep grades are particularly vulnerable to runoff and likely to be identified as CSAs.

3.7. Stream Geomorphic Assessment Final Reports[10] (Vermont Department of Environmental Conservation)

Stream geomorphic assessments have been completed for two stream/river segments within the Town of Swanton: Hungerford Brook and Jewett Brook. The assessment results are designed to direct future stream corridor restoration and protection measures.

3.7.1. Hungerford Brook Phase 2 Geomorphic Assessment[11]

For the geomorphic assessment, Hungerford Brook was divided into twelve reaches; see Figure 1: Hungerford Brook Reach Map. Part or all of nine of these reaches are in the Town of Swanton. The goal of this study was to identify stream conditions, including sediment and nutrient inputs, channel constrictions, and other features. Common stressors found in the watershed were:

- Lack of woody buffers
- Accelerated erosion due to increased hydrologic pressure

[9] http://www.lcbp.org/PDFs/IJC_MBBP/LCBP_CSA_Modeling_Report_EN.pdf

[10] https://anrnode.anr.state.vt.us/SGA/finalReports.aspx

[11] https://anrnode.anr.state.vt.us/SGA/report.aspx?rpid=28_P2A&option=download

- Undersized culverts
- Straightened channels
- Drainage of wetlands

3.7.2. Jewett Brook Phase 1 Geomorphic Assessment[12]

For the geomorphic assessment, Jewett Brook was divided into six reaches; see Figure 2: Jewett Brook Reach Map. Part or all of three of these reaches—M04, M05 through M06—are in the Town of Swanton. All of the reaches were characterized as "slightly entrenched but with access to a floodplain, moderate to high width to depth ratios, and gentle slopes." The report noted that there was very little topographic relief in the watershed (lowest point 97 feet, highest point 206 feet) and that the dominant land cover in all reaches was agricultural – either crop or field.

The report concluded that many of the challenges in managing Jewett Brook came from systemic conditions in the watershed. Specifically, the report notes:

- The original forested land cover has been replaced by an agricultural landscape.
- The agricultural lands often have narrow stream buffers
- Infrastructure investments (e.g., road, bridges and culverts) limit the streams' ability to widen.
- Large portions of the stream system have been straightened.

3.8. Lake Champlain Long-Term Water Quality and Biological Monitoring Program & Missisquoi Bay Watershed Phosphorus Load Monitoring Program[13]

The Lake Champlain Long-Term Water Quality and Biological Monitoring Program began in 1992 and has continued each year since then. The project is conducted by the Vermont Department of Environmental Conservation (DEC) and the New York State DEC, with funding provided by the Lake Champlain Basin Program and the two states. The program includes 22 monitoring stations spread throughout the basin, including a station on the Lower Missisquoi River in Swanton.

3.9. Ambient Biomonitoring Data

The biomonitoring program evaluates the abundance and composition of the stream insect (macroinvertebrate) community to assess the overall environmental condition of wadable streams and rivers. Assessed streams are given a qualitative ranking, ranging from Poor to Excellent. Data on fish communities are often collected at the same time. ANR is able to use this data to assess impacts of wastewater treatment plants, acid rain, agricultural

[12] https://anrnode.anr.state.vt.us/SGA/projects/phase1/background.aspx?pid=9

[13] http://www.lcbp.org/PDFs/MissisquoiPLoadMonitoringPlan.pdf

practices, and the removal of streamside vegetation. In Swanton, biomonitoring data have been collected from the Hungerford Brook; the data are summarized below.

Macroinvertebrate data:

- Hungerford Brook has received assessments since 1985. The table below shows the assessments, sample location at river miles, and dates, for the past ten years.

Location	River Mile	Date	Assessment
Hungerford Brook	0.8	10/12/2004	Good/Fair
Hungerford Brook	0.8	10/12/2007	Very Good
Hungerford Brook	3.9	10/12/2004	
Hungerford Brook	3.9	10/12/2007	Fair/Poor
Hungerford Brook	3.9	10/13/2009	

Fish data:

- In 2007 Hungerford Brook received a rating of "Very Good."

4. MUNICIPALITY-SPECIFIC ASSESSMENTS

In addition to the watershed-based assessments, a number of pieces of data are developed on a municipality-by-municipality basis. These are important to fold in to any effort to develop a list of strategic, prioritized projects that could be undertaken to improve water quality in and around Swanton. These include direct feedback from the Town and Village, work by the Vermont Agency of Transportation, as well as past and current planning initiatives.

4.1. Town Feedback

During a meeting between the Friends of Northern Lake Champlain, Stone Environmental and officials from Swanton Town and Village on March 7, 2012, a list of potential problem areas was identified. These include both areas where there are current concerns, such as localized flooding or erosion, and areas of future concerns, particularly where new development may be concentrated. Stone developed a series of maps following the meeting; the numbers alongside the descriptions below correspond to location numbers on the maps.

4.1.1. Village Map (Figure 3)

1. Planned stormwater treatment at Marble Mill Park; the final design recommendations included:
   - Construction of two rain gardens located on the two corners of the court area along the southeast side of the park.
   - An underground detention/recharge gallery with a hydrodynamic separator providing pretreatment for the area to the southeast of the access path.
   - A multi-cell gravel wetland with underground pre-treatment with a hydrodynamic separator beyond the northern boundary of the park.

2. “Tinkers Brook” ravine/Grand Ave: likely a partially buried stream; local officials are interested in understanding more about historic and current water movement through this area.
3. Jonergin Drive: water tends to stagnate in roadside ditches along Jonergin Drive, which in turn causes brown/discolored discharges from the ditches during high-flow events.
4. Goose Point: village-owned parcel that is currently leased to a local farmer; located between industrial area and the Missisquoi River, may have potential for stormwater mitigation.
5. Jones Court: ongoing problems with water in basements.
6. First Street: interest in opportunities for green infrastructure that might also create some “natural” traffic and parking control.

4.1.2. Swanton Town East Panel Map (Figure 4)

7. Woods Hill Rd at I-89: erosion in roadside ditch along steep section of roadway; some work has been done to stabilize the ditch with large stones.
8. Bachand Rd erosion in roadside ditch; some work has been done to stabilize the ditch with large stones.
9. Planned development at Exits 20 and 21 from I-89:
    - Exit 20: 300+ acre commercial and residential in the vicinity of Highgate Rd and Bushey Rd
    - Exit 21: 25-acre industrial park

4.1.3. Swanton Town Maquam Shore Road Map (Figure 5)

10. Maquam Shore Road/Janes Road/Sucker Brook: high sediment load in Sucker Brook impacts Swanton’s in-lake drinking water intake (~90’ off shore)

4.1.4. Swanton Town West Panel (Figure 6)

11. Tabor Point/Hog Island Road: area of concentrated development with a series of parallel roads, each with a 100’ right of way that leads directly down to Lake Champlain
12. Lakewood Dr: some shoreline erosion concerns; some year-round residences but mostly camps and seasonal homes.
13. Campbell Bay RV park: dense, seasonal-use, private RV park

4.2. Vermont Agency of Transportation-Sponsored Programs

4.2.1. Bridge and Culvert Inventory Data[14]

Vermont has 2,699 long structures (bridges and culverts) greater than 20 feet on interstate, state, and town routes and another 1,276 short structures between 6 and 20 feet on the state system that the state Agency of Transportation (VTrans) inspects. Inspections are conducted every 24 months on long structures and every 60 months on short structures unless conditions warrant more frequent inspections. Data collected as part of these inspections can help identify not only bridges and culverts with structural deficiencies but also structures that may be adversely impacting water quality. Specific bridges that have been assessed in the Swanton area are summarized in the table below.

STRUCT_NUM	CATEGORY_desc	STRC_LBL	E911RDCODE	RDFLNAME	THNUM
990003001006151	Bridge	B20	28845	WOODS HILL RD	3
990004000106151	Bridge	B1	28850	MAQUAM SHORE RD	4
990006000506151	Bridge	B11	28858	BUSHEY RD	6
990026000606151	Bridge	B14	28890	HAZARD RD	26
990027000406151	Bridge	B9	28892	VIENS RD	27
990029000806151	Bridge	B17	28895	JANES RD	29
990040000706151	Bridge	B16	28914	TOWN HWY 40	40
990002000306151	Bridge	B5	29075	BEEBE RD	2
990003000206151	Bridge	B3	28845	WOODS HILL RD	3
990003000906151	Bridge	B19	28845	WOODS HILL RD	3

Common problems observed at these structures included scour pools above and below, deposition above and below and floodplain and channel constriction.

4.3. Vermont DEC Stormwater Permitting Program

4.3.1. State Stormwater Permits

Currently, Vermont DEC requires that a stormwater permit be obtained when any construction, new development, or redevelopment, results in impervious or disturbed area equal to or greater than one acre, with stricter requirements in watersheds that are classified as stormwater impaired. The State has developed a suite of technical standards for stormwater-related mitigation that are outlined in the Vermont Storm Water Management Manual, Volumes I and II. For example, the goal of a stormwater management program during

[14] http://apps.vtrans.vermont.gov/BridgeAndCulvert/Login.aspx?ReturnUrl=%2fBridgeAndCulvert%2fDefault.aspx

construction is to mitigate sediment loss during storm events—while during and after construction, the objective is to maintain as much of the pre-developed hydrology as possible.

4.3.2. Environmental Research Tool[15]

ANR's Environmental Research Tool allows the user to look up the location of stormwater permits that have been issued by ANR, as well as hazardous waste sites, brownfields, and spills. There are approximately 40 documented stormwater permits (individual, 9010, 9003, or 9015) that have been issued to sites in Swanton. Depending on the age, style, size, and upkeep of an existing facility, these may be excellent candidates for improvement to enhance stormwater management capabilities.

4.4. Missisquoi River Basin Urban Areas Stormwater Mapping Project[16]

In 2009, Vermont DEC developed up-to-date municipal drainage maps for six communities in the Missisquoi River Basin. The drainage maps show stormwater infrastructure, including features like pipes, manholes, catchbasins, and swales within a municipality. Data sources include data collected from field work, available state permit plans, record drawings, town plans, existing GIS data from contractors, and the input and guidance of knowledgeable members of the municipalities. As part of the project, Vermont DEC also identified potential locations for Best Management Practice (BMP) stormwater retrofit sites. Twelve high-priority sites were identified in Swanton. These are sites where stormwater treatment structures could be cost-effectively added or improved.

As part of this effort, maps of the closed-pipe portion of the storm sewer system were developed and possible locations for stormwater management practices identified. The feasibility of the potential projects will need to be more fully evaluated.

4.5. Illicit Discharge Detection and Elimination (IDDE) in Six Missisquoi River Basin Communities[17]

An assessment of the Swanton Village stormwater system for illicit discharges was conducted between July and September 2009. An illicit discharge is defined as any discharge to the municipal separate storm sewer system that is not composed entirely of storm water. These non-stormwater discharges occur due to illegal connections to the storm drain system. Illicit connections may be intentional or unknown to the property owner. As a result of an illicit connection, contaminated wastewater enters into storm drains or directly into local waterways without receiving treatment from a wastewater treatment plant.

[15] http://www.anr.state.vt.us/WMID/StormWater.aspx

[16] http://www.vtwaterquality.org/erp/news/Missisquoi_FINAL_Report.pdf

[17] http://www.vtwaterquality.org/erp/news/Missisquoi-IDDE-Report_Final-no-appendices.pdf

4.6. NRPC Build-out Analysis[18]

The Northwest Regional Planning Commission conducted a build-out analysis for communities along the I-89 corridor, including Swanton, in 2006. The analysis found:

- The largest and most dense area of projected residential development is in Swanton Village, and also is projected to be south along Rt. 7 the first two miles after it crosses the Missisquoi River (roughly to Bachand Rd.)
- Other locations where fairly dense residential development is projected include the Hog Island area of West Swanton, the areas surrounding the Village, around Woods Hill Road, and south of the Champlain Country Club from the railroad to the Interstate.

This analysis fits with the projected development and growth of a few areas in the Town documented in the Swanton Town Plan. Some more-specific information for the Village Area and the Southern Growth District are provided as well:

- Village Area: The village is limited in expanding within its borders but the NRPC found that the village is not completely built out. The analysis shows that there is enough room for 114 more parcels covering 107 acres within the village boundaries. Also, "The Residential District is planned for high-density residential development within the Village and could potentially accommodate 317 new dwelling units with a minimum lot size of ¼ acre. Of the 786 parcels that are partially or entirely within the Residential District (according to most recent parcel data); 214 acres (46%) are built out." Further analysis would need to be done to determine further environmental, landowner, and physical constraints not included in the build-out analysis.
- Southern Growth District: This is the area around exit 20 on I-89. This area was changed to include mixed-use development, including commercial and residential uses, in the zoning parameters. See Figure 7 for proposed land use map.

4.7. Swanton Town Plan 2010[19]

Potential development areas should be the focus when determining future stormwater impact and the possible projects associated with it. The Swanton Town Plan outlines most of the areas identified for development of residential, commercial, and industrial uses, all of which would benefit from stormwater planning. These areas are identified below:

- Two areas have been identified for future high-density residential growth. The first is on the northern boundary of the Village east of Route 7, extending north to the Highgate border and east to I-89. The second is on both sides of Route 7 just outside (southeast of) the Village limits.

[18] http://www.transportation-landuse.org/pages/links/nrpc.htm

[19] http://www.nrpcvt.com/swantont.html

- Six areas have been identified for moderate-density residential development: Northeast Route 78, North Route 7, Woods Hill Road, Route 36/Middle Road, Maquam Shore Road, and Tabors Point.
- The Neighborhood Commercial District is located on the outskirts of the Village just beyond the Swanton Industrial Park. The purpose of this District is to provide support services to the Swanton Industrial Park and to the travelers on Route 78. Appropriate uses in this District include automobile service stations, convenience stores, and small motor inns or hotels.
- Three Industrial Districts are proposed, two of which have existing industrial parks. The three Districts are located: 1) outside the Village limits, including the area of Jonergin Drive and the Village sewage treatment lagoons; 2) the Depot Street area in the Village off Route 78; and 3) an area south of the Village corporate limits, Route 7, and a proposed Residential 2 area surrounded by the Recreation/Conservation District that flanks the Missisquoi River.
- The Southern Growth District provides an area for future residential and commercial growth in a compact and well-designed pattern of development that is complementary, rather than competitive, to Swanton Village and other growth centers in adjacent towns.

5. OTHER RELATED INFORMATION

5.1. NRCS Conservation Practice #558—Roof Runoff Structure[20]

The total barn roof area on a farm can be substantial, often in excess of one acre (the threshold for state stormwater regulation in the developed landscape)—and therefore, roof runoff from farm barns can be an important source of unmanaged stormwater. NRCS Standard #558 addresses the management of stormwater from farm structures; specifically, where roof runoff from precipitation needs to be:

- diverted away from structures or contaminated areas;
- collected, controlled, and transported to a stable outlet; or
- collected and used for other purposes such as irrigation or animal watering facility.

[20] http://efotg.sc.egov.usda.gov//references/public/VT/VT558-0311.pdf

6. CONCLUSIONS

This report is being developed as part of a larger project, funded by Vermont DEC, which will ultimately lead to a set of community-specific, prioritized projects to address stormwater runoff. Rather than starting from scratch in identifying stormwater management needs, the project (and this report) is drawing from the extensive library of water quality assessments and information that already exists, and augmenting them with interviews with local officials.

As this report demonstrates, there are numerous agencies and entities whose activities touch on various aspects of water quality in the Missisquoi watershed in general, and Swanton Town and Village more specifically. This work is dynamic and ongoing, and so, while this summary is believed to be comprehensive, it will be important to periodically review and update the content to ensure the most current information can be incorporated. A comprehensive inventory of existing water quality assessments serves as a basis for connecting land use, stormwater management, floodplain management, river management activities; and public infrastructure needs to more effectively address all of the issues which contribute to degradation of a watershed.

APPENDIX A: FIGURES

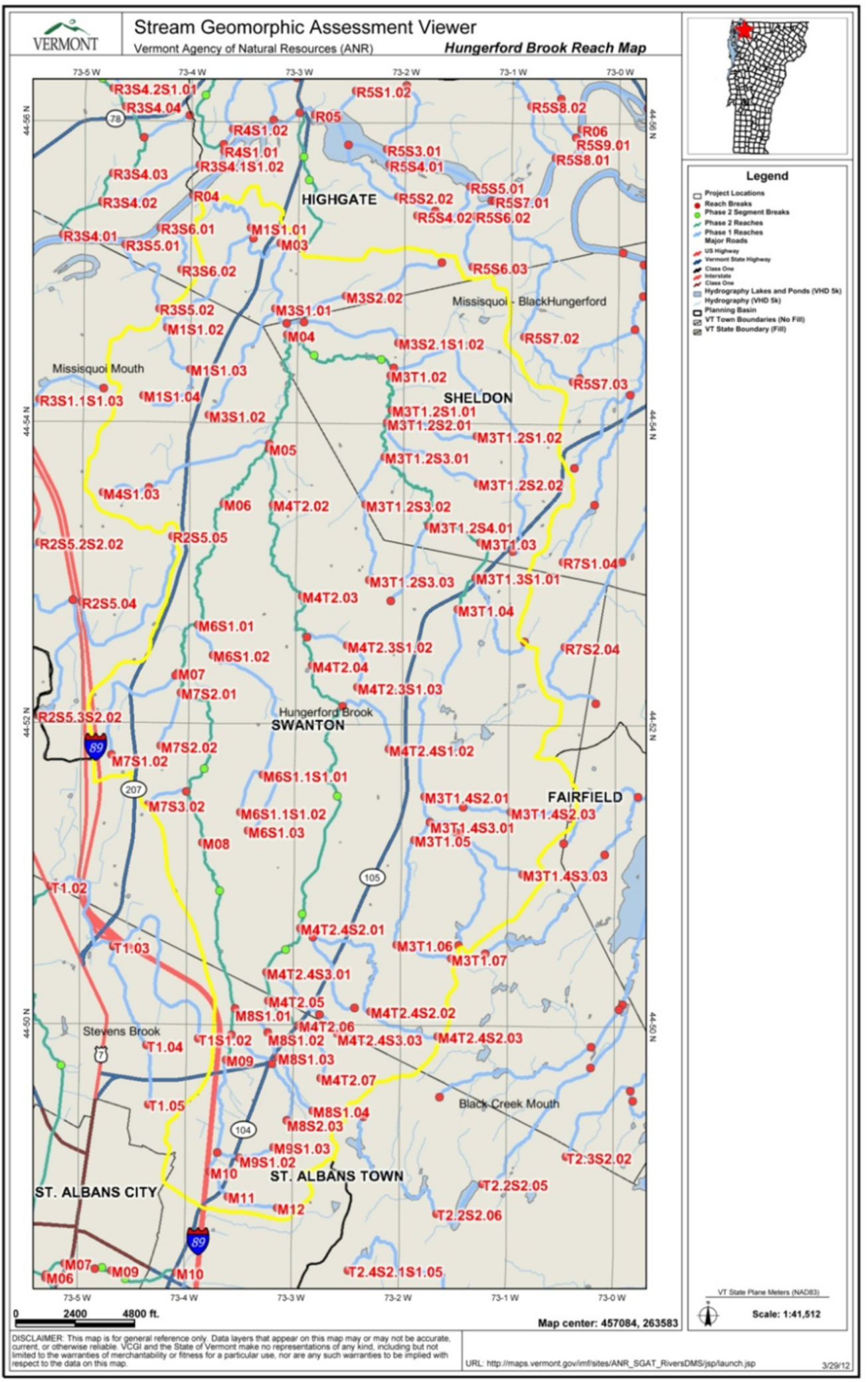


Figure 1. Hungerford Brook Reach Map

Figure 2. Jewett Brook Reach Map

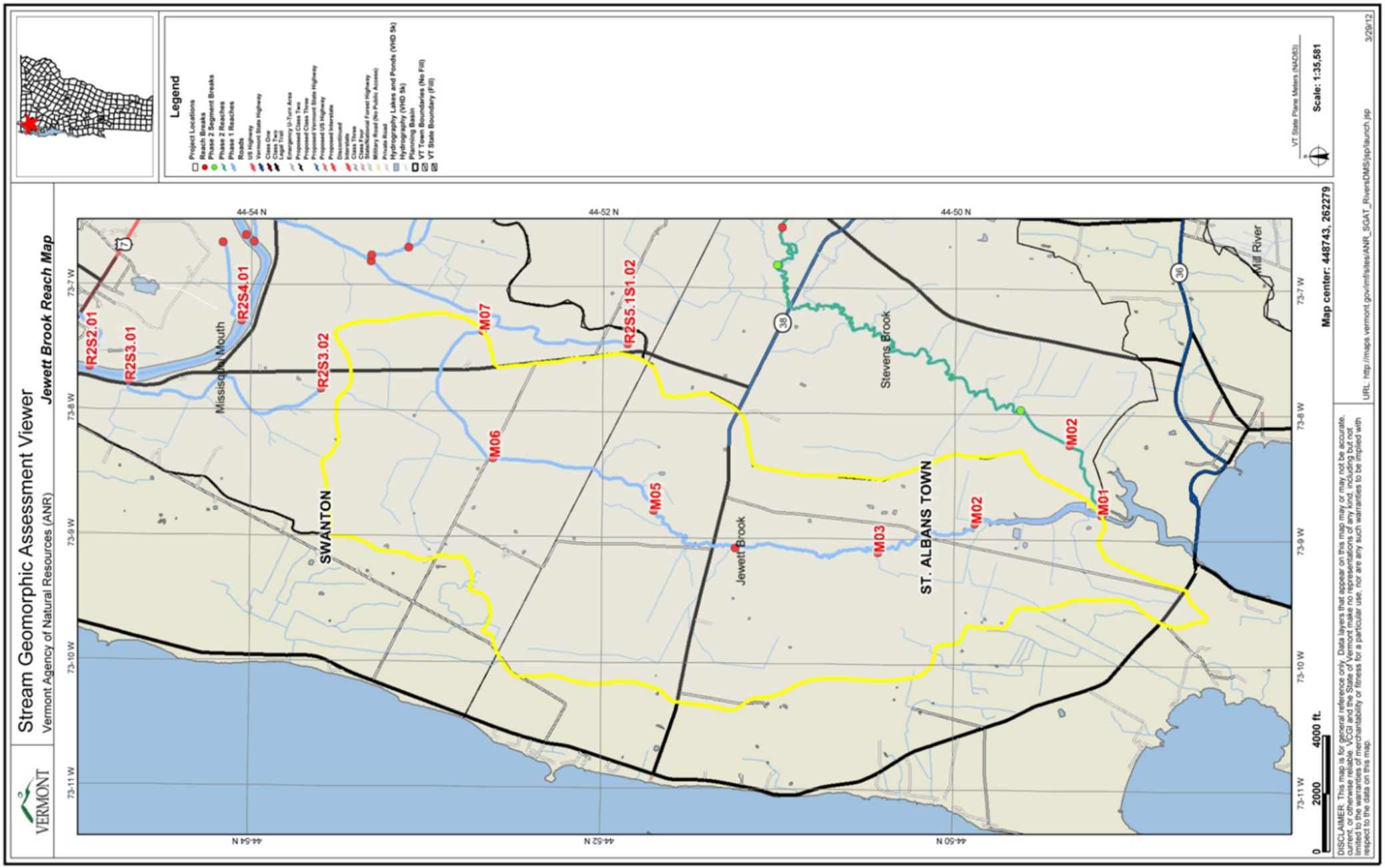


Figure 3. Swanton Village Map

Figure 4. Swanton Town East Panel Map

Figure 5. Swanton Town Maquam Shore Road Map

STONE ENVIRONMENTAL INC

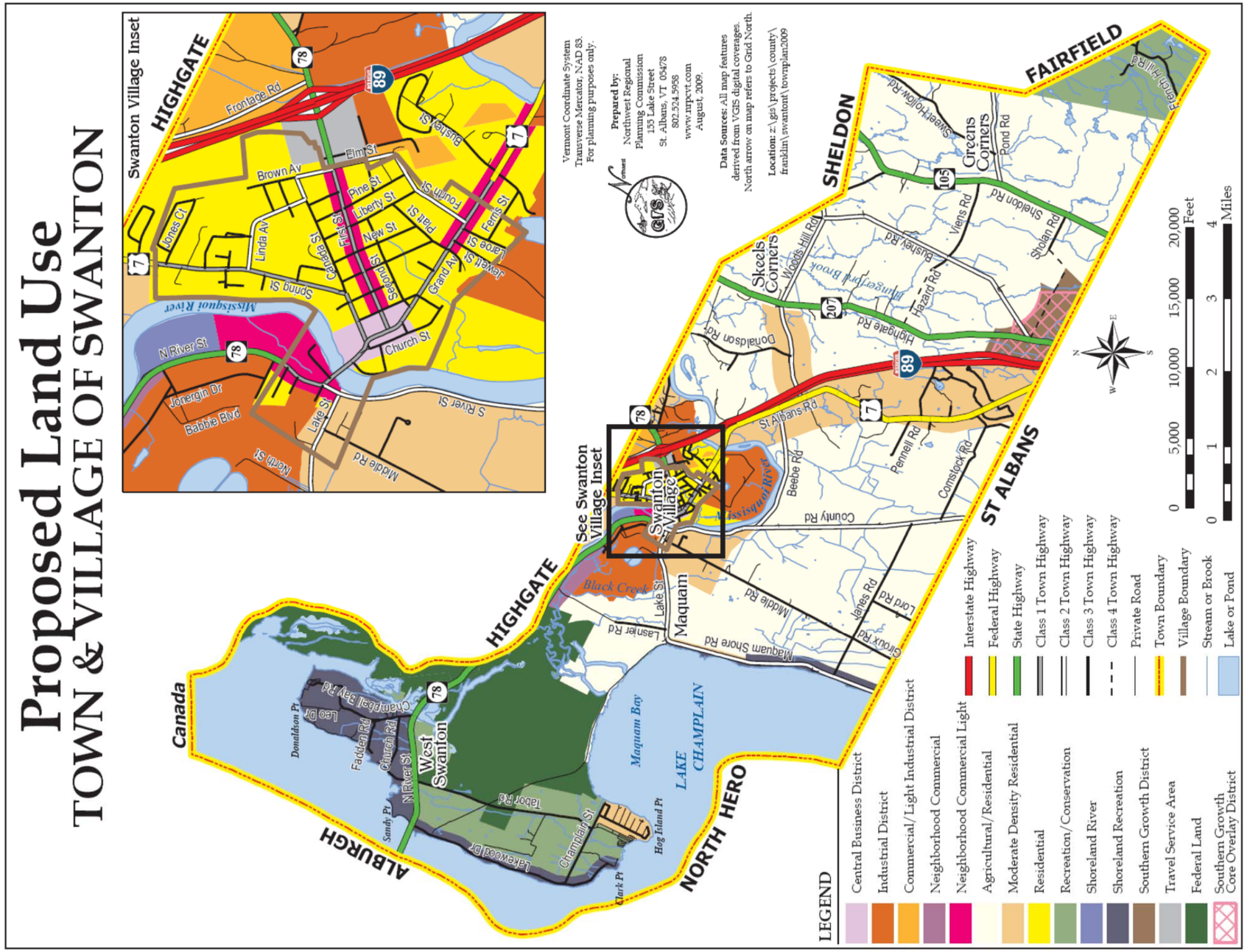
Town of Swanton, Maquam Shore Road
Swanton, VT

Figure 6. Swanton Town West Panel Map

STONE ENVIRONMENTAL INC

Town of Swanton, West Panel
Swanton, VT

Figure 7. Proposed Land Use



APPENDIX C: PROBLEM AREA DATA SHEETS

MEMO

To: Paul Madden
Executive Director
Friends of Northern Lake Champlain
P.O. Box 58
Swanton, VT 05488

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From: Julie Moore
Direct Phone: 802-229-1881
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SEI No. 112475-W, task 2
Re: REVISED Stormwater Problem Area Data Sheets – Swanton Town & Village

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Stone Environmental has reviewed existing reports and also worked directly with the Town and Village of Swanton to identify current problem areas (e.g., actively eroding sites, roadway flooding and/or water ponding areas, culverts or other structures with insufficient hydraulic capacity) that are a direct, or indirect, result of stormwater runoff.

The approach to identifying problem areas included the following elements:

- Engagement with local officials, including:
  - March 7th, kick-off meeting with Town Administrator (now retired) and the Village Manager
  - March and April, written responses from Town Administrator and Village Manager in reply to our questions about problem areas
  - May 22nd, meeting with new Town Administrator and Road Foreman
  - June 15th, meeting with Village Manager
- Targeted site visits to verify problems areas (May-July 2012)
- Documentation (with photos) of existing problem areas

A "problem area data sheet" was developed and used as a guide to ensure consistent information was collected as site visits were completed. The data sheets for all of the problem areas identified in Swanton are attached to this memo. Each problem area was given a preliminary classification according to the following system:

Level	Classification
1	Infeasible to remedy issue/outside of project scope.
2a	Stable, no urgency.
2b	Stable, but problem could escalate with future change in surrounding land use.
3	Small to moderate erosion and/or drainage problems are present; issues could be readily addressed.
4	Significant erosion and/or drainage problems are present; issues may be readily addressed.

Going forward, we will work with the Friends of Northern Lake Champlain to combine the information collected during this phase into a scoring matrix that considers both the municipality's priorities and anticipated water quality benefits of addressing each problem area to develop a short of 6-10 high priority projects for implementation.

Problem Area Data Sheet

Problem Area ID:	**LC 1**	Latitude: 44.927655 N	Longitude: 73.210405 W
Watershed:	Lake Champlain		
Road Name:	Hog Island Rd		
Problem Type:	Local Drainage		
Identification Source:	Town Feedback		
Ownership:	Private		
Classification Level:	3		

Problem Description:

Tabor Point/Hog Island Rd. is an area of high density development.

Date of Field Data Collection: 5/30/2012

Field Photos

Photo 1. Ponding on North side of road

Photo 2. Drainage ditch coming from neighborhood

Description of Observed Conditions:

High density of homes, some seasonal, along Hog Island Road and minor intersecting roads. Between house #198 and 218 high volume of ponding water on both sides of road. Drainage ditch leading to culvert with 2" of standing water. A 12" corrugated plastic culvert not positioned near drainage ditch. Outfall of culvert into ditch which drains directly into Lake Champlain.

Problem Area Data Sheet

Problem Area ID:	**LC 5**	Latitude: 44.898766 N	Longitude: 73.098613 W
Watershed:	Lake Champlain		
Road Name:	Beebe Rd		
Problem Type:	Bridge/Culvert		
Identification Source:	VTrans Bridge and Culvert Inventory		
Ownership:	Local		
Classification Level:	2b		
Problem Description:			

Two culverts on Beebe Road causing channel constriction and scour pools.

Date of Field Data Collection: 5/30/2012

Field Photos

Photo 1. Culvert Entrance (C1)

Photo 2. Ponding downstream of culvert C2

Problem Area Data Sheet

Photo 3. Poorly set culvert

Photo 4. Floodplain leading to culvert (C2)

Description of Observed Conditions:

C1- 5' corrugated culvert inside concrete armor wall. Poor alignment is causing left bank to erode as stream is forced to turn to enter culvert (Photo 1). C2- Large pool forming at outfall, exacerbated by large (20-25') grass island in channel (Photo 2). A large tree is growing adjacent to the culvert. Culvert entrance is tilted upwards (Photo 3, below) causing water to pool at entrance and possibly undermine the culvert.

Problem Area Data Sheet

Problem Area ID:	**LC 4**	Latitude: 44.892844 N	Longitude: 73.166047 W
Watershed:	Lake Champlain direct		
Road Name:	Maquam Shore Rd		
Problem Type:	Bridge/Culvert		
Identification Source:	VTrans Bridge and Culvert Inventory		
Ownership:	Local		
Classification Level:	2b		

Problem Description:

Bridge on Maquam Shore Road causing channel constriction and scour pools.

Date of Field Data Collection: 5/30/12

Field Photos

Photo 1. Deteriorated concrete armor

Photo 2. Straightened stream flowing downhill to culvert

Description of Observed Conditions:

South side of concrete armor has fallen into stream. Some evidence of erosion present. Two drainage ditches and a stream merge directly at bridge crossing. Stream has significant slope and could see heavy flows during rain events.

Problem Area Data Sheet

Problem Area ID:	**MQ 1**	Latitude: 44.921044 N	Longitude: 73.124533 W

Watershed:	Missisquoi River
Road Name:	Marble Mill Park
Problem Type:	Future Opportunities Local Drainage
Identification Source:	Town Feedback, VTDEC mapping project
Ownership:	Local
Classification Level:	3

Problem Description:

A significant portion of the stormwater runoff from the Village is piped to Marble Mill Park where it is discharged to the Missisquoi.

Date of Field Data Collection: 5/30/2012

Field Photos

Photo 1. Erosion in access road/path

Photo 2. Washout and outfall, in park near river

Description of Observed Conditions:

Erosion present in road/path to the park, runoff coming from parking lot above. Signs of standing water areas along southern end of park before the tennis courts. Washout area leading from park to rivers edge, with concrete outfall at the bottom. Outfall serves as storm water runoff from streets/village above the park. 4" of water flowing from drains.

The Village is currently working with NWRPC and VT DEC to implement a comprehensive treatment solution.

Problem Area Data Sheet

Problem Area ID:	**MQ 2**	Latitude: 44.916263 N	Longitude: 73.120755 W
Watershed:	Tinker's Brook		
Road Name:	Grand Ave		
Problem Type:	Local Drainage		
Identification Source:	Town Feedback		
Ownership:	Local		
Classification Level:	2b/3		

Problem Description:

Tinker's Brook/Ravine on Grand Ave.

Date of Field Data Collection: 5/30/2012

Field Photos

Photo 1. Stormwater pipe outfall into ravine

Photo 2. Box culvert running under Grand Ave.

Description of Observed Conditions:

Storm water entering ravine through a 24" plastic pipe from southwest corner of Grand Ave. 36" wide box culvert flowing directly under road. Ravine serves as storm water conveyance for runoff from the 2nd St and Liberty St. neighborhoods. Further investigation is needed to fully understand the source(s) of stormwater discharged to the brook.

Problem Area Data Sheet

Problem Area ID:	**MQ 17**	Latitude: 44.917296 N	Longitude: 73.118576 W

Watershed:	Tinker's Brook
Road Name:	Greenwich St.
Problem Type:	Local Drainage
Identification Source:	VT DEC
Ownership:	Public (Town)/Private
Classification Level:	2b

Problem Description:

Extensively manipulated (straightened and culverted) headwater stream in Swanton Village ("Tinker's Brook"). In areas appears to run coincident with a stormline.

Date of Field Data Collection: 8/2/12

Field Photos

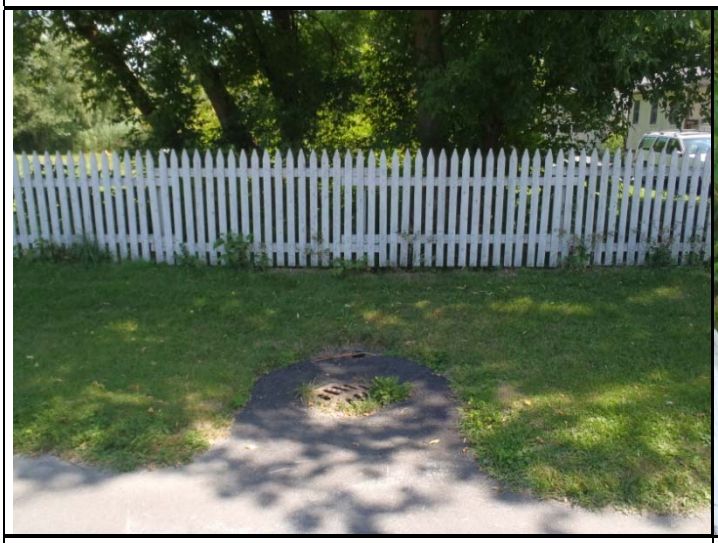


Photo 1. Stream from Greenwich, looking east

Photo 2. Stream below bridge/culvert

Description of Observed Conditions:

The stream appears to begin in the vicinity of First and Liberty Streets, and runs coincident with a stormline through the Village. Further investigation is needed to determine the extent of the system and any potential for retrofits or daylighting.

Problem Area Data Sheet

Problem Area ID:	**MQ 5**	Latitude: 44.929547 N	Longitude: 73.116766 W
Watershed:	Missisquoi River		
Road Name:	Jones Ct.		
Problem Type:	Local Drainage		
Identification Source:	Town Feedback		
Ownership:	Local		
Classification Level:	1		

Problem Description:

Jones Ct. ongoing problems with flooded basements.

Date of Field Data Collection: 5/30/2012

Field Photos

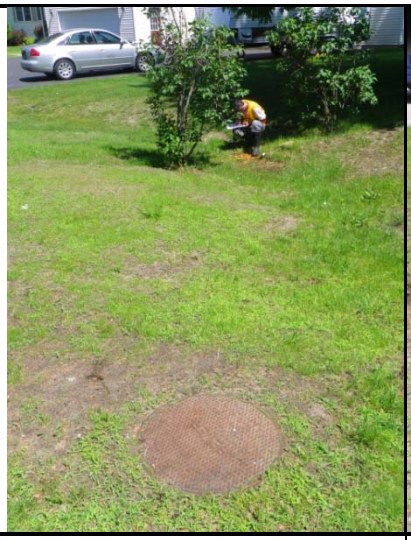


Photo 1. Catch basin (in background) seem to be working and flowing throughout neighborhood

Photo 2. Evidence of ponding water and localized erosion

Description of Observed Conditions:

Spoke with several residents; most reported having wet basements and groundwater seepage within the past year. Some feel that the exterior property drains had been incorrectly installed. Wet area behind northeast corner of development "always" flowing; water discharges to catch basins. Plugging of catch basins and culverts has not been a problem; issue appears to be related to house/foundation drains.

Problem Area Data Sheet

Problem Area ID:	**MQ 10**	Latitude: 44.924761 N	Longitude: 73.126588 W
Watershed:	Missisquoi River		
Road Name:	Brooklyn St		
Problem Type:	Local Drainage		
Identification Source:	MRBUA Stormwater Mapping Project		
Ownership:	Local/Private		
Classification Level:	3		

Problem Description:

Potential for extended detention micropool to treat runoff from area above Brooklyn Street.

Date of Field Data Collection: 5/30/2012

Field Photos

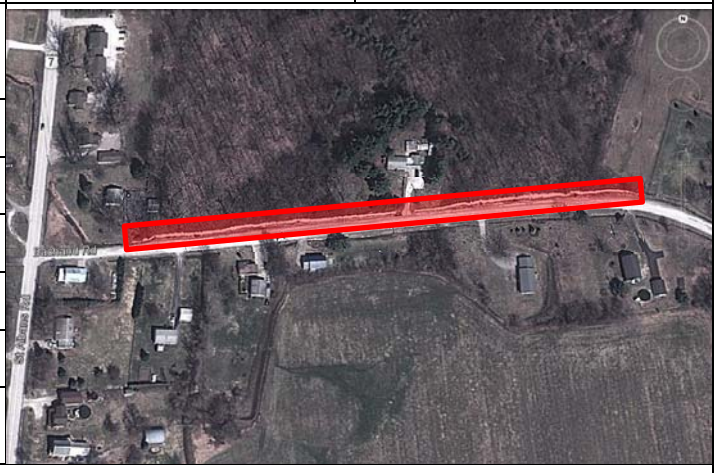
Photo 1. Existing pond

Photo 2. Swale between pond and culvert

Description of Observed Conditions:

Existing retention pond north of 6 Brooklyn St (Photo 1). Water from pond extends parallel Rt. 78 into swale before reaching culvert under Brooklyn St. Sufficient room between retention pond and beginning of swale to extend pond and improve treatment. Retrofits could provide additional treatment for stormwater flows before outfall onto Goose Point. Landowner interest/willingness is unknown.

Problem Area Data Sheet

Problem Area ID:	**MQ 12**	Latitude: 44.871713 N	Longitude: 73.095983 W
Watershed:	Missisquoi River		
Road Name:	Bachand Rd		
Problem Type:	Local Drainage		
Identification Source:	Town Feedback		
Ownership:	Local		
Classification Level:	2a		

Problem Description:

Roadside ditch erosion on Bachand Rd.

Date of Field Data Collection: 5/30/12

Field Photos

Photo 1. Upper portion of road

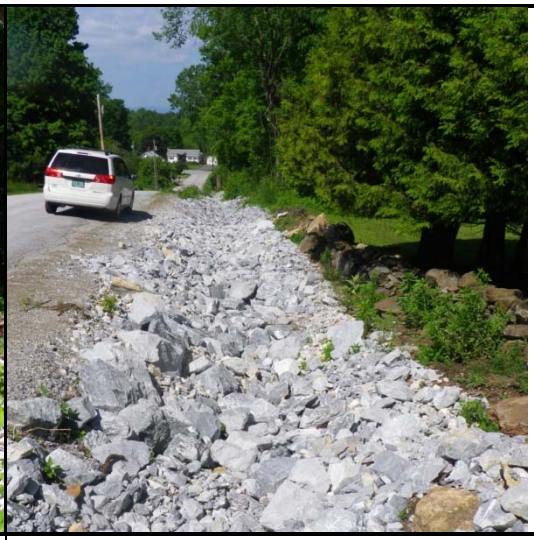


Photo 2. Lower section of road

Description of Observed Conditions:

After years of significant erosion during high flow events, the town installed rip rap in roadside ditch to ease water flow down the hill. Residents report no problems this year. There may be an opportunity to use check dams or similar measures to further slow flow, if warranted.

Problem Area Data Sheet

Problem Area ID:	**HB 1**	Latitude: 44.895405 N	Longitude: 73.089488 W
Watershed:	Hungerford Brook		
Road Name:	Woods Hill Road		
Problem Type:	Local Drainage		
Identification Source:	Town Feedback		
Ownership:	Local/State		
Classification Level:	2a		

Problem Description:

Woods Hill Road at I-89: erosion in roadside ditch along steep section of roadway (some work done already).

Date of Field Data Collection: 5/25/2012

Field Photos

Photo 1. Rip rap

Photo 2. Drop inlet

Description of Observed Conditions:

Rip rap has been placed in the ditch along the north side of road west of I-89; asphalt ditch runs below both directions of I-89. Several drop inlets exist in the ditch and the drainage system ends east of I-89 at a drop inlet. No damage visible. There may be an opportunity to use check dams or similar measures to further slow flow, if warranted.

Problem Area Data Sheet

Problem Area ID:	**SB 1**	Latitude: 44.844191 N	Longitude: 73.079877 W
Watershed:	Stevens Brook (north trib)		
Road Name:	Exit 20 Interchange		
Problem Type:	Future Opportunities		
Identification Source:	Town Feedback		
Ownership:	Public (State)/Private		
Classification Level:	2b		

Problem Description:

The Town Plan indicated a desire to encourage future development at the Exit 20 interchange.

Date of Field Data Collection: 5/25/2012

Field Photos

Photo 1. Paquette Rd. looking towards I-89

Photo 2. Paquette Rd. looking towards industrial park

Description of Observed Conditions:

The Town of Swanton wishes to encourage and concentrate future development at the Exit 20 interchange. Upstream segments of Stevens Brook are considered "stormwater impaired;" strategies need to be investigated that both address current stormwater concerns and take proactive steps to guard against the cumulative impacts of future development in order to ensure that these tributaries are not added to the State's list of impaired waters.

Problem Area Data Sheet

Problem Area ID:	**HB 3 (SGA Reach M08)**	Latitude: 44.8540 N	Longitude: 73.064261 W
Watershed:	Hungerford Brook		
Road Name:	Bushey Rd		
Problem Type:	Altered Geomorphology		
Identification Source:	Hungerford Brook SGA		
Ownership:	Private		
Classification Level:	4		

Problem Description:

Historic channel straightening and unimproved farm road crossing.

Date of Field Data Collection: 5/25/12

Field Photos

Photo 1. Destroyed Culvert

Photo 2. Bank undercutting downstream

Description of Observed Conditions:

Unimproved farm road with blown out culvert; brush is currently being used to fjord stream. Channel has been straightened and significant erosion is visible along road. Culvert was a 15" corrugated metal, now crushed. Too small for stream, undercutting bank downstream of culvert.

Problem Area Data Sheet

Problem Area ID:	**HB 4 (SGA Reach M4S1)**	Latitude: 44.896455 N	Longitude: 73.059675 W
Watershed:	Hungerford Brook		
Road Name:	Woods Hill Rd		
Problem Type:	Altered Geomorphology		
Identification Source:	Hungerford Brook SGA		
Ownership:	Private		
Classification Level:	1		

Problem Description:

Extensive straightening throughout the stream reach.

Date of Field Data Collection: 5/25/2012

Field Photos

Photo 1. Culvert C1

Photo 2. Channel straightening, upstream of C1

Problem Area Data Sheet

HB 4 Field Photos, cont.

Photo 3. Pooling upstream C2

Photo 4. Bridge crossing C2

Photo 5. Culvert C3

Photo 6. Outfall waterfall C3

Description of Observed Conditions:

C1- Extensive channeling between the two fields, no visible signs of erosion. C2- Bridge crossing; pooling upstream of bridge, channel is not aligned with the bridge. C3- 6' corrugated metal culvert, with 4" of flow. Culvert is perched with deterioration in the bottom middle of culvert evident; undercutting of culvert occurring as well.

Problem Area Data Sheet

Problem Area ID:	**HB 5 (SGA Reach M4T2)**	Latitude: 44.873938 N	Longitude: 73.048461 W
Watershed:	Hungerford Brook		
Road Name:	Bushey Rd.		
Stream Name:	N/A		
Problem Type:	Altered Geomorphology		
Identification Source:	Hungerford Brook SGA		
Ownership:	Private		
Classification Level:	2b		
Problem Description:			
Extensive channel straightening.			

Date of Field Data Collection: 5/25/2012

Field Photos

Photo 1. Metal lined concrete bridge

Photo 2. House on bank

Description of Observed Conditions:

7' tall, crushed metal culvert lining a concrete tunnel. 4" of flow, no significant erosion. Fish passage is possible. Evidence of direct livestock (cow) access directly downstream of culvert, floodplain constricted by road crossing and homes encroaching on the riparian area

Problem Area Data Sheet

Problem Area ID:	**HB 6 (SGA Reach M07b)**	Latitude: 44.855700 N	Longitude: 73.064163 W

Watershed:	Hungerford Brook
Road Name:	Bushey Rd
Problem Type:	Altered Geomorphology
Identification Source:	Hungerford Brook SGA
Ownership:	Public (Town)/Private
Classification Level:	2b

Problem Description:

Numerous concerns identified, including: loss of floodplain, direct access by cows, lack of vegetative buffer, channelization and straightening in reaches.

Date of Field Data Collection: 5/25/2012

Field Photos

Photo 1. Concrete Tunnel

Photo 2. Grass buffers

Description of Observed Conditions:

6'x8' concrete tunnel with ~1' of flow. Channel has obviously been straightened; no significant erosion. Minimal grass buffers (<10') on downstream side of tunnel.

Problem Area Data Sheet

Problem Area ID:	**HB 7 (SGA Reach M06)**	Latitude: 44.843263 N	Longitude: 73.063894 W
Watershed:	Hungerford Brook		
Road Name:	N/A Reach M06		
Problem Type:	Bridge/Culvert		
Identification Source:	Hungerford Brook SGA		
Ownership:	Private		
Classification Level:	4		

Problem Description:

Several structures in need of repair or removal.

Date of Field Data Collection: 5/25/2012

Field Photos

Photo 1. C1- Culvert

Photo 2. Cow access near C1 culvert

Description of Observed Conditions:

C1- Corrugated metal 5' culvert. Evidence of direct animal (cow) access on the north-side of the stream. C2- concrete bridge on farm road. 4' high, 15' across. Erosion present downstream; more signs of cow access. C3-concrete bridge is too small and constricts flow; erosion is present. Structure is also damaged, cinder blocks in stream. C4- rocky tunnel with extensive damage; pooling at outlet and erosion downstream. C5- Brook bypassing culvert. Major erosion and pooling at culvert. 36" culvert too small for stream flow.

Problem Area Data Sheet

HB 7 Field Photos cont.

Photo 3. Concrete bridge C2

Photo 4. Small Concrete bridge C3

Photo 5. Extensive damage C4

Photo 6. Brook bypassing culvert C5

Photo 7. Undersized culvert C5

Photo 8. Cow access near C5

Problem Area Data Sheet

Problem Area ID:	**MQ 3**	Latitude: 44.930386 N	Longitude: 73.130252 W
	Missisquoi River		
Road Name:	Jonergin Dr.		
Problem Type:	Local Drainage		
Identification Source:	Town Feedback		
Ownership:	Private		
Classification Level:	3		

Problem Description:

Stagnant water in Jonergin Dr. ditches, causes discolored discharges during heavy storms.

Date of Field Data Collection: 05/25/12

Field Photos

Photo 1. Grass swale east of Leader Evaporator

Photo 2. Lawn/dry pond east of Leader Evaporator

Description of Observed Conditions:

No stagnant water observed, likely due to recent dry conditions. Dry pond and/or grass swale retrofits may be possible to improve stormwater treatment.

Problem Area Data Sheet

Problem Area ID:	**MQ 4**	Latitude: 44.923325 N	Longitude: 73.124602 W
Watershed:	Missisquoi River		
Road Name:	Goose Point		
Problem Type:	Future Opportunities		
Identification Source:	Town Feedback		
Ownership:	Local		
Classification Level:	1		

Problem Description:

Goose Point, village owned parcel with potential for stormwater mitigation from industrial area.

Date of Field Data Collection: 8/2/12

Field Photo

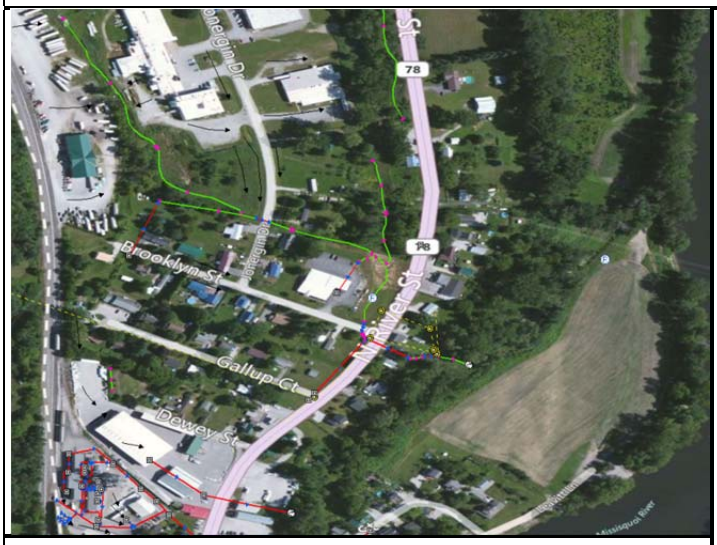


Photo 1. Stormwater infrastructure in Goose Pt area

Description of Observed Conditions:

Currently leased by the town to a local farmer for corn production, Goose Point could serve to mitigate stormwater from the industrial area (Brooklyn St and Jonergin Dr). Further study would be required to determine if a centralized solution on Goose Point is preferably to pursuing more localized opportunities within the industrial park.

Problem Area Data Sheet

Problem Area ID:	**MQ 7**	Latitude: 44.922133 N	Longitude: 73.107480 W
Watershed:	Missisquoi River		
Road Name:	Exit 21 Interchange		
Problem Type:	Future Opportunities		
Identification Source:	Town Feedback		
Ownership:	State/Private		
Classification Level:	2a		

Problem Description:

The Town Plan indicated a desire to encourage future development at the Exit 21 interchange.

Date of Field Data Collection: 5/30/2012

Field Photos

Photo 1. Partially clogged culvert

Photo 2. Reach R3S2.01 of Missisquoi

Description of Observed Conditions:

Understanding that Swanton wishes to concentrate future development at the Exit 21 interchange, strategies can be investigated that would both address current stormwater concerns and take proactive steps to help guard against the cumulative impacts of future development.

Problem Area Data Sheet

Problem Area ID:	**MQ 19**	Latitude: 44.921877 N	Longitude: 73.110001 W
Watershed:	Missisquoi River		
Road Name:	First Street		
Problem Type:	Local Drainage		
Identification Source:	VT DEC		
Ownership:	Private		
Classification Level:	3		

Problem Description:

Potential retrofit at wet area in front of Mobil Station.

Date of Field Data Collection: 8/2/12

Field Photos

Photo 1. Existing swale/wetland in front of Mobil

Photo 2. Looking east to drainage area

Description of Observed Conditions:

Could retrofit existing wet swale to enhance treatment. Existing wetland plants currently provide some filtration. A gas line present to the immediate north of the swale may prohibit widening, but swale could potentially be dug deeper. Proximity to Route 7 could make construction challenging.

Problem Area Data Sheet

Problem Area ID:	**MQ 6**	Latitude: 44.918595 N	Longitude: 73.10763 W
	Missisquoi River		
Road Name:	Precision Lane		
Problem Type:	Local Drainage		
Identification Source:	VT DEC		
Ownership:	Private		
Classification Level:	3		

Problem Description:

Permit for industrial park was first granted in 2000—likely some retrofits that can be completed to upgrade facilities to meet current stormwater (2002) standards.

Date of Field Data Collection: 8/2/12

Field Photos

Photo 1. SE corner of VT Precision looking to the west

Photo 2. Same as Photo 1, longer extent

Description of Observed Conditions:

Large area of impervious surface feeding directly into swale system. Depending on landowner interest, system could be retrofitted to improve treatment; large "campus" may offer other opportunities for low-impact type retrofits.

Problem Area Data Sheet

Problem Area ID:	**MQ 20**	Latitude: 44.91808 N	Longitude: 73.109068 W

Watershed:	Missisquoi River
Road Name:	Precision Lane
Problem Type:	Local Drainage
Identification Source:	VT DEC
Ownership:	Private
Classification Level:	3

Problem Description:

Two swales meet in the meadow visible to the lower left in the above photo, draining Elm St, 4th St, and the entirety of Robinhood Drive.

Date of Field Data Collection: 8/2/12

Field Photos

Photo 1. Looking NW to potential treatment area

Photo 2. Looking west from swale junction

Description of Observed Conditions:

Potential exists to install a treatment practice in the meadow, treating the stormwater before it crosses the Rail Trail and Leduc Drive. Landowner interest/willingness is unknown.

Problem Area Data Sheet

Problem Area ID:	**MQ 8**	Latitude: 44.916787 N	Longitude: 73.107756 W

Watershed:	Missisquoi River
Road Name:	Bushey Ave
Problem Type:	Local Drainage
Identification Source:	Collin Smythe, VTDEC mapping project
Ownership:	Private
Classification Level:	3

Problem Description:

Outfall of sections of the rail trail, Elm St, and Robinhood Drive. Base flow during summer, low flow conditions suggests that conveyance may be a stream in addition to stormwater ditch, although waterway is entirely culverted through the Bushey Ave area.

Date of Field Data Collection: 8/2/12

Field Photos

Photo 1. Outfall from culvert under Bushey Ave.

Photo 2. Existing stormwater infrastructure

Description of Observed Conditions:

Potential exists to slow stormwater and/or enhance treatment in the swale near Precision Lane. Water at outfall appeared to have an orange tint, but fish and frogs visible, suggesting that oxygen is present.

Problem Area Data Sheet

Problem Area ID:	**MQ 9**	Latitude: 44.917528 N	Longitude: 73.110371 W

Watershed:	Missisquoi River
Road Name:	Robinhood Dr.
Problem Type:	Local Drainage
Identification Source:	VT DEC
Ownership:	Public (Town)/Private
Classification Level:	3

Problem Description:

Erosion in culvert and swale system around the intersection of Robinhood Dr. and the rail trail.

Date of Field Data Collection: 8/2/12

Field Photos

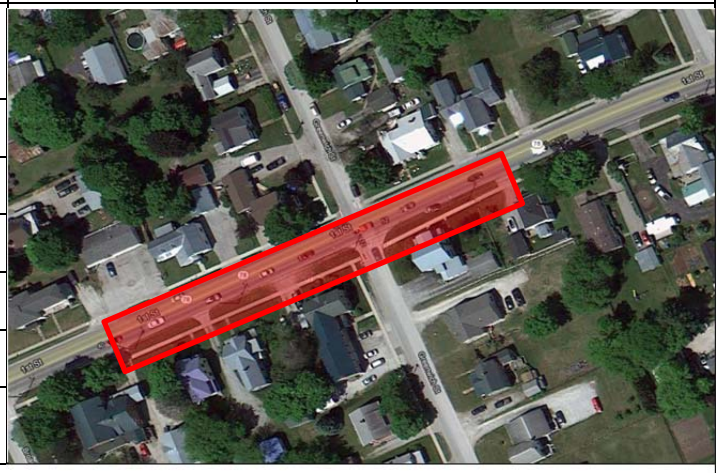
Photo 1. Ditch on SW corner of intersection

Photo 2. Under-road culvert NW corner of intersection

Description of Observed Conditions:

Ditch condition suggests high volume of water during storm events, likely clogging culvert in Photo 2. A system of check dams could be used to reduce the energy of stormwater as it moves through the system, in addition to abating further erosion. Other retrofits might be possible depending on landowner interest and ROW constraints.

Problem Area Data Sheet

Problem Area ID:	**MQ 18**	Latitude: 44.919526 N	Longitude: 73.120159 W
Watershed:	Missisquoi River		
Road Name:	First St.		
Problem Type:	Local Drainage		
Identification Source:	SWMP evaluation		
Ownership:	Private		
Classification Level:	3		

Problem Description:

Untreated/unmanaged stormwater runoff throughout the Village.

Date of Field Data Collection: 8/2/12

Field Photos

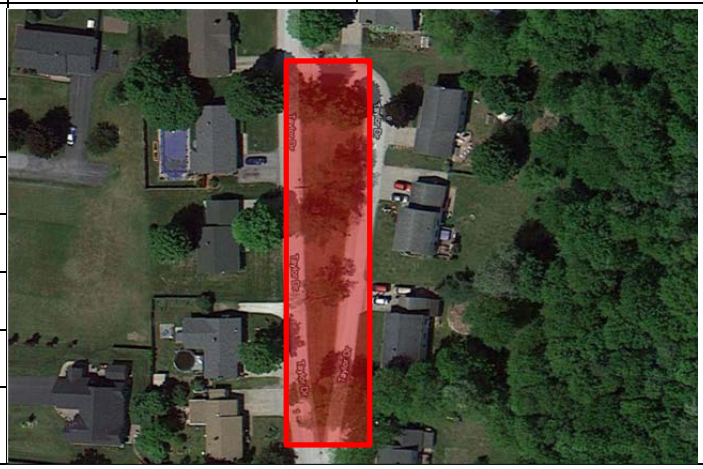
Photo 1. SW corner of First and Greenwich

Photo 2. Stormwater infrastructure

Description of Observed Conditions:

Given the high sand nature of Swanton Village soils, and the absence of curbs separating the road surface from the green space, rain gardens in on-street green spaces could serve to reduce stormwater runoff volumes. Many residences in Swanton report seasonal wet basements and residents may be reluctant to soak more water into the ground.

Problem Area Data Sheet

Problem Area ID:	**MQ 21**	Latitude: 44.926481 N	Longitude: 73.117474 W
Watershed:	Missisquoi River		
Road Name:	Taylor Dr.		
Problem Type:	Local Drainage		
Identification Source:	SWMP evaluation		
Ownership:	Private		
Classification Level:	3		

Problem Description:

Downspout disconnection and/or infiltration area potential on Taylor Dr.

Date of Field Data Collection: 8/2/12

Field Photo

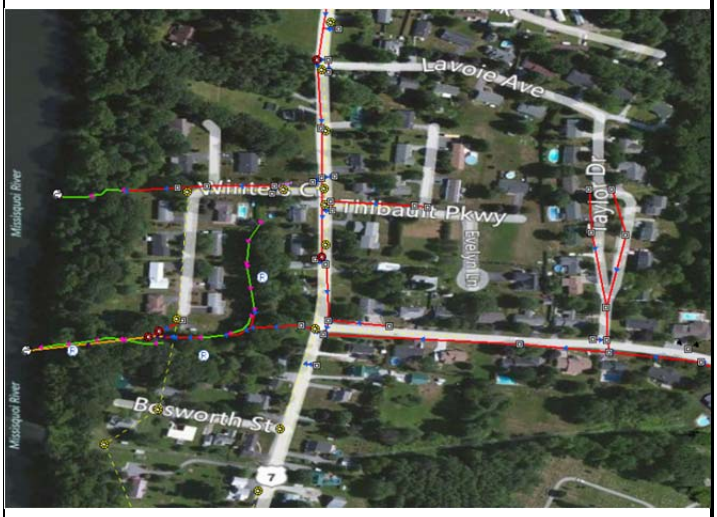


Photo 1. Stormwater infrastructure

Description of Observed Conditions:

Several roof gutter systems outfall onto driveways and flow into stormlines on Taylor Dr. Substantial green space in center of loop may offer opportunity to disconnect these downspouts from the stormline system and direct runoff to a soak away area.

Problem Area Data Sheet

Problem Area ID:	**MQ 14**	Latitude: 44.930256 N	Longitude: 73.127505 W

Watershed:	Missisquoi River
Road Name:	Route 78 N
Problem Type:	Local Drainage
Identification Source:	Collin Smythe, VTDEC mapping project
Ownership:	Private
Classification Level:	3

Problem Description:

Grassed swale SW along Route 78 provides limited treatment before discharging directly to the Missisquoi River.

Date of Field Data Collection: 8/2/12

Field Photos

Photo 1. Grass swale SW of Fournier's dealership

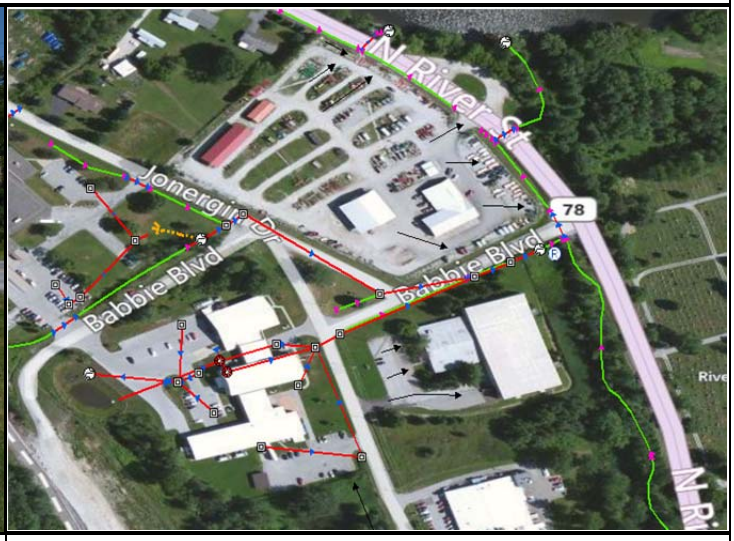


Photo 2. Stormwater infrastructure

Description of Observed Conditions:

Water from culvert under Town Highway 61 flows through this swale, then under Route 78 to outfall in the Missisquoi. Potential retrofit opportunities include converting the area to a wetland to slow/treat stormwater runoff. Landowner interest/willingness is unknown.

Problem Area Data Sheet

Problem Area ID:	**MQ 15**	Latitude: 44.919044 N	Longitude: 73.131936 W
	Missisquoi River		
Road Name:	Ally Dr.		
Problem Type:	Local Drainage		
Identification Source:	Town Plan		
Ownership:	Private		
Classification Level:	2a		

Problem Description:

New development on Ally Drive has created disproportionately large amount of impervious area, including road layout and driveways.

Date of Field Data Collection: 8/2/12

Field Photos

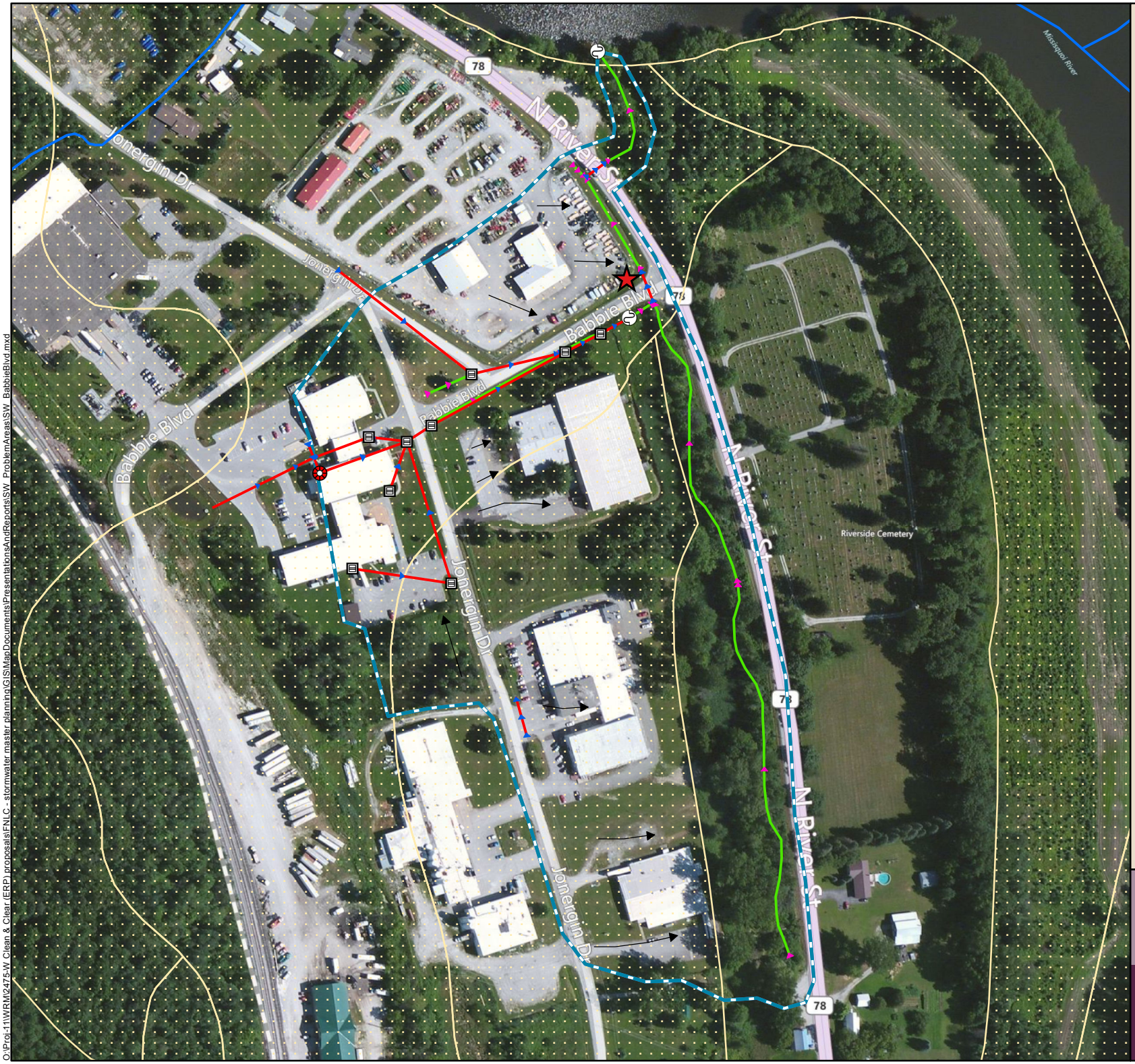
Photo 1. Ally Dr, looking east toward cul-de-sac

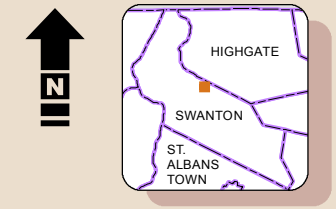
Photo 2. Stormwater infrastructure

Description of Observed Conditions:

Ally Drive development has a great deal of pavement, as seen in Photo 1 and the aerial image above. The need for stormwater treatment practices can often be minimized by employing so-called "better site design" techniques; full implementation of better site design techniques may necessitate changes in land use and development regulations.

APPENDIX D: DRAINAGE AREA MAPS FOR PRIORITY STORMWATER PROBLEM AREAS





0 75 150 300 Feet

Legend

- SW Treatment Opportunity
- River or Stream
- Catchbasin
- Outfall
- Stormwater Manhole
- Storm line or culvert
- Swale
- Overland flow
- Drainage Area (24 Acres)
- Erodible Soils (k > 0.17)

Treatment Opportunity:
Grassed swale SW along Route 78 provides limited treatment before discharging directly to the Missisquoi.

Sources: Stormwater Infrastructure, Stormsewer Subwatersheds: VT DEC; Problem Areas: Stone; Future Growth Areas: Swanton Town and Village Municipal Plan (2010); Potential Erosion Areas: SSURGO; Hydrography, Roads: VCGI; Imagery: Bing Maps.

STONE ENVIRONMENTAL INC

Babbie Blvd, Missisquoi River Watershed

MQ 14

Swanton Stormwater Management Planning

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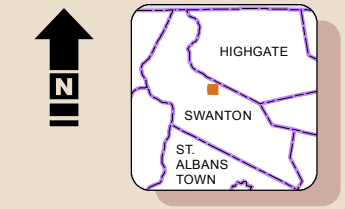

0 75 150 300 Feet

Legend

- SW Treatment Opportunity
- Catchbasin
- Sanitary Manhole
- Outfall
- Storm line or culvert
- Sanitary line
- Swale
- Overland flow
- River or Stream
- Drainage Area (27 Acres)
- Future Growth Areas
- Erodible Soils (k > 0.17)

Treatment Opportunity:
Potential for extended detention micropool to treat runoff from area above Brooklyn St.

Sources: Stormwater Infrastructure, Stormsewer Subwatersheds: VT DEC; Problem Areas: Stone; Future Growth Areas: Swanton Town and Village Municipal Plan (2010); Potential Erosion Areas: SSURGO; Hydrography, Roads: VCGI; Imagery: Bing Maps.

STONE ENVIRONMENTAL INC

Brooklyn St., Missisquoi River Watershed

MQ 10

Swanton Stormwater Management Planning

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0 10 20 40
Feet

Legend

- SW Treatment Opportunity
- River or Stream
- Erodible Soils (k > 0.17)

Treatment Opportunity:
Reach M08 exhibits evidence of channel straightening at farm road crossing.

Sources: Stormwater Infrastructure, Stormsewer Subwatersheds: VT DEC; Problem Areas: Stone; Future Growth Areas: Swanton Town and Village Municipal Plan (2010); Potential Erosion Areas: SSURGO; Hydrography, Roads: VCGI; Imagery: Bing Maps.

STONE ENVIRONMENTAL INC

Bushey Rd., Hungerford Brook Watershed

HB 3-M08

Swanton Stormwater Management Planning

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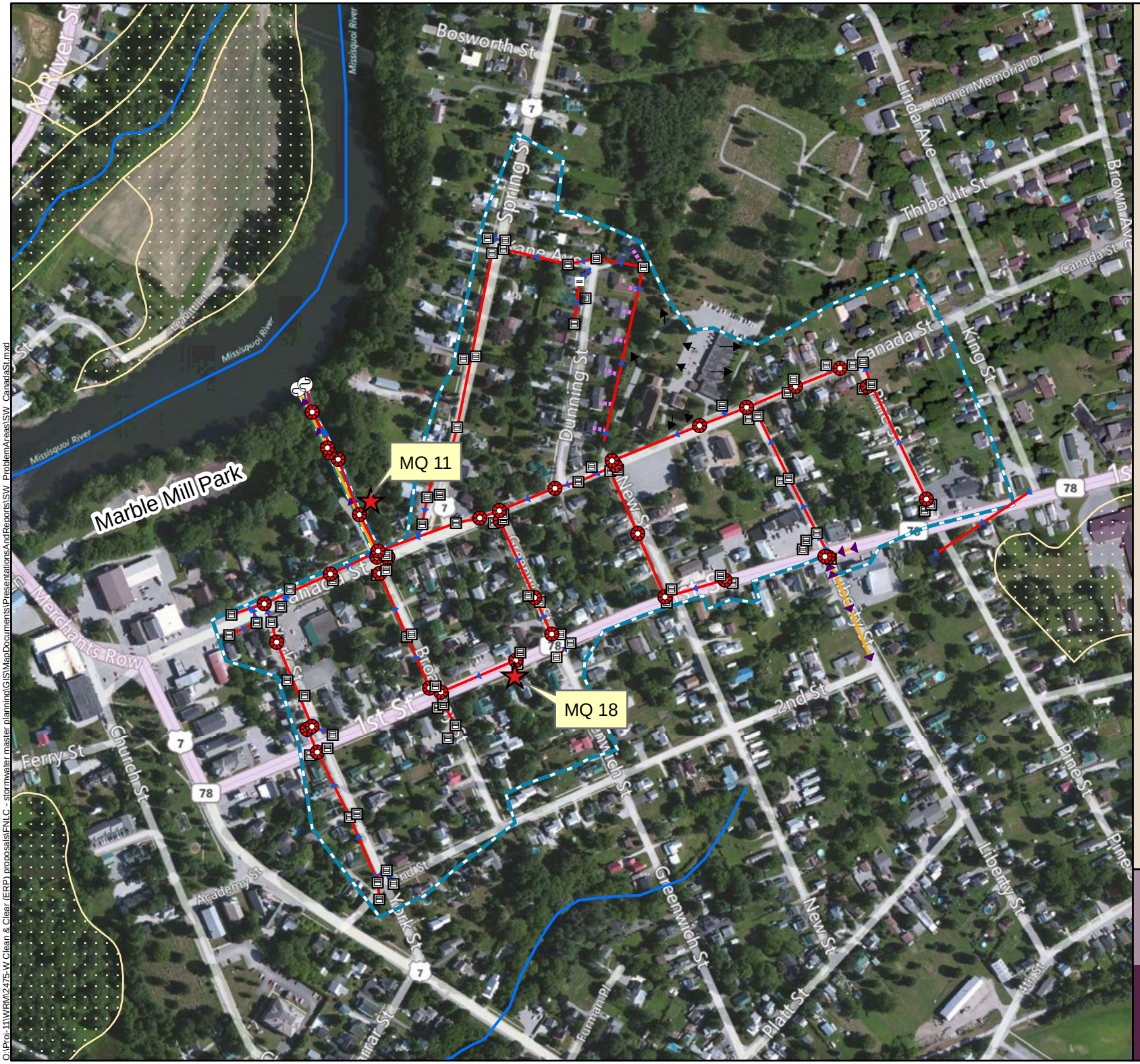

N

0 125 250 500 Feet

Legend

- SW Treatment Opportunity
- Catchbasin
- Stormwater Manhole
- Outfall
- Storm line or culvert
- Storm line (old Sanitary)
- Footing drain
- Overland flow
- River or Stream
- Drainage Area (60 Acres)
- Erodible Soils (k > 0.17)

Treatment Opportunities:
MQ 11: Potential for wet pond behind 33 Canada St.

MQ 18: Rain garden potential on First St.

Sources: Stormwater Infrastructure, Stormsewer Subwatersheds: VT DEC; Problem Areas: Stone; Future Growth Areas: Swanton Town and Village Municipal Plan (2010); Potential Erosion Areas: SSURGO; Hydrography, Roads: VCGI; Imagery: Bing Maps.

STONE ENVIRONMENTAL INC

Canada St., First St.
Missisquoi River
Watershed

MQ 11, 18

Swanton Stormwater
Management Planning

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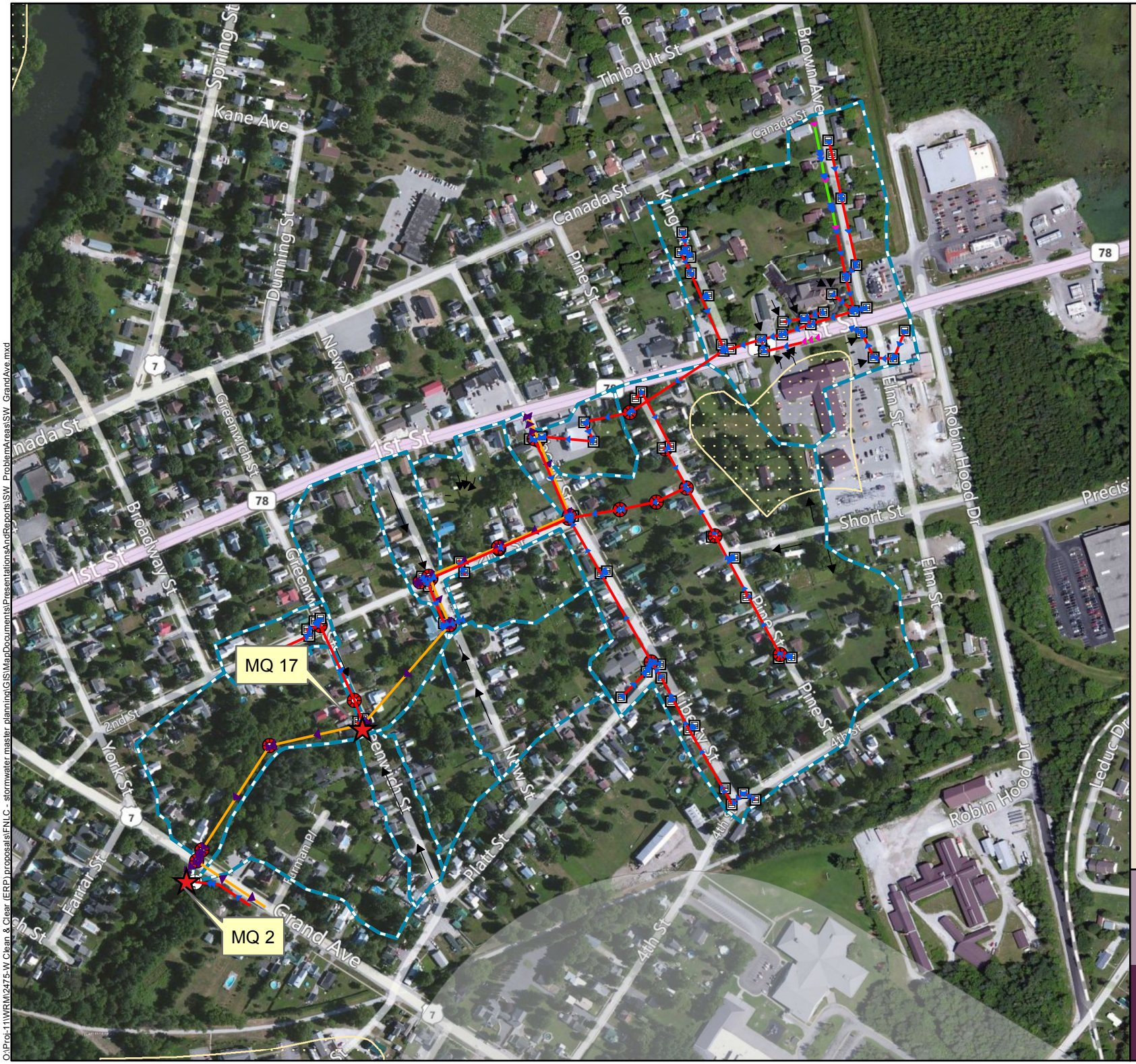

N

HIGHGATE
SWANTON
ST. ALBANS TOWN

0 125 250 500 Feet

Legend

- SW Treatment Opportunity
- Storm line or culvert
- Storm line (old Sanitary)
- Swale
- Overland flow
- Catchbasin
- Stormwater Manhole
- Outfall
- Drainage Area (73 Acres)
- Future Growth Areas
- Erodible Soils (k > 0.17)

Treatment Opportunities:
MQ 2: Ravine on Grand Ave.

MQ 17: Culverted stream on Greenwich St.

Sources: Stormwater Infrastructure, Stormsewer Subwatersheds: VT DEC; Problem Areas: Stone; Future Growth Areas: Swanton Town and Village Municipal Plan (2010); Potential Erosion Areas: SSURGO; Hydrography, Roads: VCGI; Imagery: Bing Maps.

STONE ENVIRONMENTAL INC

Grand Ave and Greenwich St, Missisquoi River

MQ 2, 17

Swanton Stormwater Management Planning

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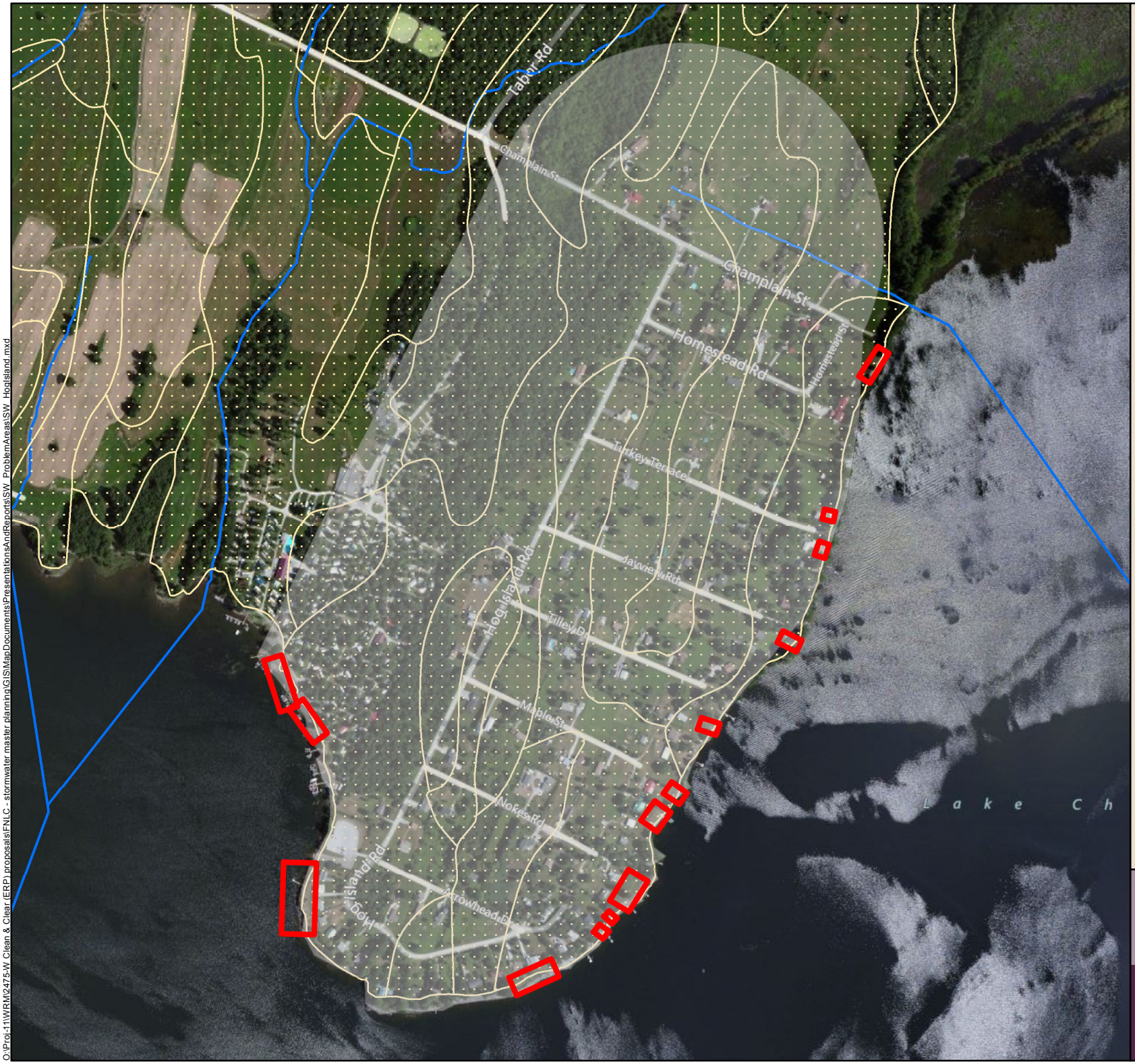

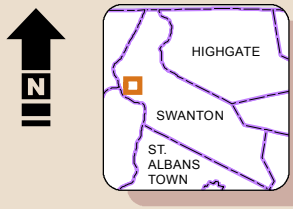

0 150 300 600
Feet

Legend

- River or Stream
- Treeless Shoreline Area
- Future Growth Areas
- Erodible Soils (k > 0.17)

Treatment Opportunity:
Tabor Point is an area of high density development, with minimal tree cover on shoreline.

Sources: Stormwater Infrastructure, Stormsewer Subwatersheds: VT DEC; Problem Areas: Stone; Future Growth Areas: Swanton Town and Village Municipal Plan (2010); Potential Erosion Areas: SSURGO; Hydrography, Roads: VCGI; Imagery: Bing Maps.

STONE ENVIRONMENTAL INC

Hog Island Rd, Lake Champlain Watershed

LC 1

Swanton Stormwater Management Planning

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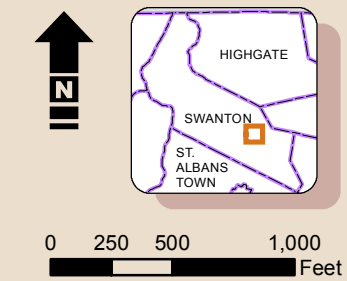

Legend

- SW Treatment Opportunity
- River or Stream
- Erodible Soils (k > 0.17)

Treatment Opportunity:
Three bridges and two culverts in reach M06 in need of repair or removal.

Sources: Stormwater Infrastructure, Stormsewer Subwatersheds: VT DEC; Problem Areas: Stone; Future Growth Areas: Swanton Town and Village Municipal Plan (2010); Potential Erosion Areas: SSURGO; Hydrography, Roads: VCGI; Imagery: Bing Maps.

STONE ENVIRONMENTAL INC

Highgate Rd/Route 207,

Hungerford Brook

HB 5-M06

Swanton Stormwater Management Planning

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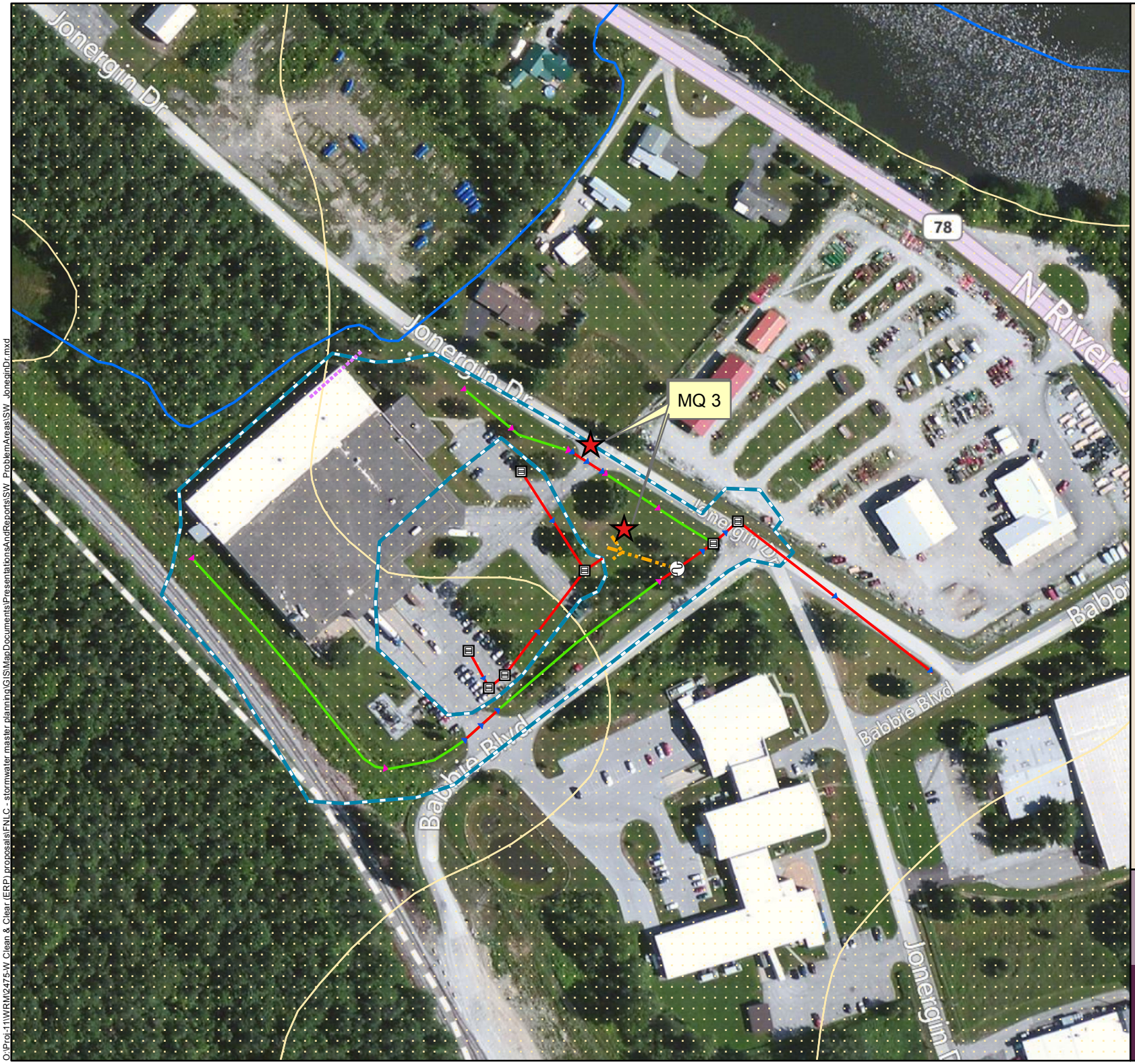

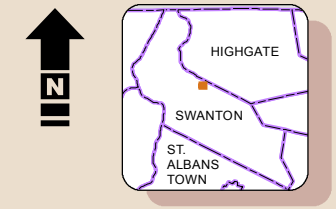

Legend

- SW Treatment Opportunity
- Catchbasin
- Outfall
- Storm line or culvert
- Swale
- Footing drain
- Under drain
- River or Stream
- Drainage Area (7 Acres)
- Erodible Soils (k > 0.17)

Treatment Opportunity:
Stagnant water in Jonergin Dr. ditches causes discolored discharges during heavy storms.

Sources: Stormwater Infrastructure, Stormsewer Subwatersheds: VT DEC; Problem Areas: Stone; Future Growth Areas: Swanton Town and Village Municipal Plan (2010); Potential Erosion Areas: SSURGO; Hydrography, Roads: VCGI; Imagery: Bing Maps.

STONE ENVIRONMENTAL INC

Babbie Blvd, Missisquoi River Watershed

MQ 3

Swanton Stormwater Management Planning

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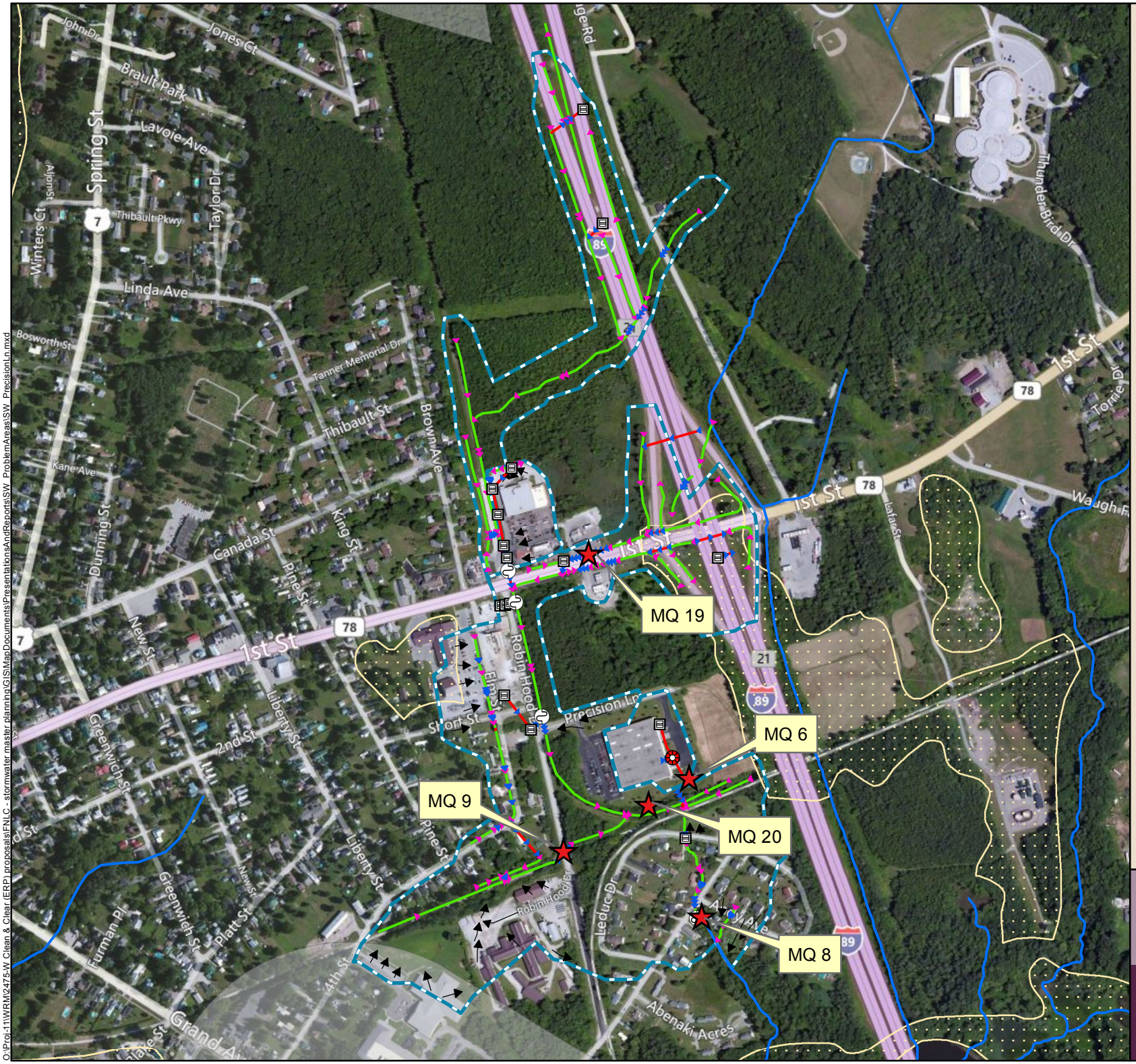

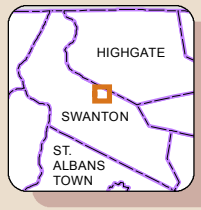

0 200 400 800 Feet

Legend

- SW Treatment Opportunity
- Catchbasin
- Stormwater Manhole
- Outfall
- Storm line or culvert
- Swale
- Overland flow
- River or Stream
- Drainage Area (101 Acres)
- Future Growth Areas
- Erodible Soils (k > 0.17)

Treatment Opportunities:
MQ 6: Retrofit potential
MQ 8: Culverted stream outfall
MQ 9: Clogged culvert, Robinhood Dr
MQ 19: Retrofit potential
MQ 20: Treatment potential in meadow

Sources: Stormwater Infrastructure, Stormsewer Subwatersheds: VT DEC; Problem Areas: Stone; Future Growth Areas: Swanton Town and Village Municipal Plan (2010); Potential Erosion Areas: SSURGO; Hydrography, Roads: VCGI; Imagery: Bing Maps.

STONE ENVIRONMENTAL INC

First St, Precision Ln, Andy Ave.
Missisquoi Watershed

Multiple

Swanton Stormwater Management Planning

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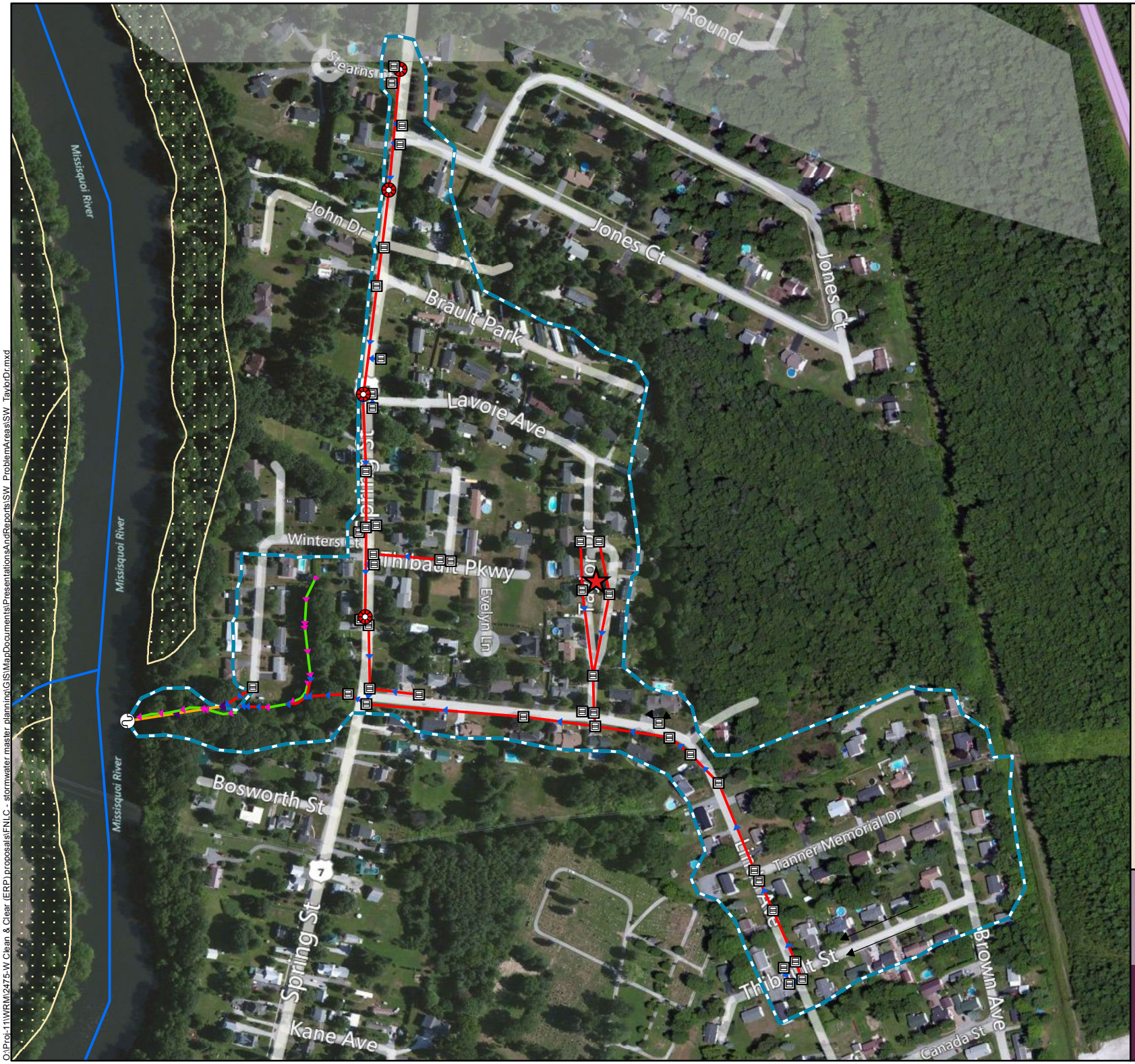

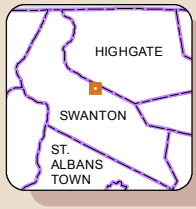

0 100 200 400 Feet

Legend

- SW Treatment Opportunity
- Catchbasin
- Stormwater Manhole
- Outfall
- River or Stream
- Storm line or culvert
- Storm line (old Sanitary)
- Swale
- Overland flow
- Drainage Area (45 Acres)
- Future Growth Areas
- Erodible Soils (k > 0.17)

Treatment Opportunity:
Downspout disconnection and/or infiltration area potential on Taylor Dr.

Sources: Stormwater Infrastructure, Stormsewer Subwatersheds: VT DEC; Problem Areas: Stone; Future Growth Areas: Swanton Town and Village Municipal Plan (2010); Potential Erosion Areas: SSURGO; Hydrography, Roads: VCGI; Imagery: Bing Maps.

STONE ENVIRONMENTAL INC

Taylor Dr., Missisquoi River Watershed

MQ 21

Swanton Stormwater Management Planning

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APPENDIX E: CONCEPTUAL SOLUTIONS FOR HIGHEST PRIORITY STORMWATER PROBLEM AREAS

January 8, 2013

MEMO

To: Paul Madden, Executive Director
Friends of Northern Lake Champlain
P.O. Box 58
Swanton, VT 05488

STONE ENVIRONMENTAL INC

535 Stone Cutters Way
Montpelier, Vermont
05602 USA

Phone / 802.229.4541
Fax / 802.229.5417
Web Site / www.stone-env.com

From: Jeremy Krohn
Direct Phone: 802-552-1005
E-Mail: jkrohn@stone-env.com

SEI No. 11-2475
Re: Swanton SWMP: Priority Projects

1.0 INTRODUCTION

During the spring and summer of 2012, Stone staff identified and evaluated problem areas in Swanton Village and Town. The evaluation criteria gave priority to those problem areas with the most significant potential impact to water quality and/or where effective treatment was most feasible. Stone then revisited the highest priority sites to further investigate treatment potential and gather additional information needed to develop conceptual solutions.

The intent of this memo is to present the list of high priority stormwater improvement projects within Swanton Village and Town; projects have been screened based on their feasibility and potential to improve water quality. All references to soil types are based on reports produced by the USDA-NRCS Web Soil Survey[1]. Measurements, watershed delineations, and direction of flow as reported in this memo are based on GIS analysis or field investigation. While this information is sufficient to support pre-engineering design, final design will require field confirmation of all values.

1 http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

1.1 Swanton Village Municipal Complex

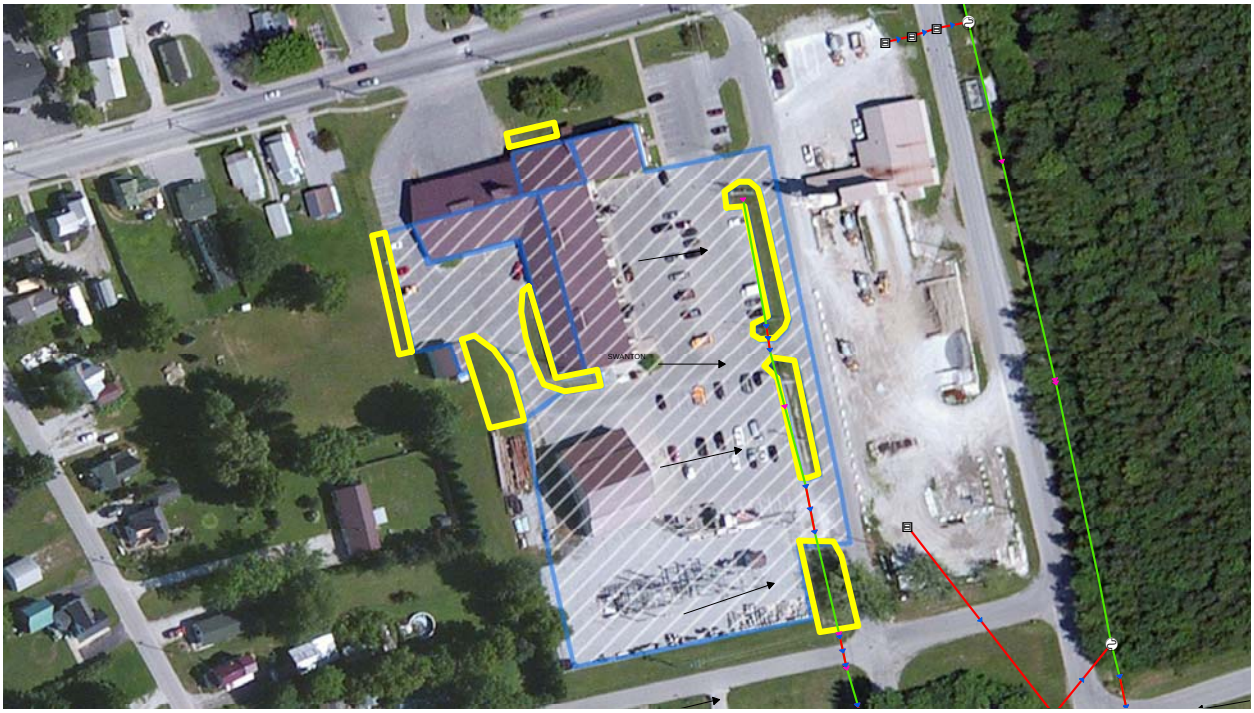

Figure 1. Swanton Village water office, fire department, and road maintenance garage: Treatable impervious area highlighted in blue and locations for potential treatment practices highlighted in yellow.

Stormwater from three acres of impervious surface at the Swanton Village Municipal Complex and adjacent electrical substation could be routed through potential stormwater treatment practices (STPs) located as shown in yellow in Figure 1.

Nearly all of the 3-acre area is impervious surface in the form of rooftops, asphalt, and the gravel pad of the substation. Impervious surface that is considered to be treatable is highligthed in blue in Figure 1. Predominant soil types are Windsor loamy fine sand (HSG A) with a deep water table. This means there is potential to soak away a large amount of stormwater that is currently running-off from this property.

The existing swales along Elm St. provide excellent opportunities for relatively simple, yet effective infiltration-based STPs (potential locations for these practices are shown in Figure 2 through Figure 4). The presence of underground utilities in the area will need to be fully and carefully investigated as part of any future design.

Figure 2. The absence of curbs along the large green strip at the Village garage simplifies design and construction of stormwater treatment practices at this location.

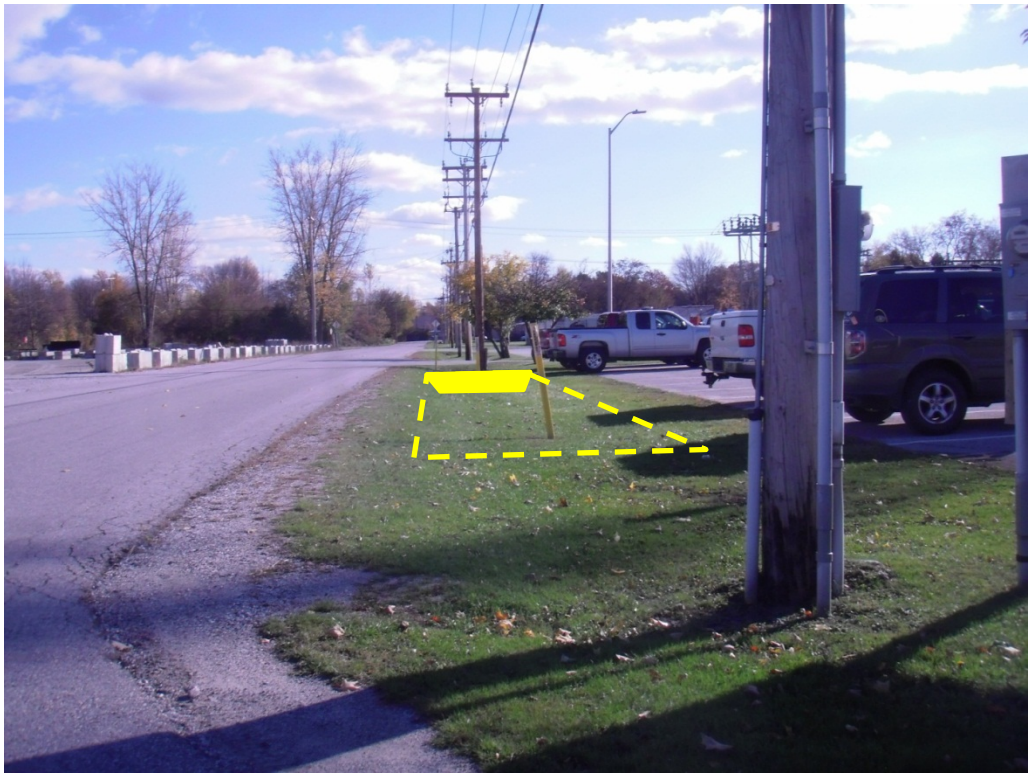

Figure 3. The existing shallow swale could easily be modified to enhance infiltration of stormwater runoff.

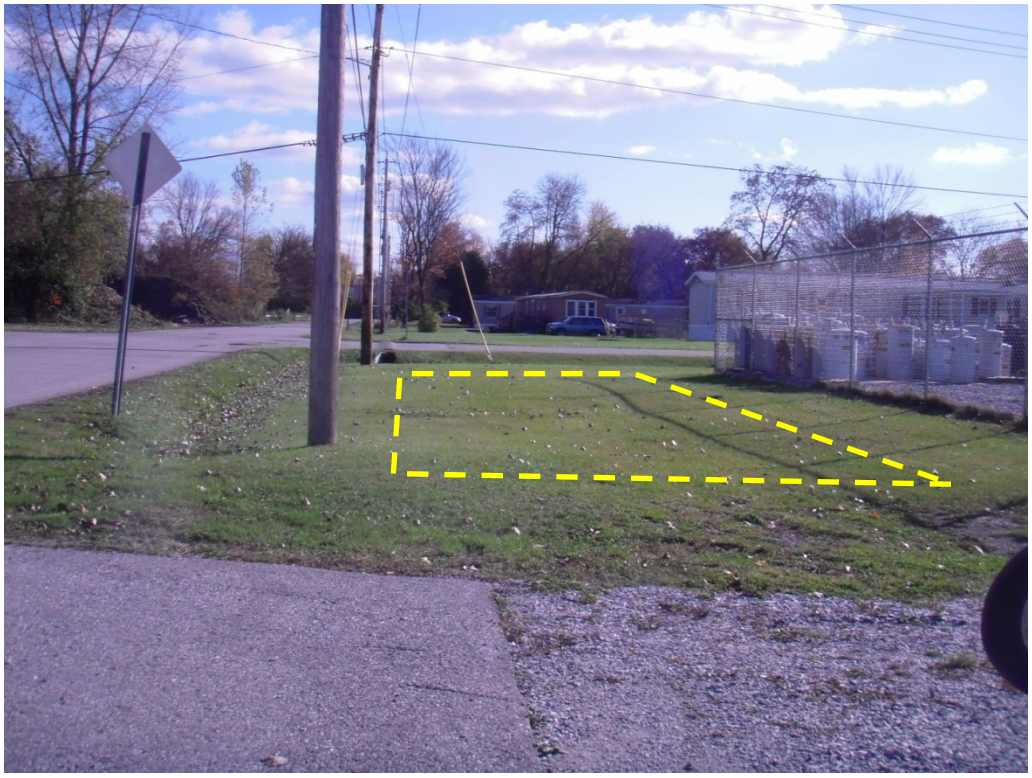

Figure 4. A large unused portion of greenspace in front of the electrical substation could be utilized to treat stormwater runoff from the substation and adjacent town properties.

1.2 I-89 Interchange Exit 21 (Town)

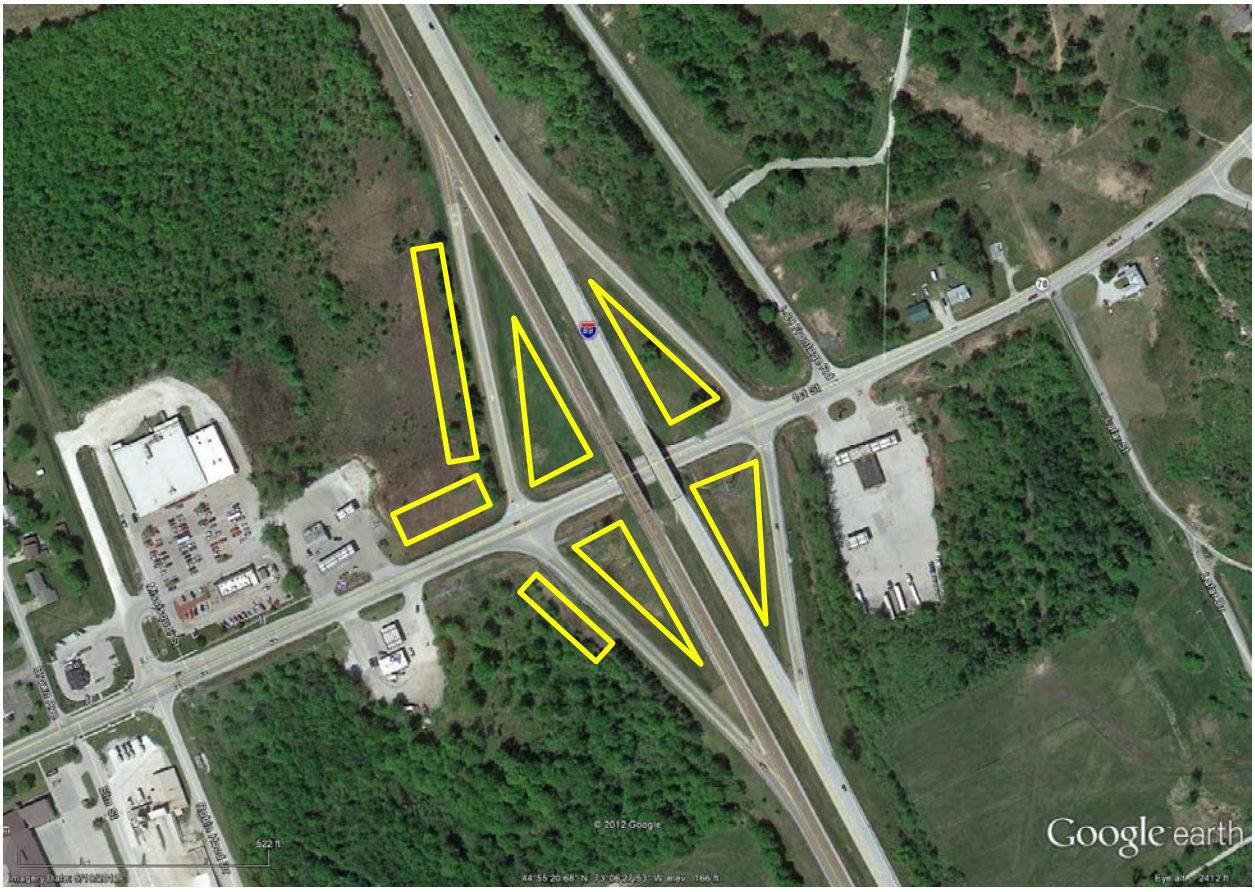

Figure 5. I-89 (Exit 21)-VT RT 78 Interchange. Potential sites for stormwater treatment practices highlighted in yellow.

Green space within and adjacent to the I-89 Exit 21 interchange could accommodate the construction of stormwater treatment practices. The diamond interchange at Exit 21 includes a stormwater conveyance system that drains the highway. The 30-acre subwatershed includes 3.8 acres of impervious surface. The large amount of space and existing conveyance structures simplify design and construction efforts required to implement a stormwater treatment practice at this location. A storm water treatment practice similar to that which was recently constructed in the highway median near I-89 Exit 20 could be effective here.

The most suitable practices are likely to be bioretention and filtration systems that include an underdrain. Soils are reported by the USGS to be Georgia stony loam and Massena stony loam, Hydrologic Soil Group (HSG) C with high water tables. These characteristics mean that infiltration cannot be expected to be a suitable treatment practice. Additionally, roadway subsoil strength can be affected by saturated soils. The proximity of the roadway further supports the need for non-infiltration-based systems.

Conceptual examples and potential stormwater treatment practice locations are shown in yellow in Figure 6 through Figure 8.

Figure 6. Conceptual example of STP installation within interchange diamond.

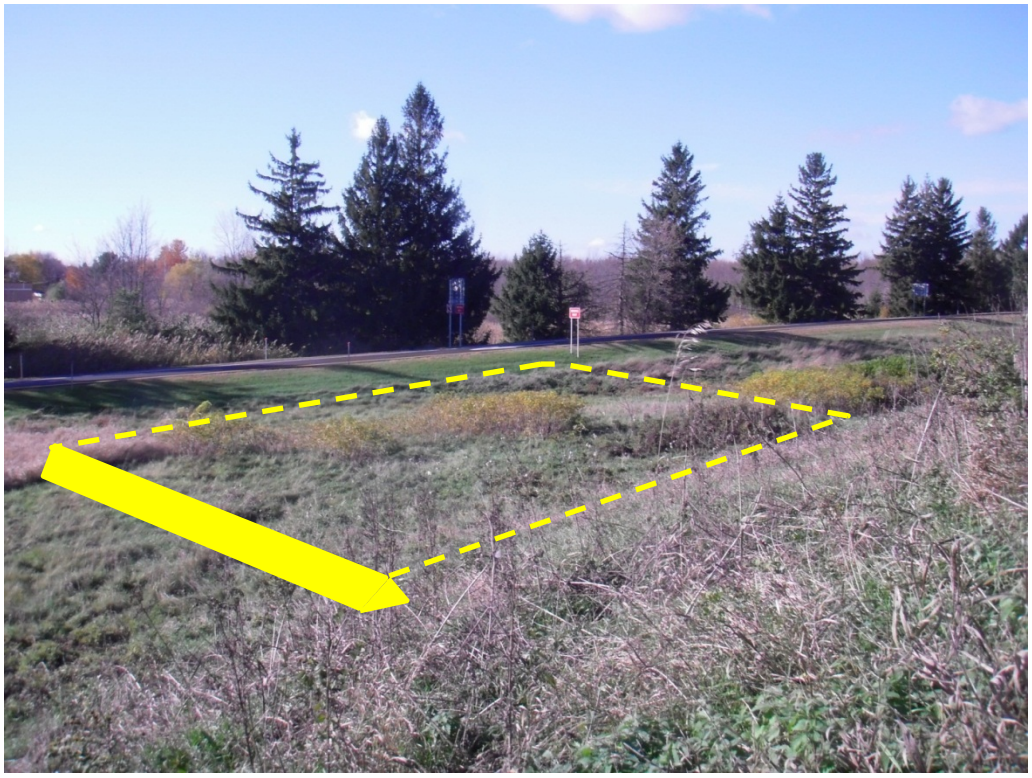

Figure 7. Another view of a conceptual STP layout within the I-89 Exit 21 interchange diamond.

Figure 8. Conceptual location of STP outside of the I-89/Exit 21 interchange.

1.3 Taylor Drive (Village)

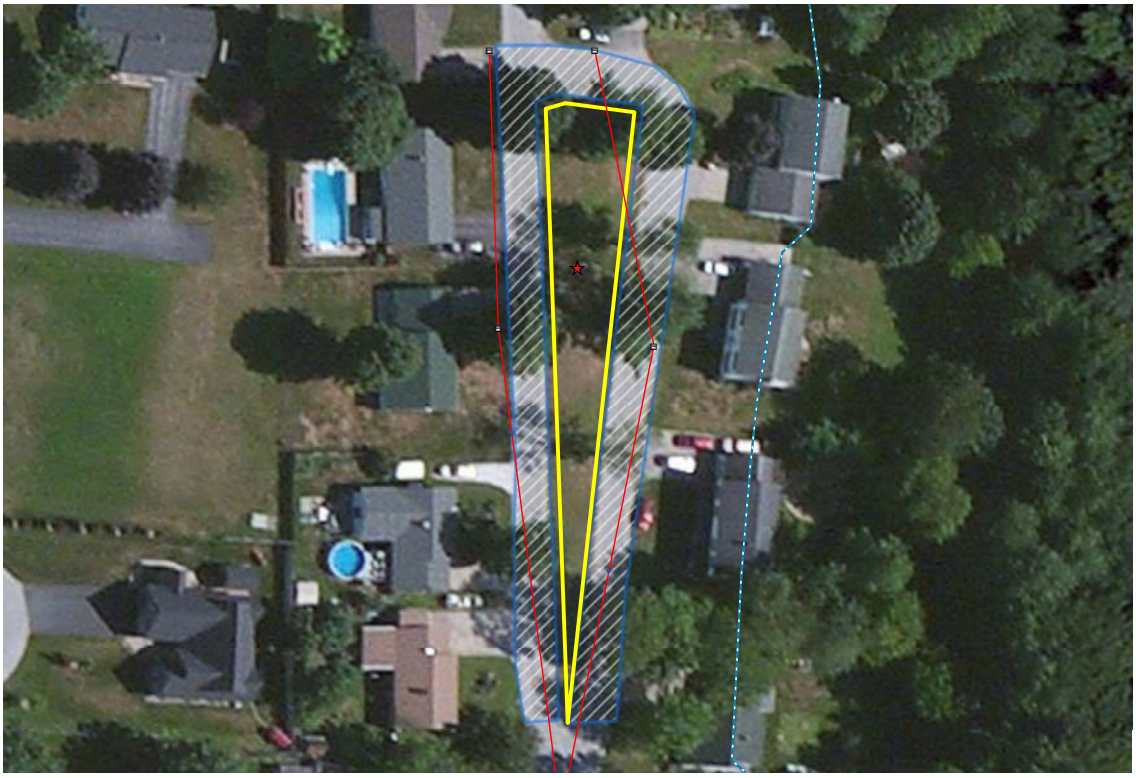

Figure 9. The Taylor Drive cul-de-sac offers ample treatment opportunity (shown in yellow). The contributing impervious area is outlined in blue.

Taylor Drive is a residential street with a large cul-de-sac that includes a median that is well-suited for stormwater treatment. Currently, water drains from the street and some of the adjacent residential lots toward the cul-de-sac where it is collected in catch basins along the existing curb.

The reported soil types in the area are Windsor loamy fine sand (HSG A) with a deep water table. This means that infiltration practices could be used to soak away a large portion of stormwater runoff from this neighborhood. Curb cuts could allow stormwater to drain to a potential stormwater treatment practice within the green space at the center of the cul de sac. The existing catch basins are located such that they could act as overflow relief for the proposed stormwater treatment practices. Figure 10 through Figure 12 show conceptual locations for the STPs and associated curb cuts.

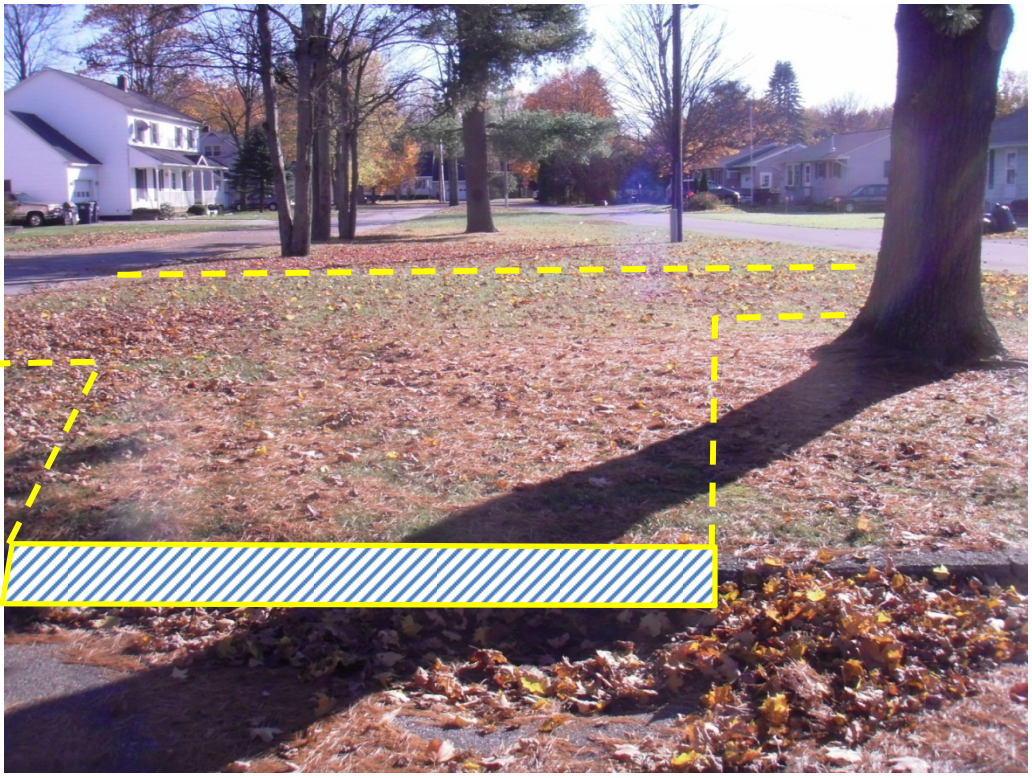

Figure 10. The green space within the cul-de-sac provides a great opportunity for infiltration practices with curb cut inlets.

Figure 11. Curb cuts along street would allow stormwater to drain to STPs inside the cul-de-sac. In high flow events, water would back up and drain to existing catch basins.

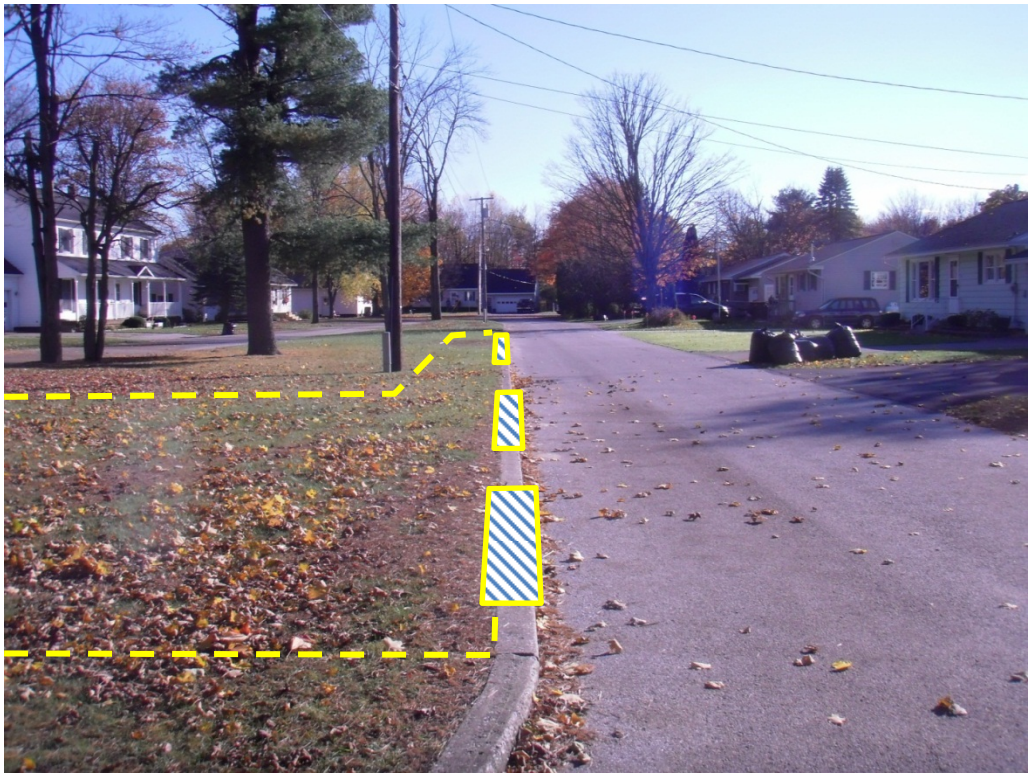

Figure 12. Curb cuts on the east side of the Taylor Dr. cul-de-sac would allow stormwater runoff to access proposed STPs.

1.4 Brooklyn Road at Route 78 (Town)

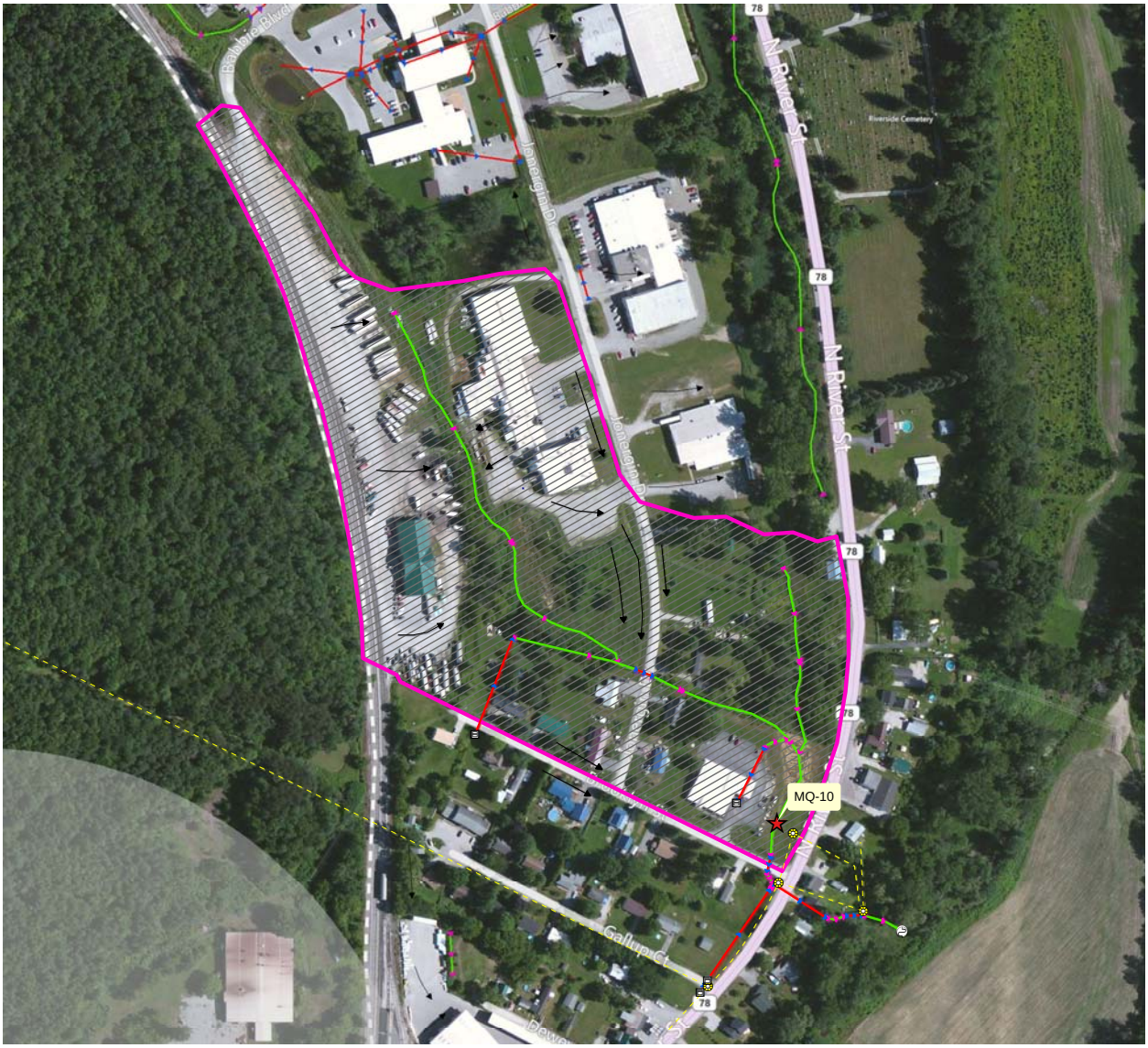

Figure 13. Subwatershed draining to a culvert at the southeast corner of the Fourniers Door and Window business at the corner of Rt. 78 and Brooklyn St.

A significant stormwater treatment opportunity exists near the Fourniers Door and Window property. Stormwater runoff from approximately 22 acres drains to a culvert at the corner of Route 78 and Brooklyn Rd., where the Fournier business is located. This 22 acre subwatershed includes 7.1 acres of impervious surface (approximately 3.6 acres of roof tops and asphalt, and 3.5 acres of compacted gravel surface). Stormwater from this subwatershed appears to receive no treatment before being routed through a culvert under Route 78 and discharged to the Missisquoi River.

There is a large swale on the east side of the Fournier property that extends 250 ft. upslope, north of an existing 24" culvert. Stormwater drains from upslope properties via this swale and picks up runoff from the Fournier property before flowing south through the culvert under Brooklyn St. Approximately 0.5 acres of

open space shown in yellow in Figure 14, appears to be a suitable location for a stormwater treatment practice.

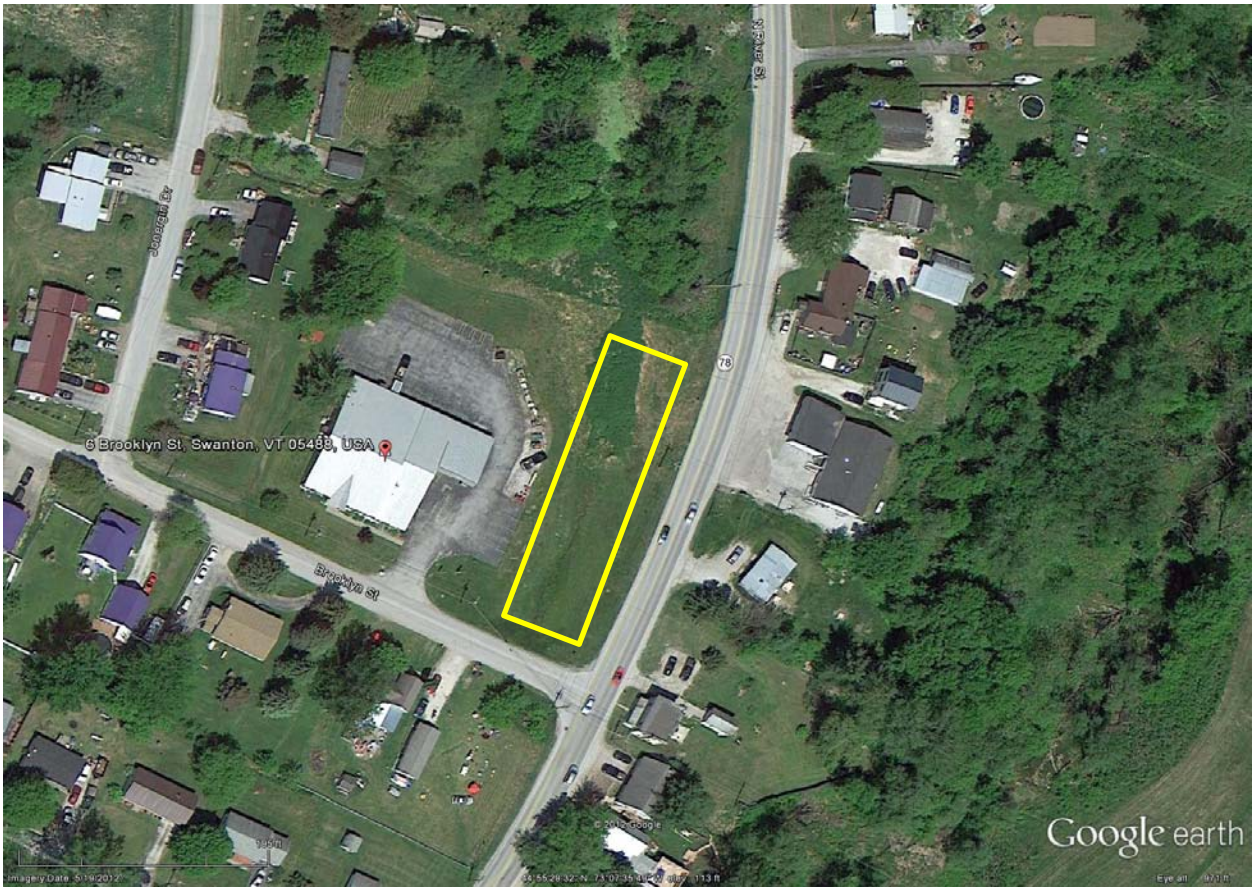

Figure 14. STP opportunity at Brooklyn St. and Route 78 (N. River St.) near Fourniers Door and Window.

Given the existing topographic conditions, a bioretention basin or small treatment wetland would be most appropriate for this property. Alteration of the existing land form would be minimal. The presence of poorly drained soils (HSG D) would necessitate an underdrain system. A practice such as bioretention or constructed-wetland treatment system would detain and slowly release water while removing sediment and solids through settling and filtration. A conceptual location for the proposed STP is shown in Figure 15.

Figure 15. Location for potential treatment at Brooklyn St. and VT Rt. 78 near Fourniers Door and Window business.

1.5 Franklin Northwest Supervisory Union (Swanton Town and Village)

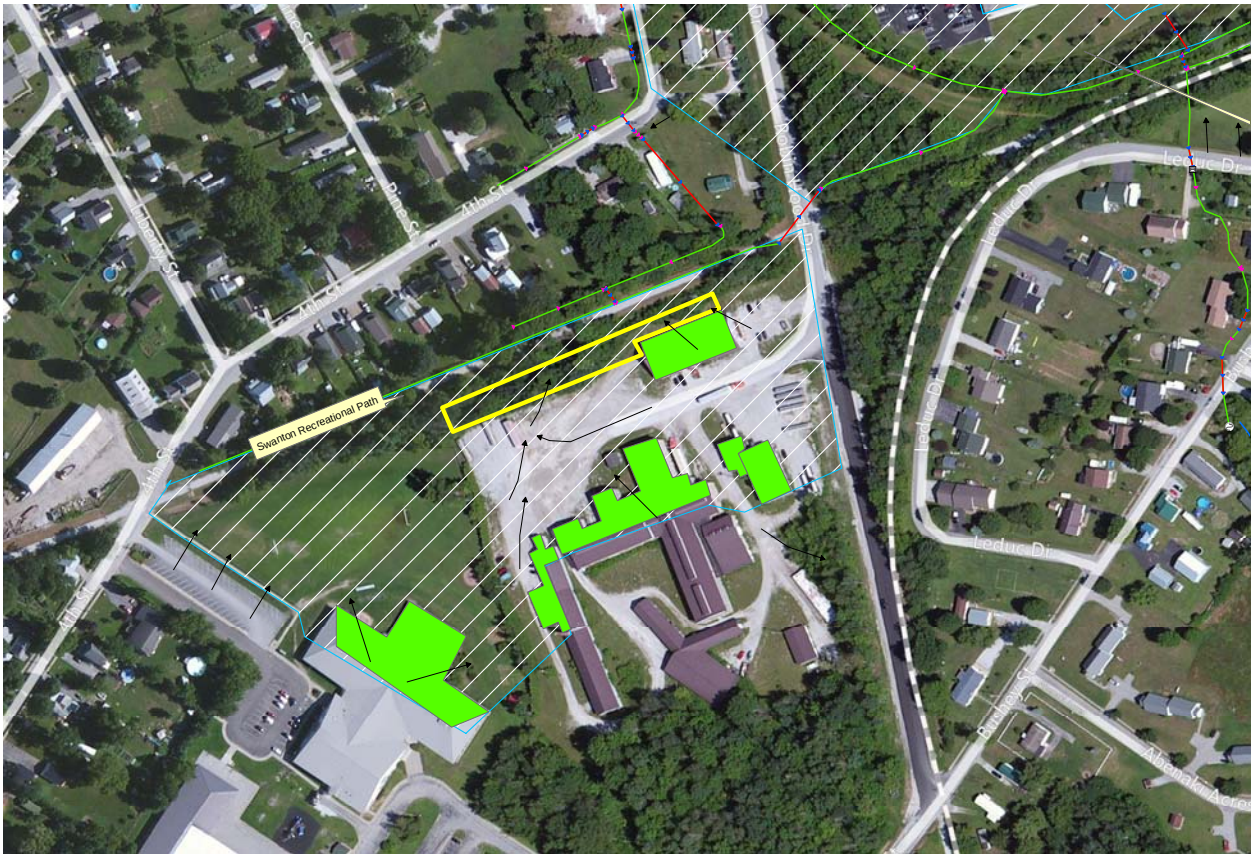

Figure 16. Drainage area at and around Swanton Elementary School: location for potential STP shown in yellow. Rooftop areas that drain to the potential STP are shown in green.

Potential stormwater treatment opportunities exist along the Swanton Recreation Path near Robinhood Drive. The subwatershed contains portions of the Swanton Elementary School and former Robinhood Ammunition plant property. Stormwater drains north to a swale that flows to the northeast along the south side of the recreation path. From the end of this swale, stormwater flows through approximately 0.5 miles of storm sewer and open channel conveyance to the Missisquoi River

The 10.5 acre subwatershed includes 3.2 acres of impervious surface (1.4 acres of roof tops and 1.8 acres of compacted gravel). The remainder of the subwatershed consists primarily of athletic turf on the school property. Athletic fields are often highly compacted and can have low infiltration rates.

A detention and filtration practice, such as a bioretention basin, could be effective in treating runoff from these properties. A conceptual location for an STP is highlighted in yellow in Figure 16 and Figure 17. The prevailing soil type is Deerfield loamy fine sand (HSG B) with a moderately high seasonal water table. This means that infiltration features could improve treatment by soaking away a portion of the treated runoff. Still, an underdrain system is recommended to ensure proper drainage throughout the year.

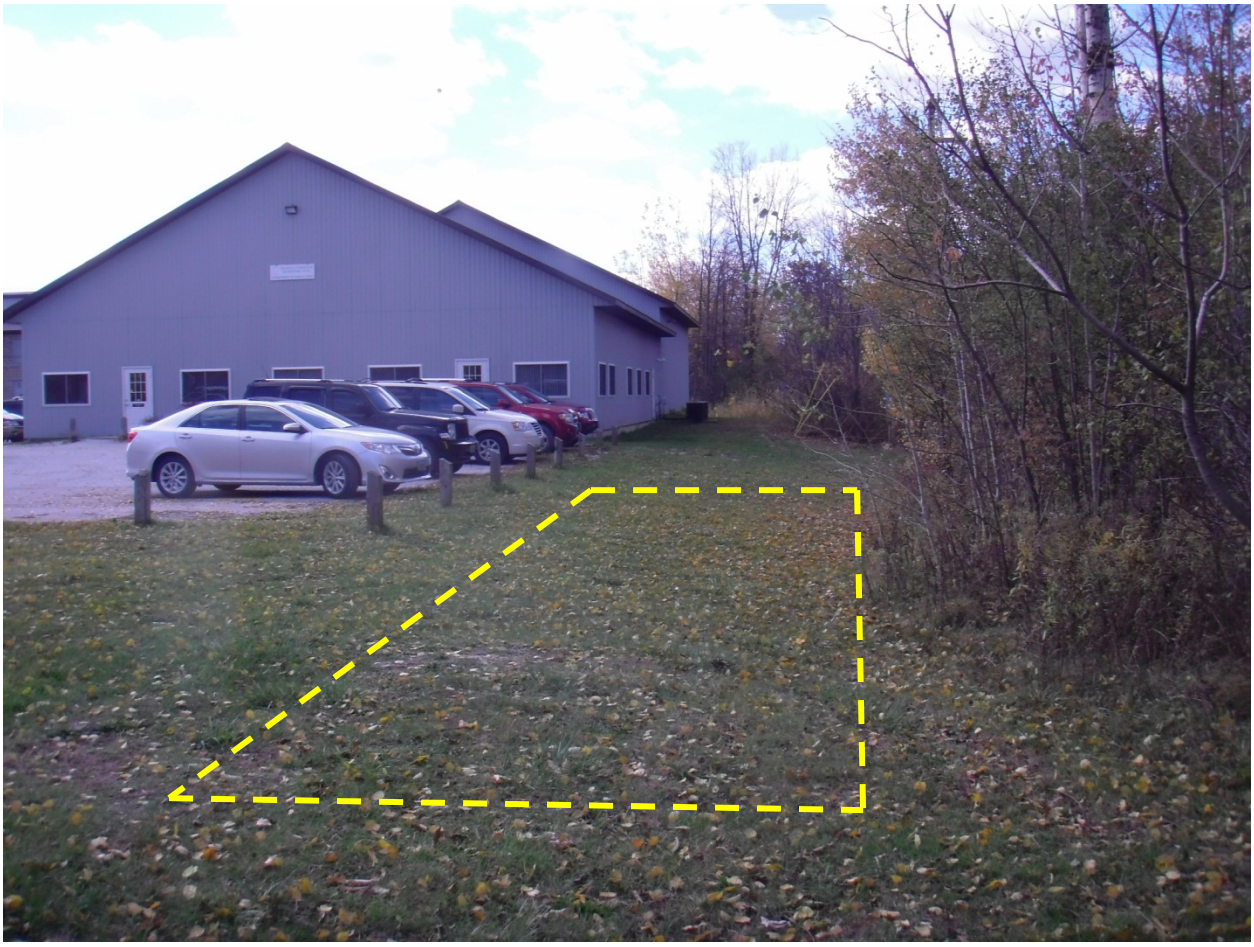

Figure 17. Proposed location for stormwater treatment at the former Robinhood Ammunition property.

Additionally, or as an alternative, it may be possible to modify the existing swale along the recreation path to enhance stormwater treatment (see Figure 18). Beyond improving water quality, installing an STP at this location will improve the aesthetic conditions along the recreation path, while providing an educational opportunity. The proximity of Swanton Elementary School and the recreation path would mean that an STP at this location could be accessible by student groups and visible to recreation path users. Interpretive signage could be used to inform users of the recreational path about water quality, stormwater treatment practices, and the benefits to the community and local environment.

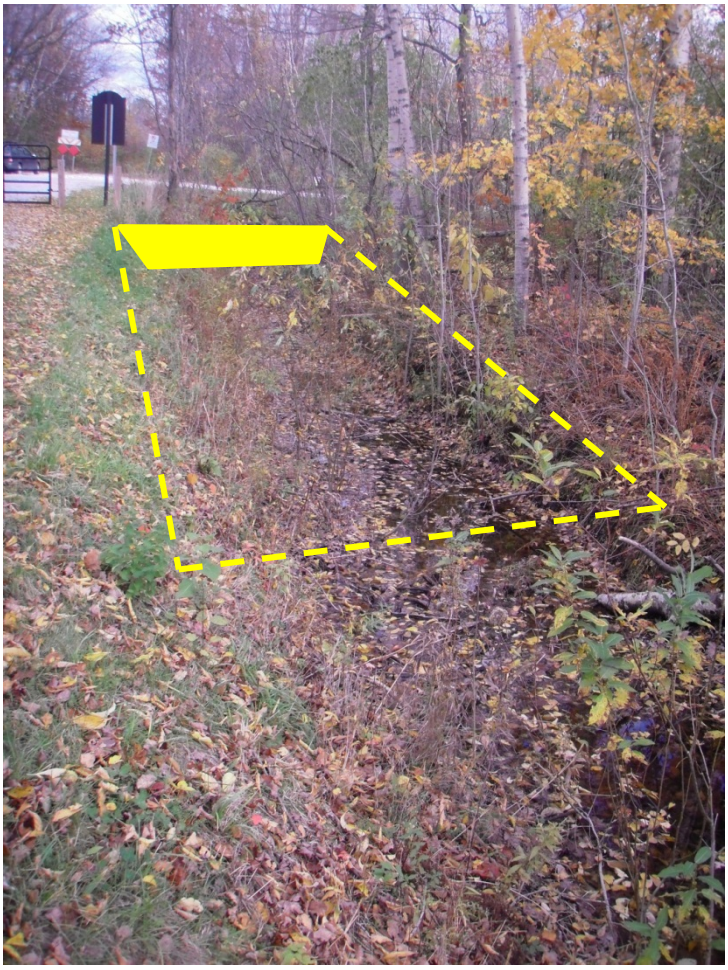

Figure 18. The existing swale along the recreation trail could be modified to improve stormwater treatment.

1.6 Jonergrin Drive Industrial Area (Town)

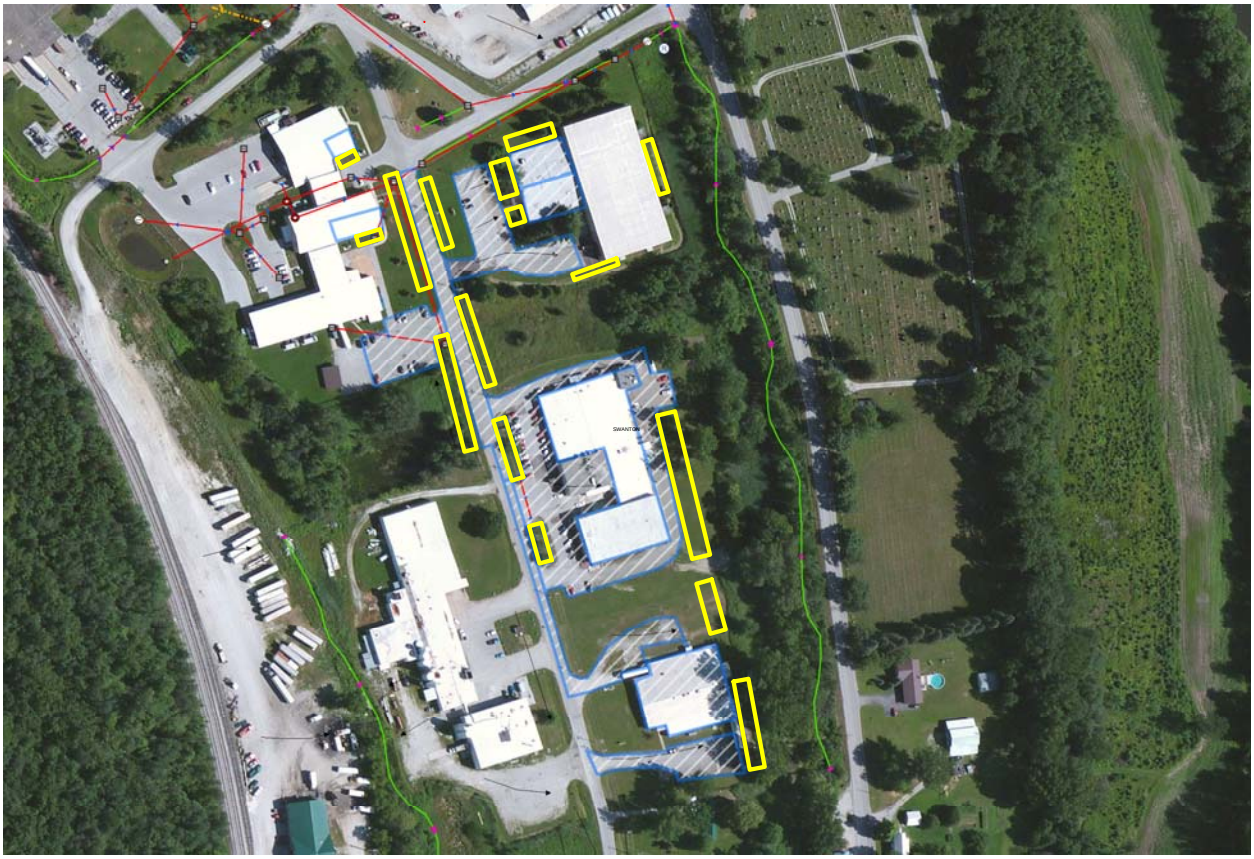

Figure 19. Stormwater from a large segment of the industrial development near Jonegrin Dr. and Babbie Blvd. is untreated and drains to the Missisquoi River. Treatable impervious area is highlighted in blue and potential locations for STPs highlighted in yellow.

The industrial area along Jonegrin Dr. and Babbie Blvd. includes a significant amount of impervious area; 3.9 acres within the subwatershed have been identified as potentially treatable. Stormwater runoff from this subwatershed makes its way to the Missisquoi River with no retention and little, if any, treatment. Many options have been identified for location of STPs as shown by the yellow highlight in Figure 19. Stormwater from a large segment of the industrial development near Jonegrin Dr. and Babbie Blvd. is untreated and drains to the Missisquoi River. Treatable impervious area is highlighted in blue and potential locations for STPs highlighted in yellow.

Massena stony loam and Raynham silt loam are the predominant soil types in this area. Both soils are reported to be HSG C with a shallow water table. Infiltration practices will not be a likely option. However, many opportunities exist for retrofitting the existing stormwater infrastructure with filtration-type treatment practices (see Figure 20).

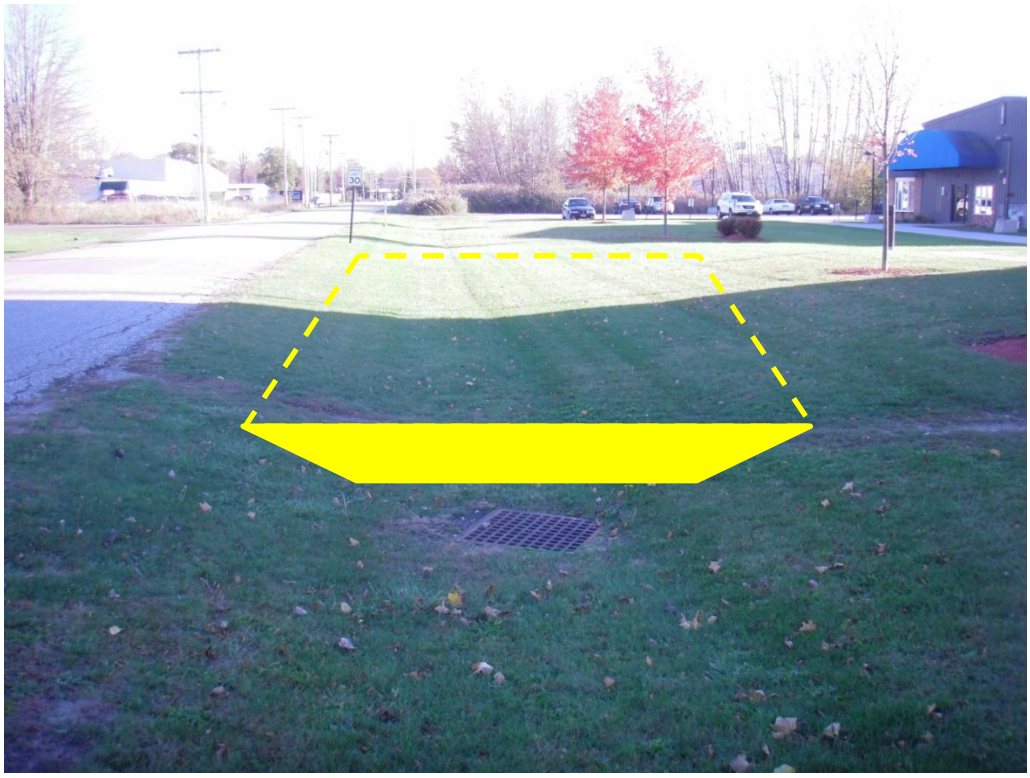

Figure 20. Existing catch basins in front of the Mylan Technologies building and neighboring property could easily be retrofitted with filtration practices.

1.7 Thibault Parkway (Village)

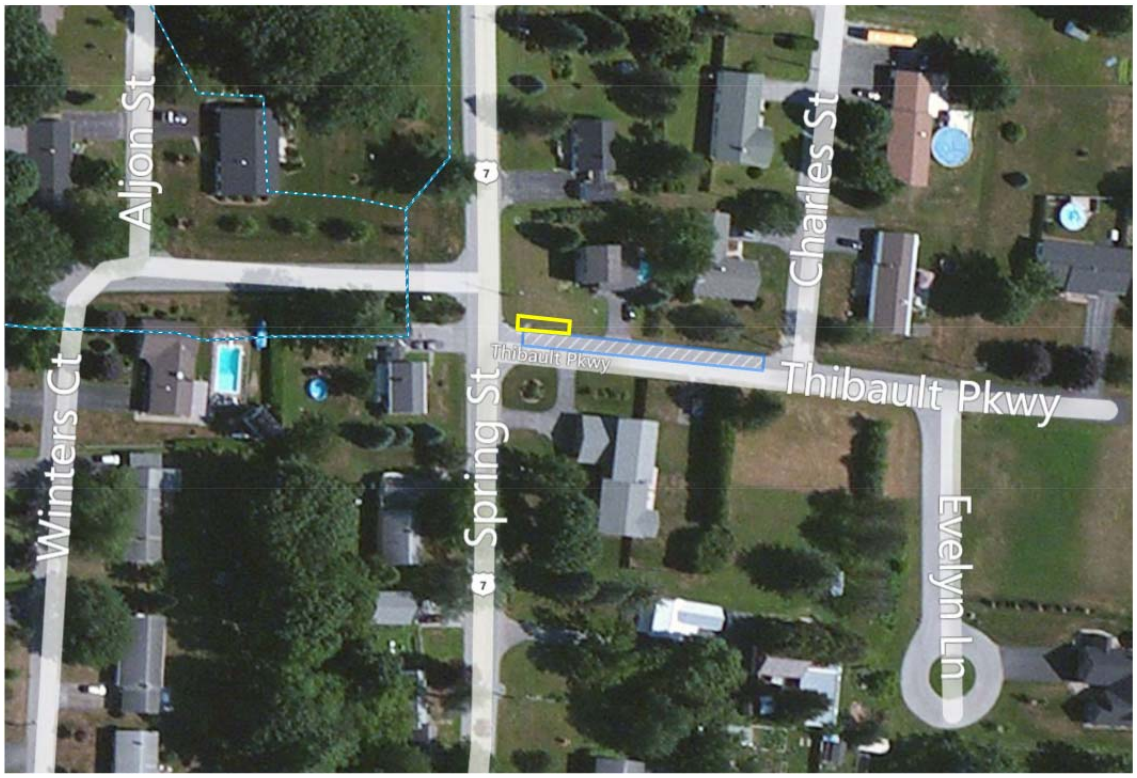

Figure 21. Stormwater treatment opportunity at corner of Thibault Pkwy and Spring St.

A catch basin adjacent to Thibault Parkway could be retrofitted and utilized as part of an STP, such as a simple rain garden. Site conditions, including Windsor loamy fine sand (HSG A) and a deep water table, would enable detention and infiltration of a significant portion of stormwater runoff from 0.04 acres of impervious surface draining to the existing catch basin.

Figure 22. Catch basin on the corner of Thibault Pkwy and Spring St. could be retrofitted with an STP, such as a rain garden.

1.8 Greenwich St. (Village)

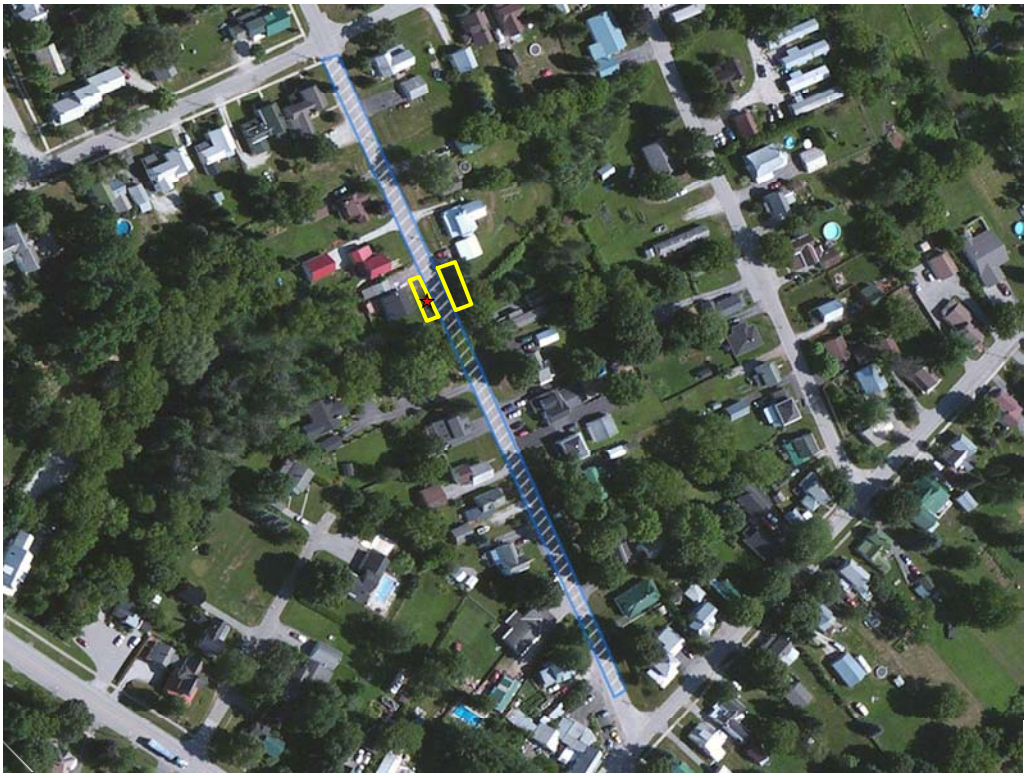

Figure 23. Greenwich Ave. drains to two existing catch basins near the middle of the block where two STPs could be located.

Two existing catch basins on Greenwich St. between 2nd St. and Platt St. are well-situated to be utilized as part of stormwater treatment practice. Approximately 0.4 acres of Greenwich Ave. drains toward the center of the block where stormwater is collected by two existing catch basins on either side of the street.

The predominant soil type is reported to be Windsor loamy fine sand (HSG A) with a deep water table. This means that there is potential to soak away a large portion of the stormwater draining from this neighborhood. The existing catch basins could then act as overflow relief for an infiltration-based STP.

Figure 24. Catch basins on along Greenwich St. could be modified and used as overflow relief for an infiltration focused STP.

1.9 Grand Ave. (Village)

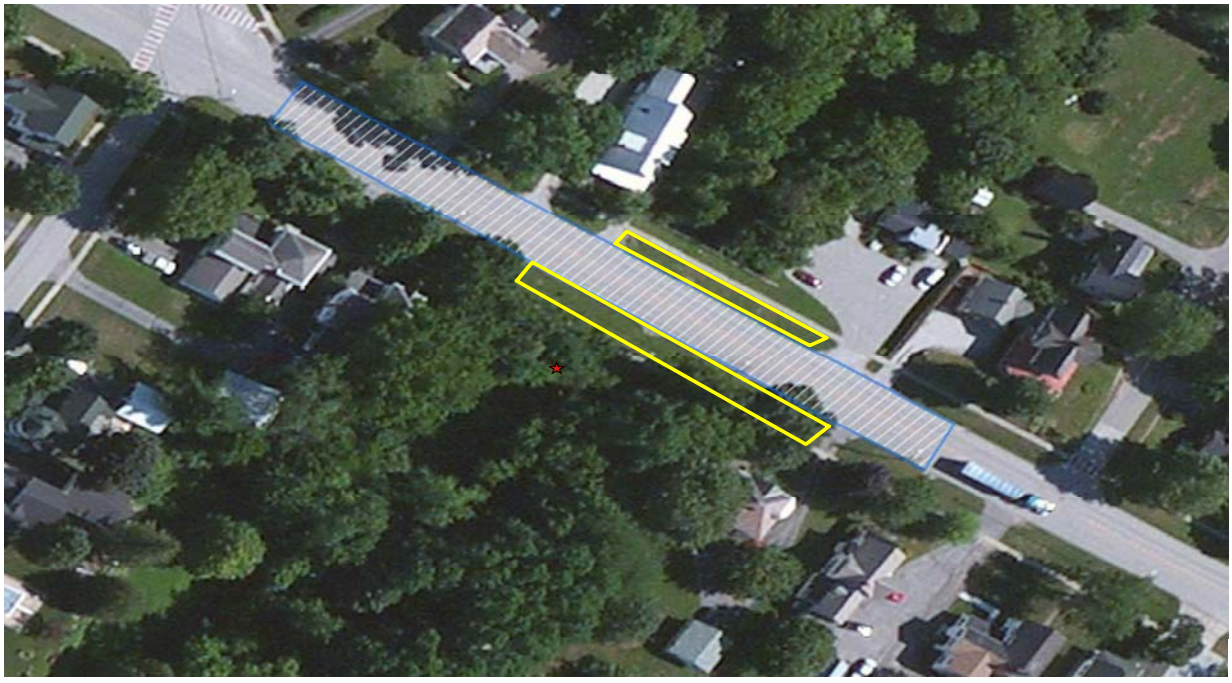

Figure 25. Grand Ave. stormwater could be treated with infiltration practices located between Farrar St. and Furnam Pl.

Stormwater runoff from 0.3 acres of Grand Ave., between Farrar St. and Furman Place, could be treated before draining to existing catch basin in the green strip. Stormwater drains toward the center of the block from both directions. Catch basins between the street and sidewalk collect stormwater on either side of Grand Ave. The predominant soil type is Windsor fine sand (HSG A) with a low water table.

Given the well-drained soils and position of existing catch basins, stormwater from this section of Grand Ave., could be treated with an infiltration-based STP (see Figure 26 and Figure 27). Water would infiltrate the underlying soils, or otherwise be slowly released with sediment removal occurring through settling and filtration.

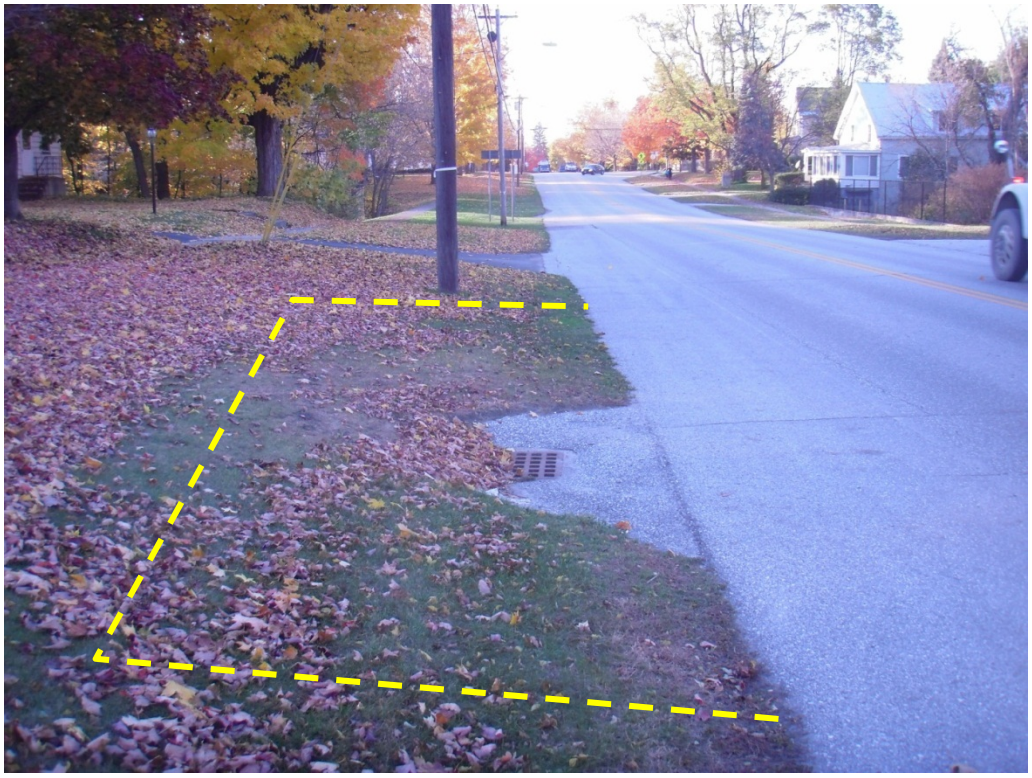

Figure 26. Catch basin on north side of Grand Ave. that could be modified as part of an STP.

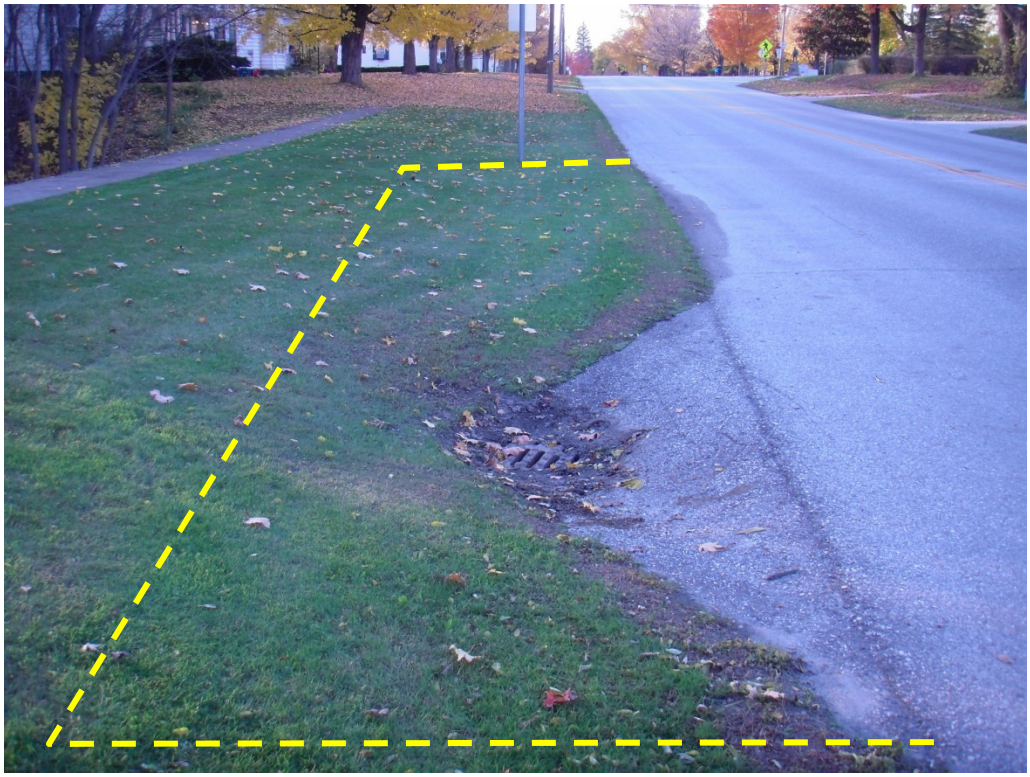

Figure 27. Catch basin on north side of Grand Ave. that could be modified as part of an STP.

1.10 Marble Mill Park (Village)

A significant portion of the stormwater runoff from the closed drainage system in Swanton Village is piped to Marble Mill Park, where it is discharged without treatment to the Missisquoi River. The area of the park near this outfall also contributes untreated runoff to the Missisquoi, including active erosion in the road and path leading to the park, runoff from the parking lot, and a washout leading from the park to the river's edge hear the outfall. The Village previously worked with the Northwest Regional Planning Commission to obtain grant funding from VT DEC to develop a comprehensive solution for stormwater management at Marble Mill Park, and a design has been prepared. Unfortunately the Village has faced a number of challenges in seeing the design implemented, including concerns raised over any construction activity within the 100-year floodplain of the Missisquoi, and as a result nothing has been built to date.

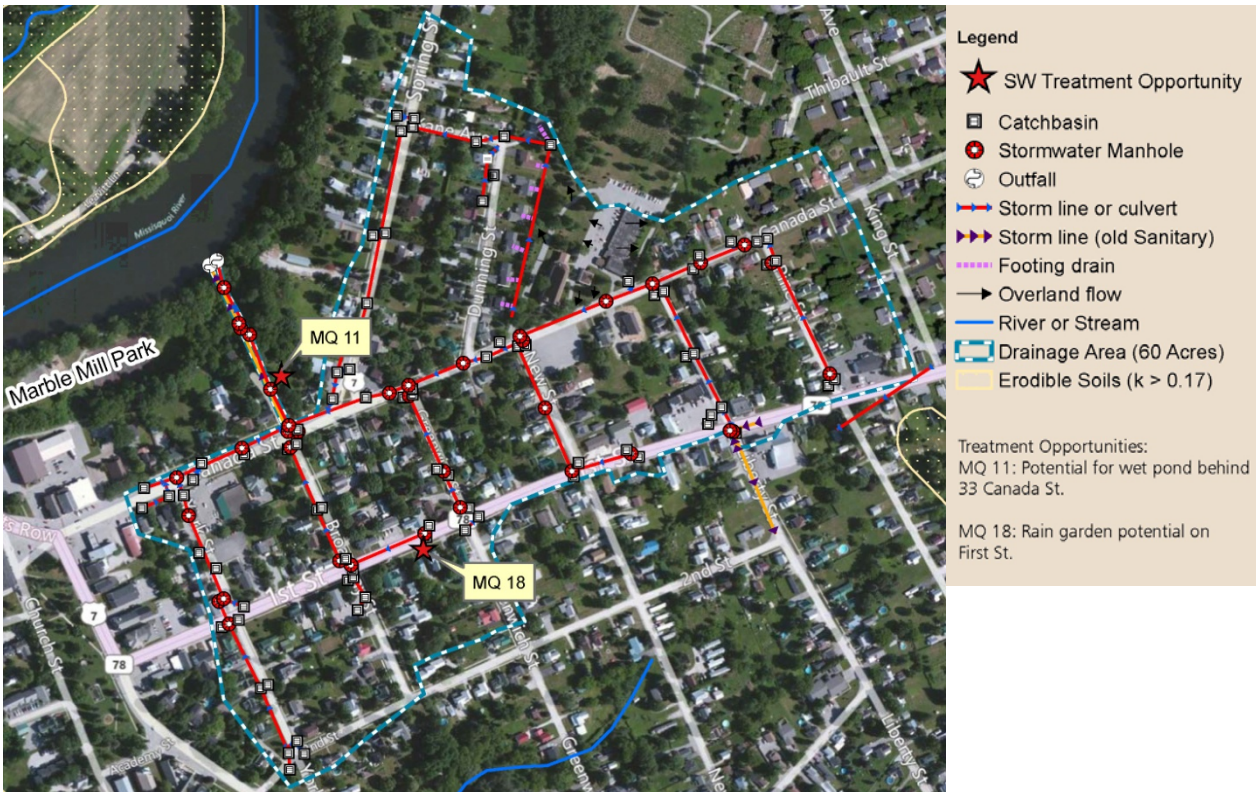

Figure 28. Marble Mill Park problem area.