Stormwater Master Plan
Town of St. Johnsbury, Vermont

STONE ENVIRONMENTAL

PROJECT NO.

15-215

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Cover: Illustrative concept design for a portion of the Oak Street drainage area before (top) and after (bottom) implementation of green infrastructure practices.

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Acknowledgements

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Executive Summary

Why is Stormwater a Concern?

The Town of St. Johnsbury, like many other Vermont cities and villages, historically took advantage of the power of water by developing mills, industry, and commerce near flowing water. The Passumpsic River flows into the center of downtown St. Johnsbury and confluences with two significant waterways within the town boundaries: the Moose River and the Sleepers River. St. Johnsbury's residents and municipal operations live and work today with a legacy of over 200 years' worth of development and infrastructure, located both along these waterways and on their surrounding picturesque but often steep hillsides.

A significant amount of the pollution in our waterways comes from actions around our homes and businesses, in our yards, in our cars, and outdoors. Individually, these activities contribute small amounts of pollutants that are washed into streams when it rains or as snow melts—pollutants like dirt, road salt and sand, oil, antifreeze, pesticides, and fertilizer. Unlike wastewater, stormwater often is not treated before flowing into St. Johnsbury's streams and rivers, and eventually into the Connecticut River.

The State of Vermont has regulations to help mitigate the stormwater impacts of larger land development projects. Projects with over an acre of impervious cover (like buildings, driveways, and parking) must include stormwater management facilities, and must obtain a permit from the State. Smaller-scale projects are not required (by the State) to include stormwater management—and most impervious surfaces in Vermont are unregulated. Of the estimated 140,000 acres of impervious surface in Vermont, only about 10% is currently covered by a permit. At the municipal level, there are also often competing priorities within water quality—should the highest priority be building and maintaining stormwater practices, or completing "good housekeeping" activities like street sweeping or catch basin cleaning that keep pollutants out of the water? Should a municipality invest in reducing areas with combined sewers, or is it better to treat runoff from otherwise un-managed impervious surfaces?

Stormwater management is essential to achieving many of Vermont's water quality goals—and it is increasingly becoming less "optional". The Vermont Agency of Natural Resources is committed to developing and issuing a general permit to require development and implementation of stormwater management plans for municipal roads, and a separate program and permit to address stormwater from existing developed lands with 3 acres or more of impervious cover, by the end of 2017. Although these regulatory commitments were made as part of the *Vermont Lake Champlain Phosphorus TMDL Phase 1 Implementation Plan*, they will extend statewide. In addition, Vermont's new Combined Sewer Overflow (CSO) Rule, effective September 15, 2016, includes substantial new requirements for systems with CSOs, including minimum control measures, public notification activities, and development of a long-term control plan. The CSO Rule is centered on overflows that occur when the combination of stormwater and sanitary wastewater during a storm event is too large for the sewer system to handle. In short: having a comprehensive plan at the municipal level for dealing with stormwater-related issues is becoming critically important.

What is a "Stormwater Master Plan"?

The Town of St. Johnsbury's current stormwater-related activities are multi-faceted, complex, and not always intentional—a balancing act between municipal capacity and priorities, local plans and regulations, existing and prospective land development, transportation system management, and sometimes rapidly changing state regulations and economic conditions. A Stormwater Master Plan assimilates existing information, collects additional data where necessary, develops solutions to existing problems, and sets priorities for possible implementation projects. This assessment is intended to plan for stormwater management specifically, and watershed management activities generally, in a more deliberate and efficient manner.

The focus area of this project encompasses 1,800 acres of drainage, primarily centered on the village area of St. Johnsbury, and extending north forming a corridor to St. Johnsbury Center. Stormwater master planning at this scale offers two primary benefits: A broad overview of existing conditions and future considerations based on anticipated development, and the opportunity to identify stormwater mitigation projects that have the greatest return on investment.

Goals for stormwater master planning include:

- Identifying as many needs as possible, along with conceptual projects or solutions to meet those needs
- Prioritizing potential projects based on criteria that account for both local and state-level priorities
- Supporting the near-term implementation of one (or more) projects
- Providing a basis to move from reactive, one-off projects to a comprehensive and proactive program

How were Stormwater Management Needs Identified?

One of the first steps towards creating a comprehensive stormwater master plan was to develop a thorough understanding of previous work (Section 3) and current related activities (Section 4). Information was inventoried, assessed, and documented from a variety of sources, including:

- Existing plans and data (documentation of existing conditions and known problems)
- Local interviews and public input
- Location of existing state/municipal landholdings, including rights-of-way, as well as significant areas of existing impervious cover
- Planned capital improvements
- Windshield and walking surveys to identify, verify, and/or document the location and nature of existing drainage problems and stormwater management concerns

Wherever a potential stormwater management need existed, the location was documented and information about the need was consistently recorded (Section 5). A total of 25 potential problem areas were identified throughout St. Johnsbury. Each problem area was given an initial classification 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 needs should be addressed when considered throughout the study area:

Total Areas Identified	Initial Stormwater Need or Problem Area Classification
7	Moderate erosion and/or drainage problems are present; issues may be readily addressed. Two of these are also strategic retrofit opportunities.
5	Significant erosion and/or drainage problems are present; issues may be readily addressed.
13	Strategic retrofit opportunity

How Were Potential Retrofits Prioritized?

The stormwater problem areas identified through the screening were carried forward through a more detailed examination and prioritization process that considered possible regulatory changes, future growth, and the suitability of different types of best management practices to each identified problem area. Some of the criteria used for prioritization included the severity of the problem, water quality or infrastructure impacts of the problem (and thus benefits of the solution), ease of taking action (including site access, ownership, and ease of maintenance), municipal needs and priorities (for instance, integration of the solution with upcoming capital improvements or co-benefits for combined sewer overflow control), and availability of funding to fix the problem.

In consultation with Town and CCNRCD staff, nine projects were selected for restoration designs and, from these, the six highest-priority projects were advanced to preliminary design (Section 7). In addition to these designs, four sites were chosen as models for illustrative concepts for integrating green stormwater management practices into other Town infrastructure (such as roadways and parking lots) in the future.

What's next for the Stormwater Master Plan?

This Stormwater Master Plan is intended to be a living document. The Town's priorities will inevitably shift as projects are completed, as funding is (or is not) available to pursue retrofits, and as major weather events upend a carefully-prioritized stormwater program without warning. In the short term, the Town will work with CCNRCD to address specific problem areas identified in this plan—either directly with existing staff and resources, or by pursuing grant opportunities.

Additionally, the Department of Public Works will seek opportunities to improve management of stormwater runoff that arise as part of routine municipal projects, such as the substantial reconstruction of a road surface or intersection. Grant funds may be available to cover the incremental cost of addressing stormwater runoff as part of such projects, especially when stormwater management is considered early in the design process.

1. Introduction

Water knows no political boundaries, and thus evaluations of water quality tend to be undertaken within watershed boundaries and involve land areas in multiple towns. From a 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 level of towns or individual sites.

A Stormwater Master Plan is responsive to existing landscape characteristics across all watersheds within local political bounds. It connects 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. Within this Plan, localized stormwater problems are examined at a larger scale (e.g., throughout the town core) to determine their relative contributions and aid in setting priorities for addressing challenges related to stormwater runoff. As adjoining municipalities 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 water. 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.

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 water quality degradation (NRC 2009).

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.

Watershed management practices have direct impacts on water quality in local creeks and streams (such as Sleepers River), as well as downstream waterbodies (the Connecticut River and, ultimately, Long Island Sound). Any decisions that affect land use have stormwater management ramifications and, in turn, impact all downstream water resources.

Vermont's streams, rivers and lakes are vital economic resources. The quality of local receiving waters affects both economic interests and quality of life in the surrounding areas. Throughout the Upper Connecticut River basin, 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. Project Goals

The ultimate objective of this stormwater master planning project is to support the Town in improving stormwater management, by providing a list of high priority water resource concerns and conceptual solutions that will support the development and implementation of future restoration projects in an efficient and targeted manner.

This Stormwater Master Plan first incorporates information from existing plans and datasets to create a single, town-specific resource to guide future stormwater management activities. The resulting stormwater management planning information and resources are included in Sections 2-4 of this report.

This Stormwater Master Plan also:

- Provides a means for comparing anticipated benefits of individual stormwater improvement projects;
- Provides recommendations to address stormwater problems, including a prioritized list of problem areas that can assist the Town in directing resources to high priority projects;
- Highlights opportunities to implement stormwater treatment in areas currently served by combined sewers; and
- Presents conceptual solutions for stormwater management measures in select high priority problem areas.

2. General Description of St. Johnsbury's Watersheds

The Town of St. Johnsbury is located in Caledonia County in the Northeast Kingdom of Vermont. The Town has a total area of 36.9 square miles (Town of St. Johnsbury, 2011), and as of the 2010 census, the population of St. Johnsbury was 7,603 (US Census Bureau, 2011). The Passumpsic River flows into the center of downtown St. Johnsbury, and confluences with two significant waterways within the town boundaries: the Moose River and the Sleepers River. The focus area of this project encompasses 1,800 acres of drainage, primarily centered on the village area of St. Johnsbury and extending north forming a corridor to St. Johnsbury Center. Each of these watersheds is described below, and watershed boundaries are shown on Figure 1 in Appendix A.

2.1. Passumpsic River

The Passumpsic River watershed encompasses a watershed area of 507 square mile, and drains a portion of Caledonia, Essex, Orleans and Washington counties in northeastern Vermont. The main waterway is formed when the East Branch, originating in Brighton, and the West Branch, originating in Westmore, of the Passumpsic join to the northeast of Lyndonville. The Passumpsic River flows south from Lyndonville and enters St. Johnsbury from the north, and confluences with the Moose River and Sleepers River, before flowing south into Waterford and ultimately Barnet where it confluences with the Connecticut River (Vermont DEC, 2009).

Within St. Johnsbury, the Passumpsic River is considered to be impaired by *E. coli* bacteria for five miles downstream from Tremont Street, due to the wastewater collection system passing combined sewer overflows (Vermont DEC, 2014).

2.2. Moose River

The Moose River is the longest tributary of the Passumpsic River, and drains an area of 126 square miles. The watershed extends from its confluence with the Passumpsic River in St. Johnsbury east towards its headwaters in the mountains in East Haven. This watershed also serves as the drainage for the Victory Basin Wildlife Management Area (Vermont DEC, 2009). A portion of the Moose River is considered to be stressed due elevated *E. coli* bacteria levels associated with agricultural activities within its tributary the Chesterfield Valley Brook (Vermont DEC, 2014a). One mile of Moose River had previously been listed as impaired, due to *E. coli* bacteria associated with failing septic systems and straight pipes in East. St. Johnsbury. These concerns were addressed and the impaired status was lifted in 2005 (Vermont DEC, 2009).

2.3. Sleepers River

Sleepers River originates in North Danville where Morill Brook and North Brook converge, and flows southeasterly towards St. Johnsbury where it is eventually joined by Burroughs Brook and Roy Brook. Ultimately the Sleepers River joins the Passumpsic River below the St. Johnsbury wastewater treatment facility

to the south of town (Vermont DEC, 2009). As with the Passumpsic River, the lower Sleepers River in St. Johnsbury is considered to be impaired by *E. coli* bacteria for 1.5 miles upstream from its mouth, due to the wastewater collection system passing combined sewer overflows (Vermont DEC, 2014). The Sleepers River is also considered stressed from its mouth to 1.3 miles upstream, for aesthetics, contact recreation, and secondary contact recreation due to historic oil spills and other environmental contamination associated with the Fairbanks Morse Foundry site (Vermont DEC, 2014a).

3. Existing Plans and Data

Numerous and varied groups and individuals have invested considerable effort in evaluating different components of St. Johnsbury's water, wastewater, and stormwater infrastructure; water resources; and the important interface between water resources and local land use decisions. At times these evaluations followed watershed boundaries, and at other times they have followed political boundaries. The following sections identify these evaluations and highlight information most relevant to St. Johnsbury and most relevant to developing a list of strategic, prioritized projects that could be undertaken to improve water quality and increase resilience to future flooding.

3.1. 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, stream geomorphic assessment and in-stream water quality assessment work, and TMDL development, each of which are briefly described below where applicable information is available for St. Johnsbury.

3.1.1. Tactical Basin Planning

The main goal of tactical basin planning 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. The Town of St. Johnsbury is located in the Passumpsic River Basin (Basin #15), where a plan was approved in June 2014 by the Agency of Natural Resources. The central component of this Tactical Basin Plan is an implementation table with targeted actions to protect high quality waters and to address identified water quality issues identified. One of the top priority actions in the plan is addressing combined sewer overflows in St Johnsbury with a focus on targeted green stormwater infrastructure.

3.1.2. Stream Geomorphic Assessments and Water Quality Monitoring

Stream geomorphic assessment work is 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 assessment data as recorded in the Vermont ANR Natural Resources Atlas Geomorphic Assessment Viewer (http://anrmaps.vermont.gov/websites/anra5/?LayerTheme=1) were reviewed prior to the start of field visits to locate potential stormwater problem areas (Section 5), especially for the Moose River where a Phase 2 assessment was completed in 2007.

In-stream water quality assessment data collected by Vermont ANR, including water chemistry and biological assessments is also available through the Vermont Integrated Watershed Information System (IWIS), the VTDEC-Watershed Management Division's online data portal for water quality information, at https://anrweb.vt.gov/DEC/IWIS/.

3.2. Town-Wide Assessments and Programs

In addition to the watershed-based assessments, a number of assessments and datasets are developed on a municipality-by-municipality basis. These are important to fold into any effort to develop a list of strategic,

prioritized projects that could be undertaken to improve water quality in and around St. Johnsbury. These include direct feedback from the Town, work by the Vermont Agency of Transportation and Vermont Department of Environmental Conservation, and past and current planning initiatives.

3.2.1. Direct Input from Town Staff

In meetings with Stone Environmental, the Town Manager and Public Works director identified nearly a dozen areas of concern and priority project opportunities throughout St. Johnsbury, including a key opportunity to couple improved stormwater management with a planned combined sewer separation project in the Oak Street outfall drainage area.

3.2.2. Vermont Agency of Transportation-Sponsored Programs

VTrans-sponsored programs, including both routine inspections of bridges and culverts and grant opportunities provided by the Better Roads Program, have identified a few potential projects to protect existing infrastructure whose implementation would also improve stormwater management. Information in the agency's online bridge and culvert inventory (available at https://www.vtculverts.org/) for the Town of St. Johnsbury was reviewed prior to field screening and evaluation of potential stormwater problem areas (Section 5). Much of the planning area, however, is served by closed-system stormwater infrastructure, which was mapped by Vermont DEC in 2010 (see below).

In addition, the Better Roads Program funded a Road Erosion Inventory and Capital Budget Plan for the Town of St. Johnsbury in 2015, which identified priority road improvement needs in the town. This report was also reviewed prior to field screening and evaluation of potential stormwater problem areas. Although most of the projects included in the inventory were outside the planning area, Site #8 (Almshouse Road) informed our evaluation of sites MR-03, MR-04, and MR-05.

3.2.3. Vermont DEC-Sponsored Programs

Vermont DEC-sponsored programs, including detailed stormwater infrastructure mapping completed in support of Illicit Discharge Detection and Elimination (IDDE) efforts and state-issued post-construction stormwater permitting records, were examined in order to identify additional stormwater management opportunities. The infrastructure mapping data represent an important supplement to VTrans' online bridge and culvert inventories and were invaluable during evaluations of existing problem areas and retrofit opportunities (Section 5 and as further described below).

In addition, the age, style, size, and upkeep of existing facilities permitted by DEC – particularly facilities constructed prior to 2002 – may make them candidates for improvement to enhance stormwater management capabilities. Post-construction stormwater management permits for the planning area (as available at http://dec.vermont.gov/watershed/stormwater/statewide-map-of-existing-stormwater-permits) were reviewed during field screening of potential stormwater problem areas (Section 5) and development of potential implementation projects (Section 6).

A stormwater infrastructure mapping project completed by the ANR's Vermont DEC Clean and Clear program for the Town of St. Johnsbury identified potential locations for stormwater retrofit sites among priority drainage areas (Vermont DEC, 2010). The identified potential retrofits included:

- A swirl separator/ sand filter combination was proposed in drainage areas #1 and #104, which is currently under construction.
- Extended detention basins were proposed to capture and treat a portion of the runoff from drainage areas #11, #57, #65 and #44.

- In drainage area #65 there was also a second option proposed of creating a bioretention area in the median in order to treat runoff prior to entering the waterway.
- In drainage area #44 there was also the potential to convert parking lot islands into rain gardens to treat runoff prior to entering the waterway.
- Catch basin cleaning was proposed in drainage areas #7, #63, #2, #60, and #90.
- A treatment tank was proposed to serve drainage areas #45 and #46 simultaneously.

A stormwater infrastructure mapping project by the ANR Ecosystems Restoration program for the Village of East St. Johnsbury identified one high-priority location for a stormwater retrofit among priority drainage areas (Vermont DEC, 2015). Catch basin cleaning was proposed to treat runoff from drainage areas #18, #19, and #20 in order to treat runoff before it entered the receiving waterway.

4. Combined Sewer Overflow Reduction Practices and Status

Combined sewer overflows are regulated by the EPA under the Federal Clean Water Act. In Vermont, this is delegated by EPA to the Vermont ANR, Department of Environmental Conservation, Watershed Management Division. NPDES is the national program for issuing permits and conducting enforcement. The Town of St Johnsbury has a NPDES Discharge Permit with compliance schedules described in 1272 Orders.

The nine minimum controls from EPA's CSO Control Policy, per Vermont's newly adopted 2016 CSO Rule are:

- Proper operation and regular maintenance programs for the collection systems and CSO outfalls
- Maximum use of the collection system for storage without endangering public health or property, or causing solids deposition problems
- Review and modification of pretreatment requirements to assure that CSO impacts are minimized
- Maximization of flow to the treatment plant for treatment consistent with an evaluation of alternative treatment options
- Prohibition of CSOs during dry weather
- Control of solid and floatable materials in CSOs
- Establishment of pollution prevention programs to minimize contaminants in CSOs
- Public notification to ensure that the public receives adequate notification of CSOs and CSO impacts, which shall, at a minimum comply with § 34-404 of this Rule
- Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls

The new CSO rule (in effect September 15, 2016) provides Vermont CSO communities with two choices to achieve compliance with the Vermont Water Quality Standards from this point forward: eliminate overflows, or provide pre-discharge treatment (solids removal and disinfection). In addition, the new CSO rule requires reporting to the state within one hour of discovery and submitting a discharge volume estimate within 12 hours.

Since the first preliminary engineering report (PER) was submitted to the state in 1993, and as a result of a phased separation approach, St. Johnsbury has:

- Completed more than 20 combined sewer separation projects.
- Verified the locations of all CSOs and plugged several CSO outfalls that have been determined to be unnecessary.

- Completed surveys of many sections of the combined sewer system to identify catch basins that are still connected to the sanitary sewer.
- Substantially reduced the frequency of overflows.
- Since 2008, the Town of St. Johnsbury has undertaken approximately $32,000,000 in utility improvement projects, including new separate sanitary sewers and storm drains, water system improvements, and road and sidewalk improvements.

The Town's next steps in addressing combined sewer overflows include:

- Complete an effectiveness study at eight CSO manholes for a period of at least 6 months where abatement projects have been recently completed in the drainage area to determine the effectiveness of the work.
- Complete smoke testing to identify any catch basins that are still connected to the sanitary sewer system in areas where separation work has been completed.
- Complete final design and implement sewer separation for the Oak Street drainage area combined sewer.
- Complete final design and implement sewer separation for the Green Street and Boynton Avenue combined sewer system.

5. Stormwater Problem Areas

One of the goals of this plan is to "develop a prioritized list of stormwater problem areas that can assist the Town in directing resources to high priority projects." To achieve this goal, a thorough effort was made to identify existing problem areas, and then to evaluate existing conditions and potential solutions.

5.1. Identification and Initial Evaluation of Problem Areas

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

- Reviewing existing plans and data, as described in Section 3, and noting the location of any concerns related to stormwater
- Engagement with Town, CCRNCD, and State of Vermont staff
- Targeted site visits to verify problem areas during spring and summer 2016
- Documentation (with photos) of existing problem areas

A "problem area data sheet" was developed and used as a guide to ensure that consistent information was collected as site visits were completed. A total of 25 potential problem areas were identified and geo-located (Figure 2, Appendix A). The data sheets for all of the problem areas identified in St. Johnsbury are provided in Appendix B of this report.

5.2. Initial Screening Evaluation of Problem Areas

Working from the list of potential problem areas, Stone staff 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, and observations were recorded about the source or cause.

Each problem area was given an initial 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 across the project area (Appendix B). Scores were assigned as described in Table 1.

The problem areas identified during this initial evaluation were carried forward through a more detailed examination and prioritization process as described in Section 6.

Table 1. Scoring Criteria for Preliminary Evaluation of Stormwater Problem Areas.

Level	Classification
1	Outside of project scope, or infeasible to remedy due to project size.
2	Stable, but problem could escalate with future change in surrounding land use.
3	Limited erosion and/or drainage problems are present; issues may be readily addressed.
4	Moderate erosion and/or drainage problems are present; issues may be readily addressed.
5	Significant erosion and/or drainage problems are present; issues may be readily addressed
6	Strategic retrofit opportunity

6. Prioritization of Stormwater Management Opportunities and Implementation Matrix

Stone completed a field screening that identified 25 stormwater management opportunities in the Town of St. Johnsbury during the spring and summer of 2016 (Section 5). The locations of the opportunities are shown on Figure 2 (Appendix A), and the nature of each identified problem and potential opportunity is summarized in Table 2.

During and following the field screening, Stone recorded observations about each site which were used in the implementation matrix (Table 2) to develop a score for each opportunity relative to several criteria:

- **Existing environmental concerns** – score was assigned based on the type(s) of problems present, with 1 point added for each of the following concerns presented by the site's current condition: water quality concerns; infrastructure vulnerability; localized drainage issues/flooding; streambank or in-stream erosion; and overbank flooding. Although sites were generally anticipated to receive between 1 and 3 points, the maximum score a site could receive was 5.
- **Environmental priority –** relative environmental impact on nearest receiving water (e.g., proximity, location) and how "active" the problem area was during the site visit, with 1 being the smallest impact and 5 being the greatest impact.
- **Constructability –** relative ease with which a project could be implemented, including whether the recommended practice(s) could be constructed on publicly-owned land or with a willing landowner-partner, existing access to the site, and the amount of additional assessment and engineering design work that would be required to move the project to implementation. The maximum score a site could receive was 3, indicating a project that should move quickly and easily to implementation.
- **Ease of operation –** including the amount and frequency of maintenance likely to be required and whether maintenance activities would be straightforward to complete. The maximum score a site can receive is 3, indicating a project with infrequent maintenance needs that are easily completed.

In addition, 1 extra point was awarded to projects located in areas the Town identified as areas with existing combined sewer systems.

The type of ownership of each project location, an initial indication of project cost, and the amount of additional engineering likely needed for implementation are also presented in the matrix (Table 2). These measures are not included in the score tabulated for each potential project, but are provided to give additional context for project prioritization.

Finally, in the three right-most columns, the matrix indicates the projects selected for development of a restoration plan, as well as sites that will be advanced to preliminary design and/or have an illustrative drawing developed by the Project Team's landscape architect. These projects were selected in consultation with the Town, CCNRCD, and representatives from VT DEC.

Table 2. Stormwater Opportunity Prioritization and Implementation Matrix

Site ID	Site Name	Need	Proposed Approach	Ssoil Survey Mapped HSG	Existing Environmental Concerns (scale 1-5)	Environmental Priority (scale 1-5)	Constructability (scale 1-3)	Ease of Operation (scale 1-3)	CSO Area? (yes = 1; no = 0)	Implementation Score	Project Type	Estimated Implementation Cost	Green Infrastructure Opportunity (Y or N)	Need for Additional Engineering	Develop Restoration Plan?	Prepare Preliminary Design?	Prepare Illustrative Drawings?
PR-01	Pearl St. municipal parking lots	Retrofit opportunity	Reconfigure lots to increase width of existing "islands" and install recessed bioretention practices	NR (Urban) Adams / Nicholville	2	2	3	2	1	10	C	M	Y – sands	H	√	√	√
PR-02	Bay St. sand pile	Large stockpile located in close proximity to the WWTP is actively eroding into a drainage swale; the is evidence of significant sediment transport to the Passumpsic River	The stockpile apparently belongs to a private contractor and is material that was removed during a now-complete street renovation project; the contractor should be required to immediately and properly stabilize and ultimately relocate the pile.	NR (Urban) Adams / Nicholville	3	5	3	3	0	14	D	L	N	L			
PR-03	659 Bay St.	Heavy sediment load was observed in the swale immediately to the north of 659 Bay St, Swale appears to receive stormwater runoff from the St Johnsbury Academy campus, as well as Main St., Railroad St., and a small section of Bay St.	Reshape and retrofit swale to function as bioswale and provide treatment in addition to conveyance.	NR (Urban) Adams / Nicholville	3	4	2	2	0	11	A	MH	N – shallow GW	H			
PR-04	Farmer Dr., north of Waterman Circle	Undersized culvert ~30 feet below grade; embankments of road crossing are unstable and show evidence of slumping.	Remove paved swale along the south side of Waterman Circle and install check dams to promote infiltration; it will be challenging to effectively stabilize the embankment without addressing the undersized culvert.	B, C/D	5	3	1	2	0	11	C	L (swale only)	N – shallow GW	M			
PR-05	1569 Breezy Hill Rd.	Stormwater runoff from roadway is creating unstable embankment.	Install step-pool conveyance to safely carry water down the slope and provide modest treatment.	B/D, NR (Sand and Gravel Pit))	3	3	2	2	0	10	C	M	N	H			
PR-06	Lackey Hill Rd.	Unstable ditches, turnouts and cross-culverts are resulting in significant erosion and visibly more turbid water in Roberts brook between Spaulding Rd. and Breezy Hill Rd.	Bring overly-wide section of road back to standard width; use this space to establish rock-lined ditches with appropriate side slopes; remove berm and turnouts along south road shoulder instead promoting sheetflow; install energy dissipation measures at cross culvert outlets.	D	4	5	3	2	0	14	C	M	N	M	√		
PR-07	Green Mountain Mall (VT DEC #65)	Retrofit opportunity	Site includes more than 10 acres of unmanaged impervious surface. Existing islands within the parking lot could be retrofit as bioretention areas. Opportunities exist for treatment in the green spaces to the west and north of the parking lot. There may also be opportunities to reconfigure/de-pave certain areas without interfering with existing uses, including CDL training.	NR (Urban) Adams / Nicholville, B	2	2	1	2	0	7	A	MH	Y - partial – fill N of parking, possible GW limitation in swale along Rte. 5, needs TPs if advanced to design	H			
PR-08	857 Memorial Dr. (Price Chopper) (VT DEC #45)	Significant scour pool has formed where two drainage systems outlet at the southeast corner of the parking lot; retrofit opportunity	Install stormwater detention practice near the outfall; siting may be challenging as area is within mapped river corridor. Existing green spaces within parking lot are recessed and could be easily retrofit to provide detention and treatment.	NR (Urban) Adams / Nicholville	3	3	2	2	0	10	D	M	Y (partial) – did not confirm soils	M			
PR-09	644 Memorial Dr. (FedEx) (VT DEC #57)	Retrofit opportunity	Retrofit existing green spaces in the parking lot by recessing them and re-grading the lot to drain to these areas; swale along the north-side of the parking lot could be retrofit as a bioswale to provide enhanced stormwater treatment	NR (Urban) Adams / Nicholville	2	2	1	2	0	7	C	M	Y - possible GW limitation, needs TPs if advance to design	M			
PR-10	Sherman Dr.	There are a number of small stormwater practices which appear to be designed to treat runoff from buildings and parking facilities along Sherman Dr., several of which appear unmaintained and potentially undersized, and are discharging onto a steep slope without energy dissipation	Conduct a comprehensive review of stormwater management on Hospital Hill in order to understand which areas are covered by the existing stormwater permit and develop a comprehensive strategy for improving stormwater management	A	3	3	2	2	0	10	A	M	N	H			

Site ID	Site Name	Need	Proposed Approach	Ssoil Survey Mapped HSG	Existing Environmental Concerns (scale 1-5)	Environmental Priority (scale 1-5)	Constructability (scale 1-3)	Ease of Operation (scale 1-3)	CSO Area? (yes = 1; no = 0)	Implementation Score	Project Type	Estimated Implementation Cost	Green Infrastructure Opportunity (Y or N)	Need for Additional Engineering	Develop Restoration Plan?	Prepare Preliminary Design?	Prepare Illustrative Drawings?
PR-11	Hospital Rd. at Route 5 (VT DEC #44)	Existing swale along the south-side of Hospital Rd (and adjacent to the Price Chopper shows evidence of high flows and sediment transport	Retrofit existing swale to enhance detention storage and treatment; would likely require VTrans cooperation as footprint would extend into Route 5 right-of-way	A	2	4	2	2	0	10	D	MH	N	H			
PR-12	Oak St. drainage area	Retrofit/CSO control opportunity	Area is characterized by relatively short, narrow, low-volume residential streets, underlain by HSG A soils. The City is planning to implement sewer separation in this neighborhood in late-2016; a comprehensive GSI retrofit plan could be developed for the neighborhood to see if such an approach would be cost-competitive.	A	3	3	2	2	1	11	C	H	Y - Best soils on Southard St. and north portion of Union St.; then Emerson; then St. John. Pleasant St. location least well suited.	H	√	√	√
PR-13	Fred Mold Park (Concord Ave. at Gilman Ave.)	Retrofit opportunity	Restructure enlarged intersection to standard design, likely as part of future reconstruction of Gilman Ave. Provide treatment in expanded green space that will be created as a result.	B	3	2	3	2	0	10	C	M	Y - Pavement remains under soil outside landscaping on W end of park; 30" fill inside landscaping, but sand beneath.	M	√		√
SR-01	West of High Street at Route 2 (VT DEC #11)	Retrofit opportunity	Swirl concentrator planned for this location; not considered further.	NR (Urban) Adams / Nicholville	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N	N/A			
SR-02	The St. Johnsbury School	Retrofit opportunity	Take advantage of existing green around perimeter of upper parking lot and flag circle at School to provide treatment for runoff from the parking lot.	NR (Urban) Adams / Nicholville	2	2	2	2	0	8	C	M	N - Flag circle underlain by recent fill. Infiltration capacity should not be assumed.	M			
SR-03	Kiwanis Pool and Tennis Courts	Runoff from the parking lot is causing gully erosion along steep embankment to the south of the parking lot.	Install level spreader along edge of parking lot to promote sheet flow over the embankment or construct reinforced conveyance to safely move stormwater from the parking lot to the green space below.	NR (Urban) Adams / Nicholville	3	3	1	2	0	9	A	M	N	H	√	√	
SR-04	Valley St.	Unmanaged runoff from Kiwanis Pool (SR-03) and a small cluster of homes along Valley St. has formed a gully to the Sleepers.	Small stormwater detention basin to slow stormwater runoff, settle sediment, and provide controlled release to the Sleepers.	NR (Urban) Adams / Nicholville	3	3	2	2	0	10	D	M	N	M			
SR-05	Underclyffe Rd.	Significant gully off the west-side of the loop and just south #191; appears to be attributed to outlet from roadway storm drain system. The park and ride facility between the toe of slope and Route 2 is currently serving to pond water and promote sedimentation.	Promote downspout disconnection to reduce "effective impervious area" in the sewershed. Work with VTrans, which is in the initial stages of an expansion of the park and ride facility, to ensure that the sedimentation function is not loss as their project progresses.	A	4	4	1	1	0	10	A	H	N	H	√		
SR-06	St. Johnsbury Academy	Retrofit opportunities	There are numerous retrofit opportunities available on the campus; perhaps the greatest concentration of which surrounds the Field House. These include managing roof runoff from the athletic building complex, was well as retrofitting existing green spaces in the parking lot by recessing them and installing bioretention practices	A	3	2	2	2	0	10	A	M	Y – Sandy soils encountered in the 3 locations tested, south and west of fieldhouse.	M	√	√	√

Site ID	Site Name	Need	Proposed Approach	Ssoil Survey Mapped HSG	Existing Environmental Concerns (scale 1-5)	Environmental Priority (scale 1-5)	Constructability (scale 1-3)	Ease of Operation (scale 1-3)	CSO Area? (yes = 1; no = 0)	Implementation Score	Project Type	Estimated Implementation Cost	Green Infrastructure Opportunity (Y or N)	Need for Additional Engineering	Develop Restoration Plan?	Prepare Preliminary Design?	Prepare Illustrative Drawings?
MR-01	Overlook Dr.	Driveways along Overlook Dr generally intersect the road surface at a steep angle and little or no apron resulting in significant gravel being carried into the road and ultimately the storm sewer system.	Establish or re-grade driveway aprons; generally the difference between the cross slope of the roadway and the upward grade of the driveway entrance should not exceed 8%	C/D, B	3	3	1	2	0	9	A	L	N	M			
MR-02	Concord Ave. (VT DEC #104)	Retrofit opportunity	Potential to intercept and treat a portion of the sewershed bounded by Concord St and Parker Ave to the east, Lafayette St to the north with a swirl separator or sand filter. Existing outfall is significantly (~20 feet) below grade which could complicate retrofit.	NR (Urban) Adams / Nicholville	3	3	1	1	0	8	A	MH	N	H			
MR-03	Ballfield and Parking Lot; Almshouse Rd.	Almshouse Rd. runs through a large gravel parking lot that drains overbank to the Moose River; some evidence of rill and gully erosion on bank in areas where concentrated flow leaves the parking lot; during heavier rain events sediment flows down to Concord Ave. into the Moose River.	Implementing measures to control runoff from Town Forest Dr. which currently runs onto Almshouse Rd; establishing an intentional parking strategy for the lot could allow for a similar amount of parking spots coupled with regarding the lot to have runoff shed via sheetflow into an expanded top-of-slope buffer between the gravel lot and the riverbank to provide filtering and stability.	NR (Urban) Adams / Nicholville	4	5	3	2	0	14	C	M	N	M	√		
MR-04	Town Garage	Sand pile at the Town Garage is experiencing "creep" and has slumped over the jersey barriers intended to prevent material from eroding into a nearby drainage swale; both stormwater outlets from the facility show evidence of significant sediment transport and active erosion.	Repurpose existing open space south of the haul road, as a sediment control basin to provide settling for sand entrained in stormwater runoff from the facility; construct step-pool or similar conveyance to safely carry treated flows to the river.	NR (Urban) Adams / Nicholville	4	5	3	2	0	14	C	M	N	M	√	√	
MR-05	Town Forest access road and parking area	Visible erosion along the shoulder of the access road; currently at least a portion of runoff from the road and parking area contributes to the problems observed at the Town Garage.	Reshape and rock-line the swales along the access road; consider installing cross-culvert that would prevent runoff from this area from comingling with the Town Garage.	C/D	4	3	3	2	0	12	C	L	N	L			
MR-06	Gilman Ave	Retrofit opportunity	Bring overly-wide section of road back to standard width, establishing a pitched green space between the road and ditches, as needed, on both sides of the road.	B	2	2	3	2	0	9	C	L	N	L			

Project Type "key":

A	Private property
B	State property or right-of-way
C	Public property (town-owned land or right-of-way)
D	Hybrid; part public land, part private land

Estimated Implementation Cost "key":

L	less than $20,000
M	$20-$50,000
MH	$50-$100,000
H	more than $100,000

Need for Additional Engineering "key":

L	Project can be implemented without formal engineering
M	Project requires some amount of engineering design to ensure proper sizing
H	Project requires full engineering

7. Conceptual Solutions for High Priority Stormwater Problems and Opportunities

Initially, the prioritization of all of the identified problem areas and opportunities (Section 6) resulted in 17 of the identified problem areas being assigned an implementation score of 10 or higher. In consultation with CCNRCD, Town staff, and Vermont DEC staff, this list was further narrowed to 12 projects for potential restoration plans. Nine of the originally identified 12 restoration plans were ultimately prepared. One of the three sites that was ultimately removed from further consideration involved property/right-of-way controlled by VTrans (PR-11, Hospital Rd. at Route 5) and after meeting on-site with VTrans staff it was determined that no restoration plan would be developed. One site was removed from further consideration based on feedback received from Vermont DEC (PR-07, Green Mountain Mall); and the remaining site was removed from further consideration based on a combination of poor soil test results and infrastructure conflicts (SR-02, The St. Johnsbury School). Six of the sites with restoration designs were then advanced to concept design, with selection based largely on projects the Town indicated an interest in moving to implement in the next 2-3 years. In concert with these plans and designs, four sites were chosen as models for illustrative concepts for integrating green stormwater management practices into other infrastructure (such as roadways and parking lots), both for the currently conceived retrofit projects and in the future (Section 7.1).

The nine opportunities advanced to restoration plan development (Appendix C) were:

- PR-01, Pearl Street municipal parking lots
- PR-06, Lackey Hill Rd.
- PR-12, Oak Street drainage area
- PR-13, Fred Mold Park (Concord Ave. at Gilman Ave.)
- SR-03, Kiwanis Pool and Tennis Courts
- SR-05, Underclyffe Rd.
- SR-06, St. Johnsbury Academy
- MR-03, Ballfield and Parking Lot; Almshouse Rd.
- MR-04, Town Garage

The six opportunities advanced to concept design (Appendix D) were:

- PR-01, Pearl Street municipal parking lots
- PR-06, Lackey Hill Rd.

- PR-12, Oak Street drainage area
- SR-03, Kiwanis Pool and Tennis Courts
- SR-06, St. Johnsbury Academy
- MR-04, Town Garage

The four locations chosen for development of green stormwater management concept illustrations (Section 7.1) were:

- PR-01, Pearl Street municipal parking lots
- PR-12, Oak Street drainage area
- PR-13, Fred Mold Park (Concord Ave. at Gilman Ave.)
- SR-06, St. Johnsbury Academy

Green Stormwater Management Opportunities

The following section provides concepts to incorporate green infrastructure systems into specific locations in St. Johnsbury to convey and reduce the volume of stormwater runoff and to improve water quality. These sites have been iden-tified through the master plan process as locations where 'green' stormwater practices are a good fit. There are other opportunities in town as well. For each site there is a summary of the existing conditions, an explanation of applicable green stormwater management practice(s) that would be appropriate in this location, an example of the practice, using Vermont examples where possible, a conceptual plan, and a graphic with a 'before' and 'after' illustration of the site.

The following provides visual glossary of various green stormwater management facilities:

Rain Gardens collect and absorb runoff from rooftops, sidewalks, and streets. Rain gardens mimic natural hydrology by infiltrating and evapotranspiring runoff. Rain gardens are versatile features that can be installed in almost any unpaved space.

Vegetated Swales are depressed graded linear landscape features that can be designed to detain, treat and infiltrate stormwater through both grading and absor-bent soils. Landscaping can be naturalistic or manicured depending on the location.

Pervious Paving are paved surfaces of concrete, asphalt or unit pavers with permeable pores or spaces that allow stormwater to infiltrate from the paved surface to a deep crushed stone subsurface bed where it is treated and stored. These pavements are particularly appropriate where there is limited landscape space, where land values are high and where flooding or icing is a problem.

Stormwater Curb Extensions are hardscape designs that combine elements of curbing inlets, rain gardens, porous pavers, and stormwater planters to remove runoff from the roadside and provide improved stormwater management. Frequently they are combined with safer pedestrian walkways and crosswalks.

Trees reduce and slow stormwater by intercepting precipitation in their leaves and branches and they absorb water through the root system. Subsurface structures such as tree root cells provide for lightly compacted soil that stores stormwater and greatly improves street tree health. Coupled with porous pavers, these structures also allow for stormwater infiltration and treatment.

Gravel Wetlands are created wetlands that collect, store and infiltrate stormwater through treatment basins with subsurface gravel layers. Plantings associated with these projects are typically native grasses and woody plants and appear informal and natural.

Source: USEPA, "What is Green Infrastructure," http://water.epa.gov/infrastructure/greeninfrastructure/gi_what.cfm

Pearl Street Municipal Lot - Vegetated Swales and Rain Gardens

Overview

This is a large municipal parking lot that has excess paved area which can be redesigned to incorporate vegetated stormwater swales. This can be done without losing any parking spaces--in fact, due to inefficiencies in the existing layout, it appears that there is room to increase the number of spaces using standard 18' parking stalls and 24' drive aisles. Vegetated stormwater swales can be placed between parking stalls and at the perimeter of the parking lot to collect and infiltrate stormwater.

Vegetated swales capture, infiltrate and convey stormwater, thereby decreasing volume and improving water quality.

Benefits - Rain Gardens and Vegetated Swales

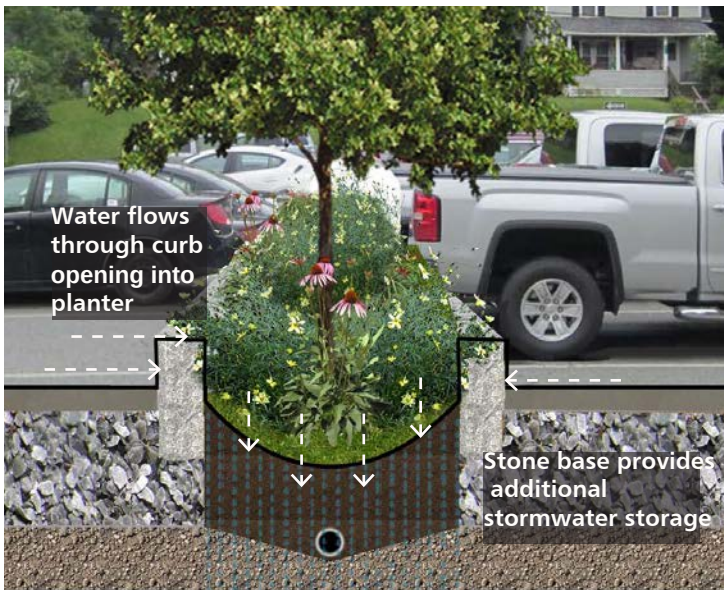
- Requires less infrastructure to build
- Provides an attractive landscape aesthetic to the area

Constraints - Rain Gardens and Vegetated Swales

- Working around utilities in retrofit situation

Maintenance Considerations - Rain Gardens and Vegetated Swales

- Periodic landscape maintenance and debris removal



Example

- Vegetated stormwater planter in White River Junction

Existing Condition

The existing municipal parking lot at Pearl Street.

Conceptual Green Infrastructure Retrofit - Rain Gardens and Vegetated Swales in Planters

The plan on the previous page shows how the parking lot could be retrofitted to incorporate green infrastructure and the illustrations above show before and after views of the parking lot.

Concord Avenue - Rain Garden and Vegetated Swale Landscape Buffer

Overview

The intersection of Concord Avenue, Old Concord Avenue and Gilman Avenue is an overly wide expanse of paving--measuring more than 90-feet immediately west of the residential green. The green spaces in the area can be expanded to reduce the amount of impervious surface area and incorporate rain gardens and vegetated swales which capture, convey and infiltrate stormwater. The improvements can also make the area more pedestrian-friendly, by calming traffic, providing a shorter crosswalk with a refuge island, and placing a landscaped buffer (stormwater swale) between the sidewalk and roadway for a portion of the street.

Conceptual improvements for this area include the following:

- Neighborhood green enlarged with a rain garden.
- Pedestrian crossing incorporated into vegetated island, creating a refuge for pedestrians.
- Vegetated swale lanscape buffer along the pocket park on the south side of the road.

Benefits - Rain Gardens and Vegetated Swale Landscape Buffer

- Requires less infrastructure to build
- Provides an attractive landscape aesthetic to the area

Constraints - Rain Gardens and Vegetated Swale Landscape Buffer

- Working around utilities in retrofit situation

Maintenance Considerations - Rain Gardens and Vegetated Swale Landscape Buffer

- Periodic landscape maintenance and debris removal

Existing Condition

The excessive paving at Concord Avenue, Old Concord Avenue and Gilman Avenue. The pedestrian crossing is 50’ wide and the street is 90’ wide just west of the residential square.

Conceptual Green Infrastructure Retrofit - Rain Garden and Vegetated Swale

Conceptual reconfiguration of the intersection with a rain garden extension of the residential square and a stormwater swale along the south side of Concord Avenue.

Oak Street Neighborhood - Vegetated Swales and Pervious Paving

Overview

The Oak Street neighborhood is characterized by short, narrow low-volume streets and is slated for a sewer separation retro-fit. A green infrastructure approach in this neighborhood which utilizes vegetated swales supplemented with porous block pavers could capture and infiltrate stormwater within the street rights-of-way. The plan on the right provides one concept for how these elements may be employed in the neighborhood. The swales, which are a minimum of four feet in width, could provide an attractive landscape feature on at least two low-traffic-volume streets in the neighborhood, and the pervious paving could further calm traffic in this residential neighborhood.

Benefits - Pervious Paving

- Good for low volume streets
- Works better on street slopes less than 5%
- Works in areas with limited space for landscape measures

Constraints - Pervious Paving

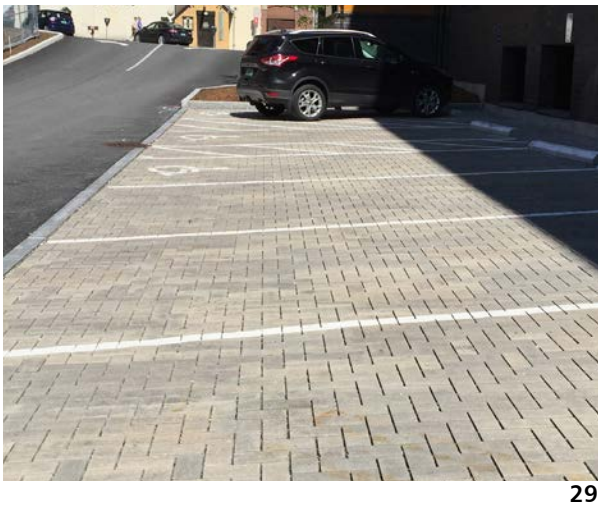
- Higher cost than stormwater swales

Maintenance Considerations - Pervious Paving

- Periodic vacuuming of pores

Examples

- Stormwater swale in Oregon (lower left)
- Pervious pavers used for pedestrian crossing in California (right)
- Pervious pavers in a Burlington, Vermont parking area (lower right)



Conceptual Green Street Neighborhood Plan

The plan above provides one concept for a green infrastructure street plan using a combination of vegetated swales and pervious paving. This plan does not disrupt existing sidewalks. Pervious paving blocks may be used at intersections to absorb additional stormwater and calm traffic.

Existing Condition - St. John Street

Above, existing conditions on St. John Street near the intersection with Pleasant Street.

Conceptual Retrofits - St. John Street - Stormwater Swales and Pervious Pavers

St. John Street with stormwater swales on both sides of the road street and pervious pavers at the intersection. Street trees are planted adjacent to the cemetery and also help to reduce and slow stormwater by intercepting rain on their leaves and branches.

St. Johnsbury Academy - Rain Garden and Vegetated Swale

Overview

The area around the field house at St. Johnsbury Academy includes an opportunity to consider stormwater management techniques that manage runoff from the large roof of the structure as well as the surrounding parking areas.

Conceptual improvements for this area include the following:

- Retrofitting existing green areas in the parking area with vegetated swales and rain gardens
- Installation of pervious pavers for walkways surrounding the building
- Drainage Dry Wells

Benefits - Drainage Dry Well

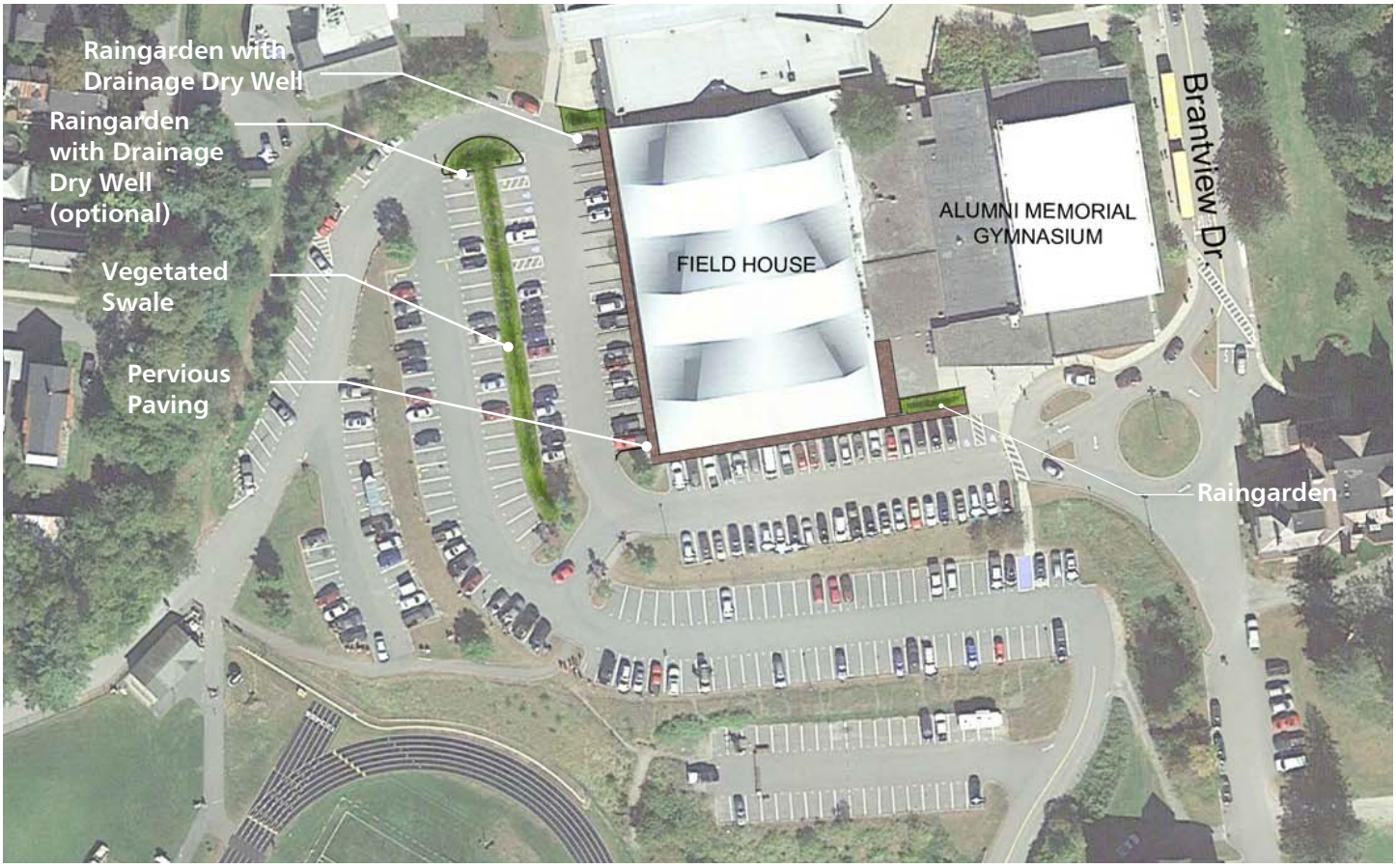
- The drainage well provides a large volume storage facility within a relatively small footprint.

Constraints - Drainage Dry Well

- More costly

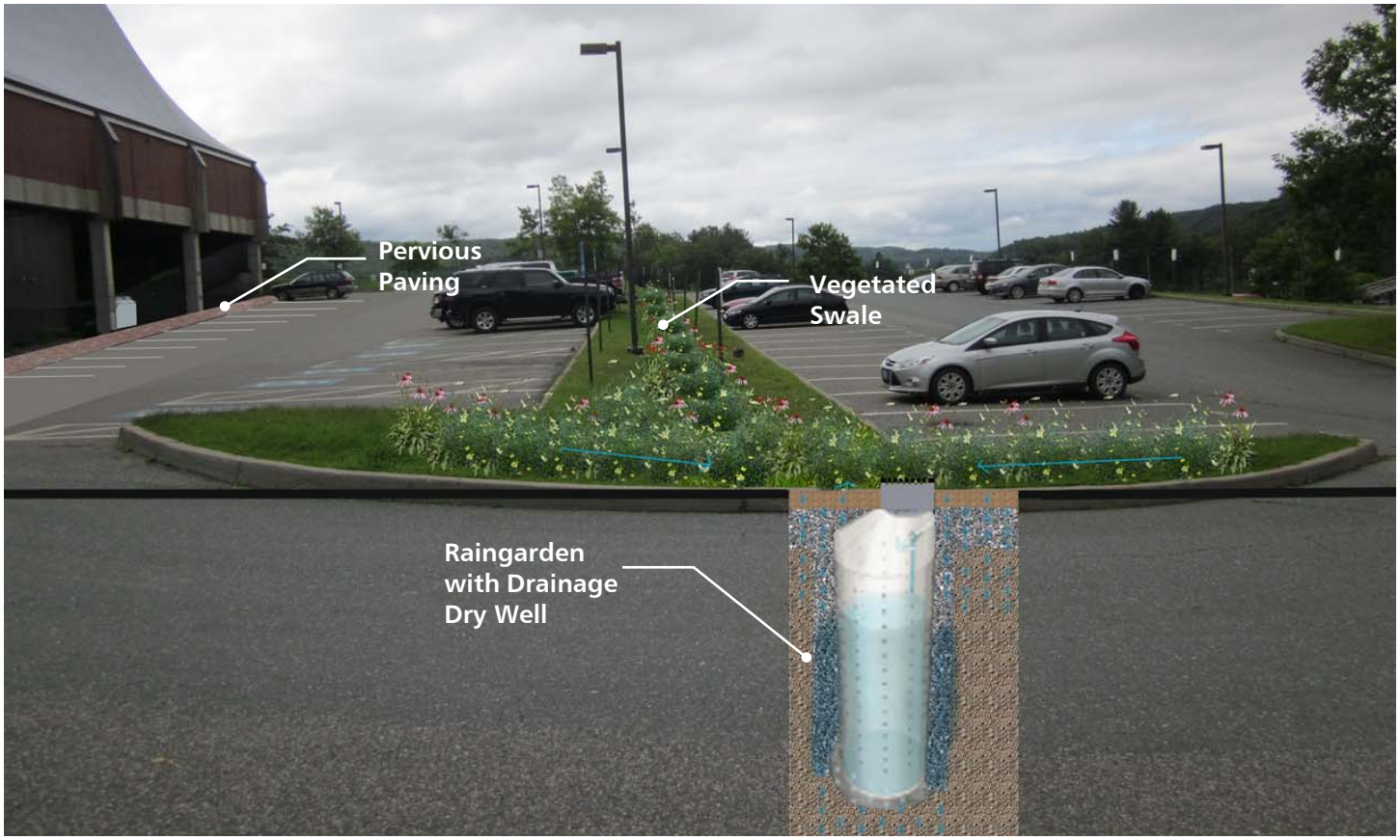
Maintenance Considerations - Drainage Dry Well

- Periodic removal of collected sediments



Existing Condition

The parking area behind the field house includes a landscaped area between parking bays.



Conceptual Green Infrastructure Retrofits - Vegetated Swales, Pervious Paving and Drainage Dry Well

Possible retrofits for this area include a vegetated swale in the landscaped planter, the use of pervious paving and a drainage dry well. A subsurface dry well collects stormwater and then discharges the water through perforations in the well to surrounding stone storage media and soils. The dry well allows sediments to settle out before discharge. Stormwater may enter the dry well directly from inlet structures or via pretreatment systems as shown above.

8. Next Steps

This document represents an extensive effort to identify and evaluate potential stormwater problem areas throughout the more densely developed areas of the Town of St. Johnsbury. Several high priority potential stormwater improvement projects, including conceptual solutions, were identified in Section 7 that the Town could pursue directly, or could work with partners to pursue funding to address.

Beyond addressing the specific problem areas identified in this plan, there are often opportunities to improve management of stormwater runoff that arise as part of routine municipal projects, such as sewer separation efforts or the substantial reconstruction of a road surface or intersection. Grant funds may be available to cover the incremental cost of addressing stormwater runoff as part of such projects, if stormwater management is considered early enough in the design process and does not exceed regulatory thresholds for state stormwater permits. The Town will likely need to consult on a case-by-case basis with the VT DEC Stormwater Program to determine whether or not a specific project will be subject to state jurisdiction.

Regardless, it is often significantly more cost-effective and efficient to incorporate stormwater management measures into a planned municipal project as compared to the construction of a "stand alone" stormwater management retrofit. The Oak Street drainage area and Fred Mold Park retrofit concepts described in Section 7 are prime examples of how to take strategic advantage of such opportunities.

9. References

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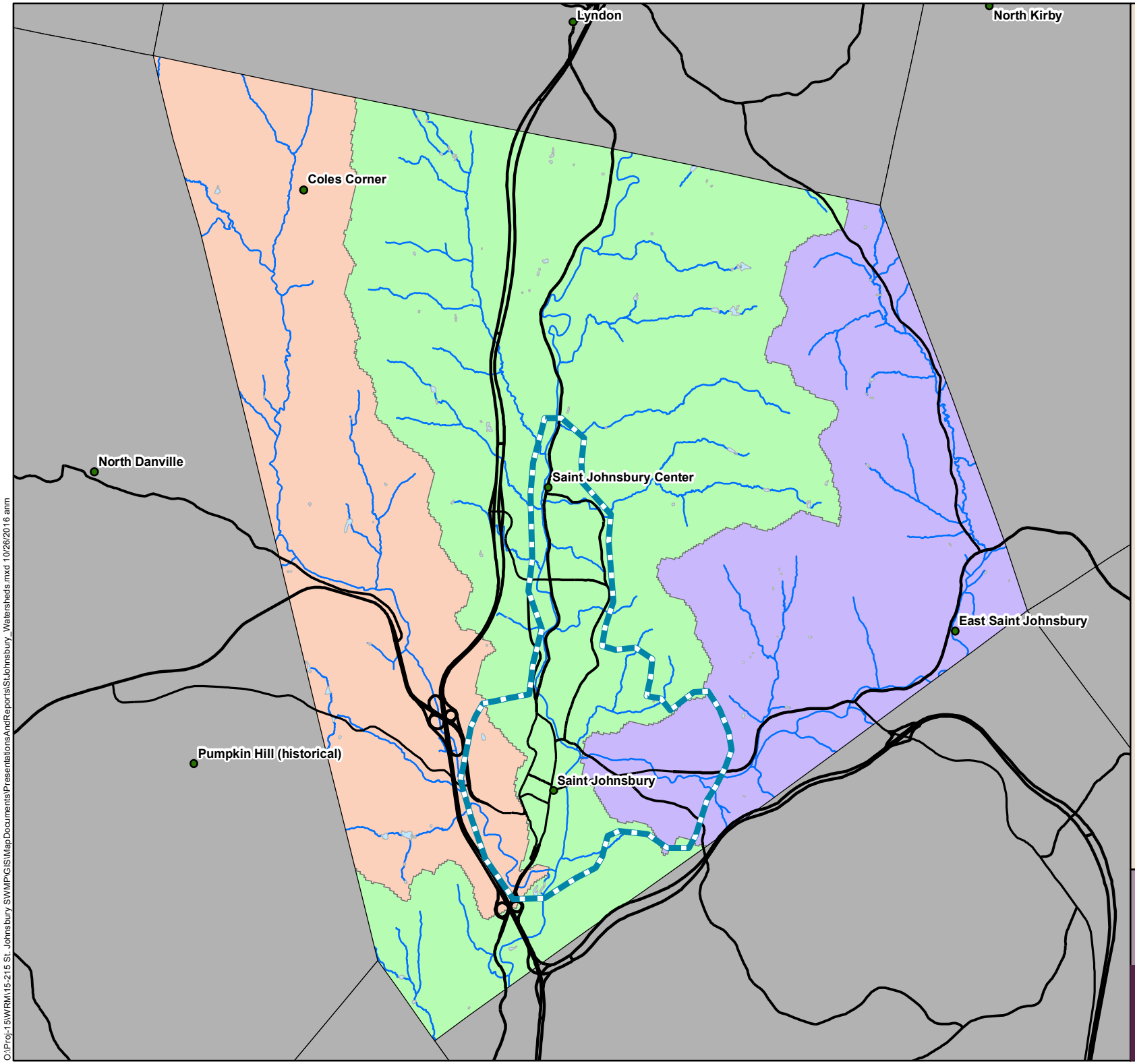
Appendix A. Maps


Lyndon
North Kirby
Coles Corner
North Danville
Saint Johnsbury Center
East Saint Johnsbury
Pumpkin Hill (historical)
Saint Johnsbury
N
0
0.55
1.1 Miles
Stormwater Master Plan Area
River or Stream
St. Johnsbury Watersheds
Moose River
Passumpsic River
Sleepers River
Sources: Watershed Boundaries: NHD Plus 2; Administrative Boundaries, Roads: VCGI.
STONE ENVIRONMENTAL
Watershed Boundaries
Figure 1
St. Johnsbury Stormwater Master Planning
O:\Proj-15\WRM\15-215 St. Johnsbury SWMP\GIS\MapDocuments\PresentationsAndReports\StJohnsbury_Watersheds.mxd 10/26/2016 ann

PR-07
Saint Johnsbury Center
PR-06
PR-05
PR-10
PR-11
PR-08
PR-09
PR-12
PR-14
PR-04
MR-05
PR-13
MR-03
MR-04
SR-05
PR-01
MR-02
SR-01
SR-02
SR-03
SR-04
SR-06
MR-01
PR-03
PR-02

Legend

Problem Area Classification

1 6
4 1, 4
5 4, 6

Draft SWMP Area

St. Johnsbury Watersheds

Moose River
Passumpsic River
Sleepers River

N

0 0.1 0.2 0.4 Miles

Level	Classification
1	Infeasible to remedy issue/ outside of project scope
2	Stable, but problem could escalate with future change in surrounding land use
3	Limited erosion and/or drainage problems are present
4	Moderate erosion and/or drainage problems are present
5	Significant erosion and/or drainage problems are present
6	Strategic retrofit opportunity

Sources: Watershed Boundaries: Stone/HNDPlus2; Hydrography, NHD; Administrative Boundaries:VCGI

STONE ENVIRONMENTAL

Problem Area Locations

Figure 2

St. Johnsbury Stormwater Master Planning

O:\Proj-15\WRM\15-215 St Johnsbury SWMP\GIS\MapDocuments\PresentationsAndReports\ProblemAreaLocations_10_1.mxd

Appendix B. Problem Area Data Sheets

November 16, 2016

MEMO

To: Kerry O'Brien
CCNRCD

STONE ENVIRONMENTAL INC

535 Stone Cutters Way
Montpelier, Vermont
05602 USA

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

From: Julie Moore
Direct Phone: 802-229-1881
E-Mail: jmoore@stone-env.com

SEI No. 15-215
Re: DRAFT Stormwater Problem Area Data Sheets for the Town of St. Johnsbury

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Stone Environmental has combed through existing reports, including the stormwater infrastructure mapping completed by VT DEC, and also worked directly with the Town Manager and Public Works Director to identify current problem areas (e.g., actively eroding sites, areas impacted during past high flow events) that are a direct, or indirect, result of stormwater runoff.

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 the St. Johnsbury study area 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.
2	Stable, but problem could escalate with future change in surrounding land use.
3	Limited erosion and/or drainage problems are present; issues could be readily addressed.
4	Moderate erosion and/or drainage problems are present; issues may be readily addressed.
5	Significant erosion and/or drainage problems are present; issues may be readily addressed.
6	Strategic retrofit opportunity

Ultimately, the information collected during this phase of the project will be incorporated in an evaluation that considers both the Town's priorities and anticipated water quality benefits of addressing each problem area to develop a refined list of high priority projects.

Problem Area Data Sheet

Problem Area ID: SR-01	Latitude: 44.250149	Longitude: -72.014192

Watershed: Sleepers River

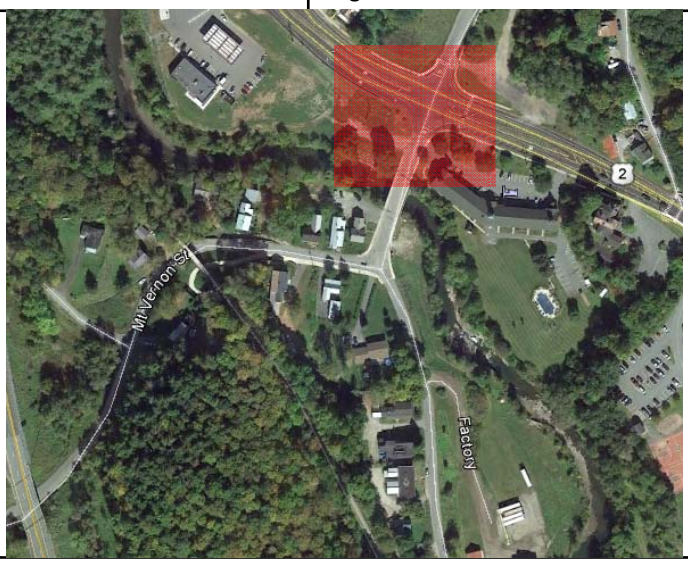
Location: West of High Street at Route 2 (VT DEC #11)

Problem Type: Umanaged impervious

Identification Source: VT DEC Stormwater Infrastructure Mapping Project

Ownership: Private/Town

Classification: 6



Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

Potential to capture and treat a portion of the runoff from sewershed bounded by Cliff St to the west, Summer St to the east and Mt Pleasant St to the north in the existing green space to the south of Route 2 and west of High St. A “best fit” solution for this site has been designed and the project is moving to construction.

Field Photos

Photo 1. Potential retrofit location

Photo 2. Existing outfalls to the Sleepers River

Problem Area Data Sheet

Problem Area ID: SR-02	Latitude: 44.245956	Longitude: -72.012929

Watershed: Sleepers River

Location: The St Johnsbury School

Problem Type: Unmanaged impervious

Identification Source: SWMP field work

Ownership: Town

Classification: 6

Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

Retrofit opportunity; Take advantage of existing green around perimeter of upper parking lot and flag circle at School to provide treatment for runoff from the parking lot. There are existing sewer lines in the vicinity of this retrofit opportunity and care will need to be take to avoid potential conflicts.

Field Photos

Photo 1. Flag circle and green space in upper parking lot

Photo 2. Flag circle

Problem Area Data Sheet

Problem Area ID: SR-03	Latitude: 44.245575	Longitude: -72.012948

Watershed: Sleepers River

Location: Kiwanis Pool and Tennis Courts

Problem Type: Erosion

Identification Source: SWMP field work

Ownership: Local

Classification: 4

Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

Runoff from the parking lot is causing gully erosion along steep embankment to the south of the parking lot; in addition to gully stabilization, there may be an opportunity to install a retrofit along the eastern edge of the lot to improve stormwater management.

Field Photos

Photo 1. Looking southward from parking lot at gully

Photo 2. Possible retrofit area east of parking area

Problem Area Data Sheet

Problem Area ID: SR-04	Latitude: 44.245137	Longitude: -72.012588

Watershed: Sleepers River

Location: Valley St

Problem Type: Erosion

Identification Source: SWMP field work

Ownership: Town/Private

Classification: 4

Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

Unmanaged runoff from Kiwanis Pool (SR-03) and a small cluster of homes along Valley St concentrates and has formed a gully which enters the Sleepers River.

Field Photos

Photo 1. Erosion at western end of Valley St

Photo 2. Gully caused by stormwater runoff from SR-03

Problem Area Data Sheet

Problem Area ID: SR-05	Latitude: 44.251436	Longitude: -72.013352

Watershed: Sleepers River

Location: Underclyffe Rd

Problem Type: Erosion, unmanaged impervious

Identification Source: SWMP field work

Ownership: Private/State

Classification: 5

Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

Significant gully off the west-side of the loop and just south #191; appears to be attributable to outlet from roadway storm drain system. Gully terminates in large, flat area immediately to the east of an existing park and ride facility and much of the sediment eroded from the gully appears to be deposited here. VTrans is in the process of acquiring additional landholdings in this area as part of a planned expansion of the park and ride; CCNRCD met on-site with VTrans representatives to make them aware of the existing condition.

Field Photos

Photo 1. Significant gully west of 191 Underclyffe Rd.

Photo 2. Existing catch basins draining to the gully behind 191 Underclyffe Rd.

Problem Area Data Sheet

Problem Area ID: SR-06	Latitude: 44.245958	Longitude: -72.010961

Watershed: Sleepers River

Location: St. Johnsbury Academy

Problem Type: Unmanaged impervious

Identification Source: SWMP field work

Ownership: Private

Classification: 6

Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

There are numerous retrofit opportunities available on the campus; perhaps the greatest concentration of which surrounds the Field House. These include managing roof runoff from the athletic building complex, was well as retrofitting existing green spaces in the parking lot by recessing areas at the toe of slope and installing linear bioretention practices.

Field Photos

Photo 1. Field house roof and drop-off loop

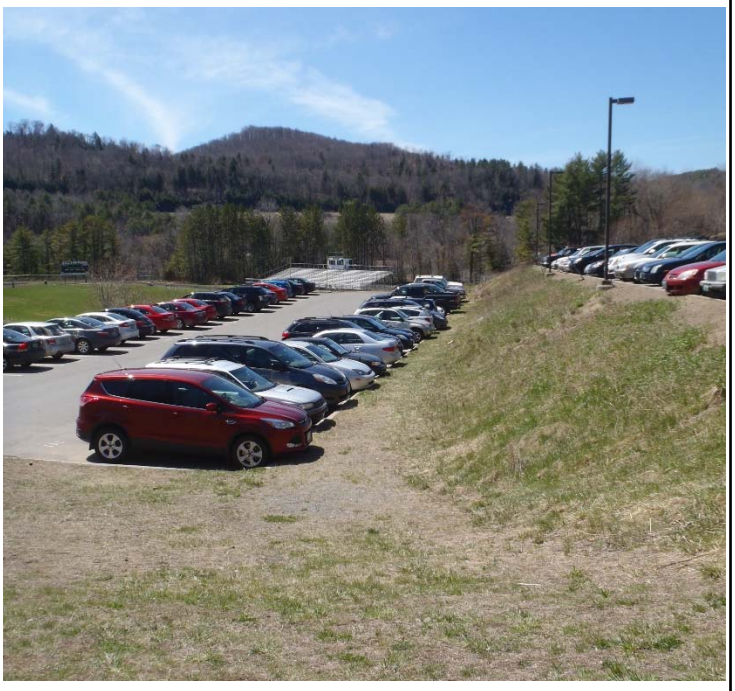


Photo 2. Potential retrofit at "toe" of green space in parking lot

Problem Area Data Sheet

Problem Area ID: MR-01	Latitude: 44.245814	Longitude: -71.595446

Watershed: Moose River

Location: Overlook Drive

Problem Type: Unmanaged impervious

Identification Source: SWMP field work

Ownership: Private/Town

Classification: 6

Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

Driveways along Overlook Dr generally intersect the road surface at a steep angle and little or no apron resulting in significant gravel being carried into the road and ultimately the storm sewer system. Undeveloped lots remain around the cul-de-sac and could be encouraged to implement better driveway design.

Field Photos

Photo 1. Steep driveway intersection with Overlook Dr.

Photo 2. Cul-de-sac at end of Overlook Dr; additional driveways should be encouraged to intersect road with better geometry

Problem Area Data Sheet

Problem Area ID: MR-02	Latitude: 44.250930	Longitude: -72.000279

Watershed: Moose River

Location: Concord Ave (VT DEC #104)

Problem Type: Retrofit opportunity

Identification Source: VT DEC Stormwater Infrastructure Mapping Project

Ownership: Private

Classification: 6

Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

Potential to intercept and treat a portion of the sewershed bounded by Concord St and Parker Ave to the east, Lafayette St to the north with a swirl separator or sand filter. Existing outfall is significantly (~20 feet) below grade which could complicate retrofit.

Field Photos

Photo 1. Potential retrofit location; currently used for residential waste transfer and heavy equipment storage

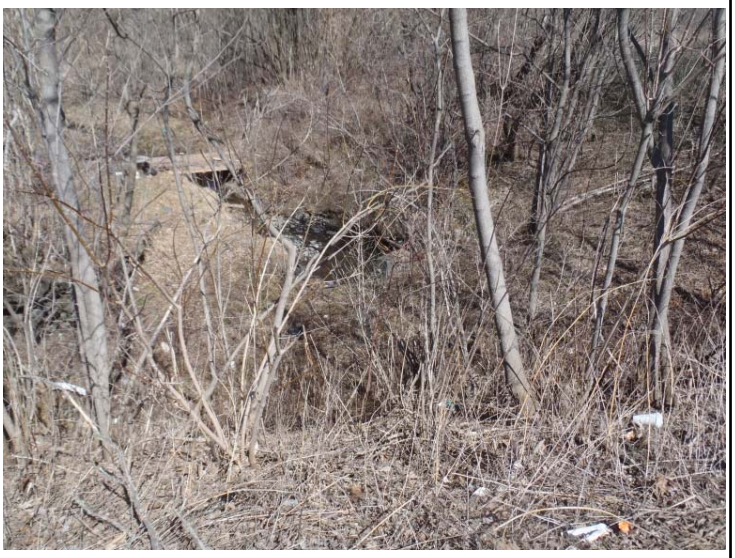


Photo 2. Existing storm sewer outfall to unnamed tributary to the Moose River

Problem Area Data Sheet

Problem Area ID: MR-03	Latitude: 44.252702	Longitude: -72.002680

Watershed: Moose River

Location: Almshouse Rd

Problem Type: Erosion

Identification Source: SWMP field work

Ownership: Town

Classification: 5

Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

Almshouse Rd runs through a large gravel parking lot that drains overbank to the Moose River and provides access to the Town Garage and St. Johnsbury Municipal Forest. Some evidence of rill and gully erosion along streambank in areas where concentrated flow leaves the parking lot; during heavier rain events sediment flows down to Concord Ave also into the Moose River.

Field Photos

Photo 1. Accumulated sediment in top-of-bank tree line

Photo 2. Significant sediment piled at edge of parking lot/top of bank

Problem Area Data Sheet

Problem Area ID: MR-04	Latitude: 44.424143	Longitude: -72.006645

Watershed: Moose River

Location: Town Garage, Alsmhouse Rd.

Problem Type: Erosion, materials storage

Identification Source: SWMP field work

Ownership: Town

Classification: 5

Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

Sand storage pile at the Town Garage is experiencing "creep" and has slumped over the jersey barriers intended to prevent material from eroding into a nearby drainage swale; both stormwater outlets from the facility show evidence of significant sediment transport and active erosion.

Field Photos

Photo 1. Gully erosion through Town Garage maintenance yard

Photo 2. Visible "creep" of the sand storage pile

Problem Area Data Sheet

Problem Area ID: MR-05	Latitude: 44.42523	Longitude: -72.005856

Watershed: Moose River

Location: St. Johnsbury Municipal Forest access road and parking area

Problem Type: Erosion

Identification Source: SWMP field work

Ownership: Town

Classification: 4

Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

Visible erosion along the shoulder of the access road; currently at least a portion of runoff from the road and parking area contributes to the problems observed at the Town Garage.

Field Photos

Photo 1. Stormwater outfall from Municipal Forest parking area

Photo 2. Municipal forest access road

Problem Area Data Sheet

Problem Area ID: MR-06	Latitude: 44.253659	Longitude: -72.003642

Watershed: Moose River

Location: Gilman Ave

Problem Type: Retrofit opportunity

Identification Source: SWMP field work

Ownership: Town

Classification: 6

Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

Bring overly-wide section of road back to standard width, establishing a grassed channel with check dams, as needed, on both sides of the road to convey stormwater runoff.

Field Photos

Photo 1. Looking south down Gilman Ave toward Concord Ave

Photo 2. Looking north up Gilman Ave toward Waterman Circ

Problem Area Data Sheet

Problem Area ID: PR-01	Latitude: 44.417161	Longitude: -72.016939

Watershed: Passumpsic River

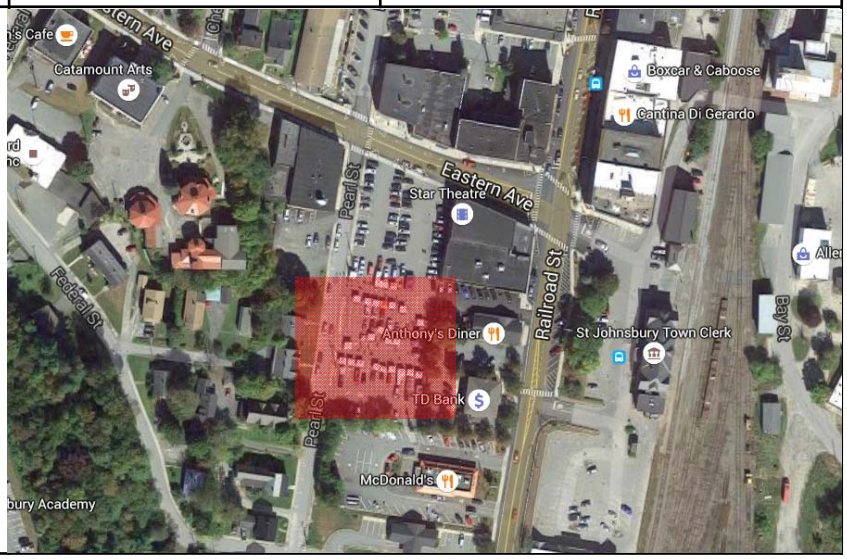
Location: Pearl St municipal lots

Problem Type: Retrofit opportunity

Identification Source: SWMP field work

Ownership: Town/Private

Classification: 6



Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

Significant, unmanaged impervious area. Opportunity to repurpose and recess painted/striped "islands" within the parking lot to intercept and infiltrate stormwater runoff.

Field Photos

Photo 1. Existing "island" in municipal lot

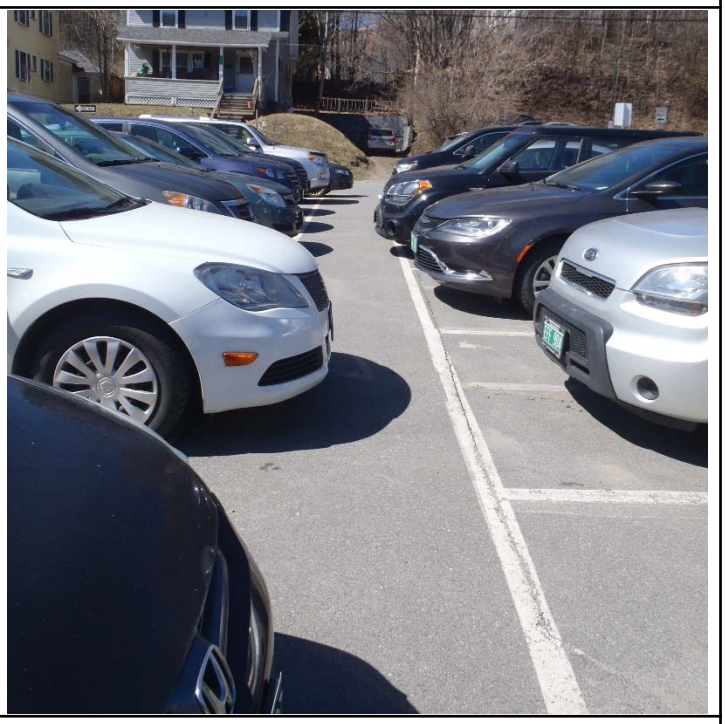


Photo 2. . Existing "island" in municipal lot

Problem Area Data Sheet

Problem Area ID: PR-02	Latitude: 44.413490	Longitude: -72.015901

Watershed: Passumpsic River

Location: Bay Street, adjacent to WWTP

Problem Type: Erosion

Identification Source: SWMP field work

Ownership: Private

Classification: 5

Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

Large stockpile located in close proximity to the WWTP is actively eroding into a drainage swale; the is evidence of significant sediment transport to the Passumpsic River.

Field Photos

Photo 1. Unmanaged sand pile

Photo 2. Evidence of significant sediment transport

Problem Area Data Sheet

Problem Area ID: PR-03	Latitude: 44.244437	Longitude: -72.005892

Watershed: Passumpsic River

Location: 659 Bay St

Problem Type: Sediment deposition

Identification Source: SWMP field work

Ownership: Private

Classification: 4

Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

Heavy sediment load was observed in the swale immediately to the north of 659 Bay St. The swale receives stormwater runoff from the west side of Bay St through a cross-culvert, but the origin of the stormwater is unknown as the infrastructure in this location has not been mapped.

Field Photos

Photo 1: Evidence of sediment deposition at system outfall entering swale on west side of Bay St.

Photo 2. Swale, looking east from Bay St, with sediment deposition

Problem Area Data Sheet

Problem Area ID: PR-04	Latitude: 44.254521	Longitude: -72.002911

Watershed: Passumpsic River

Location: Farmer Dr, north of Waterman Circ

Problem Type: Erosion, unmanaged impervious

Identification Source: SWMP field work

Ownership: Town/Private

Classification: 1, 4

Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

There is an undersized culvert ~30 feet below grade; embankments of road crossing are unstable and show evidence of gully erosion slumping. Although it is unlikely to be possible to replace this culvert as part of a stormwater master plan, there are opportunities to better manage stormwater runoff from adjacent residential areas.

Field Photos

Photo 1: Gully erosion where Farmer Dr crosses unnamed tributary to the Passumpsic

Photo 2. Paved swale along Waterman Circ. at intersection with Farmer Dr.

Problem Area Data Sheet

Problem Area ID: PR-05	Latitude: 44.271720	Longitude: -72.003495

Watershed: Passumpsic River

Location: 1569 Breezey Hill Rd

Problem Type: Erosion

Identification Source: SWMP field work

Ownership: Town

Classification: 4

Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

Unmanaged stormwater runoff from roadway concentrates where Breezey Hill Rd crosses Roberts Brook (Passumpsic River tributary) and is causing gully erosion and general embankment instability.

Field Photos

Photo 1: Series of small gullies caused by road runoff

Photo 2. Area of overbank flow and previous stabilization efforts

Problem Area Data Sheet

Problem Area ID: PR-06	Latitude: 44.271817	Longitude: -72.001880

Watershed: Passumpsic River

Location: Lackey Hill Rd

Problem Type: Erosion

Identification Source: SWMP field work

Ownership: Town

Classification: 5

Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

Unstable ditches, turnouts and cross-culverts are resulting in significant erosion and visibly more turbid water in Roberts Brook between Spaulding Rd and Breezey Hill Rd. Opportunity to bring overly-wide section of road back to standard width and establish properly shaped ditches, with stone-lining and check dams as needed.

Field Photos

Photo 1: Erosion at driveway culvert outlet

Photo 2. Unstable turn-out along southside of Lackey Hill

Problem Area Data Sheet

Problem Area ID: PR-07	Latitude: 44.273805	Longitude: -72.004960

Watershed: Passumpsic River

Location: Green Mountain Mall (VT DEC #65)

Problem Type: Unmanaged impervious

Identification Source: VT DEC Stormwater Infrastructure Mapping Project

Ownership: Private

Classification: 6

Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

Site includes more than 10 acres of unmanaged impervious surface. Existing islands within the parking lot could be retrofit as bioretention areas. Opportunities exist for treatment in the green spaces to the west and north of the parking lot. There may also be opportunities to reconfigure/depave certain areas without interfering with existing uses, including CDL training.

Field Photos

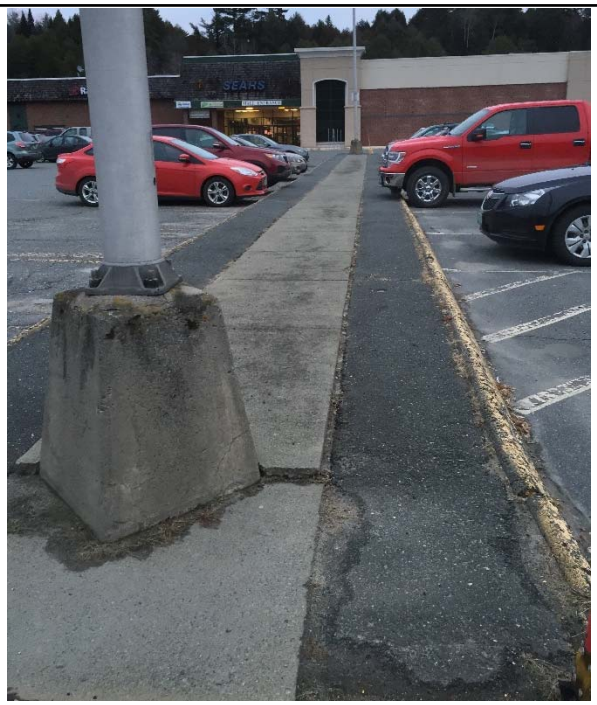


Photo 1: Impervious islands with Green Mountain Mall parking lot

Photo 2. Green space to the west of the Green Mountain Mall parking lot

Problem Area Data Sheet

Problem Area ID: PR-08	Latitude: 44.262991	Longitude: -72.005191

Watershed: Passumpsic River

Location: 857 Memorial Dr – Price Chopper (VT DEC #45)

Problem Type: Retrofit opportunity

Identification Source: VT DEC Stormwater Infrastructure Mapping Project

Ownership: Private

Classification: 6

Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

Significant scour poll has formed where two drainage systems outlet at the southeast corner of the parking lot. Opportunities exist to both improve outlet stability and to better manage stormwater within the parking lot. It should be noted that the existing stormwater facilities within the parking lot (photo 2) are subject to State Stormwater Permit 3185-9010.

Field Photos

Photo 1: Scour pool at discharge point.

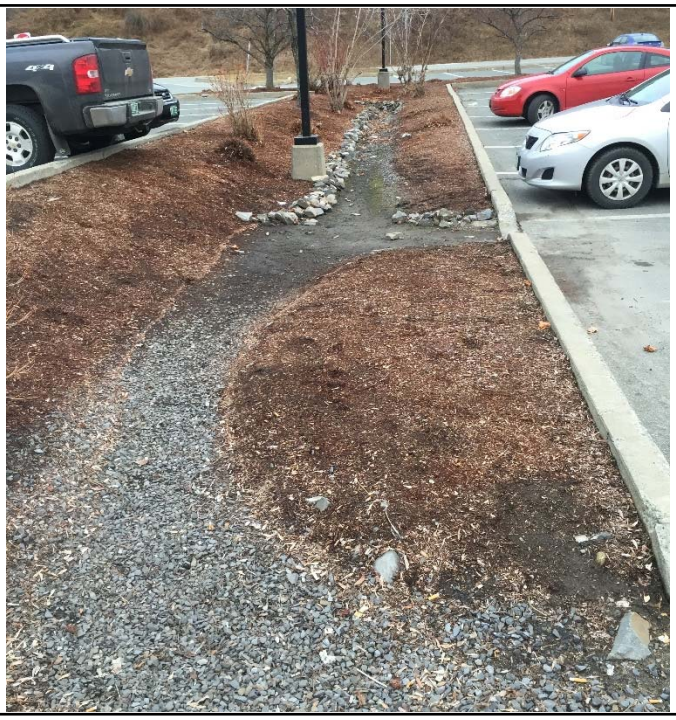


Photo 2. Underutilized, existing island in Price Chopper parking lot

Problem Area Data Sheet

Problem Area ID: PR-09	Latitude: 44.262991	Longitude: -72.005191

Watershed: Passumpsic River

Location: 644 Memorial Dr (FedEx) (VT DEC #57)

Problem Type: Retrofit opportunity

Identification Source: SWMP VT DEC Stormwater Infrastructure Mapping Project

Ownership: Private

Classification: 6

Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

Retrofit existing green spaces in the parking lot by recessing them and regrading the lot to drain to these areas; swale along the north-side of the parking lot could be retrofit as a bioswale to provide enhanced stormwater treatment

Field Photos

Photo 1: Existing island within parking lot at 644 Memorial Dr

Photo 2. Existing swale along the northside of the parking lot

Problem Area Data Sheet

Problem Area ID: PR-10	Latitude: 44.264896	Longitude: -72.004307

Watershed: Passumpsic River

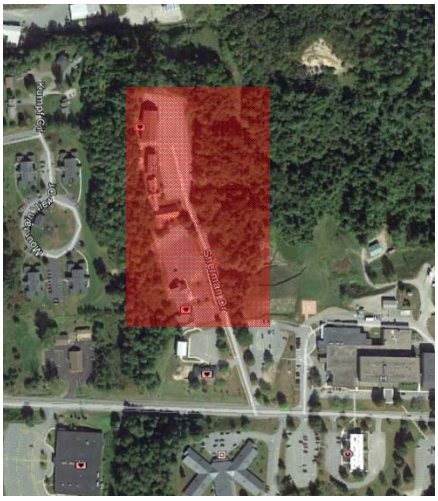
Location: Sherman Dr

Problem Type: Unamanged impervious

Identification Source: SWMP field work

Ownership: Private

Classification: 4, 6



Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

There are a number of small stormwater practices which appear to be designed to treat runoff from buildings and parking facilities along Sherman Dr., several of which appear unmaintained and potentially undersized, and are discharging onto a steep slope without energy dissipation. There are retrofit opportunities to use existing green spaces in the parking lots by recessing them and regrading to drain to these areas; swale along the north-side of the parking lot could be retrofit as a bioswale to provide enhanced stormwater treatment. Other parts of the campus are covered under an existing stormwater discharge permit (5099-9015).

Field Photos

Photo 1: Erosion along the road shoulder

Photo 2. Green space and potential retrofit opportunity

Problem Area Data Sheet

Problem Area ID: PR-11	Latitude 44.264338	Longitude: -72.005582

Watershed: Passumpsic River

Location: Hospital Rd at Route 5 (VT DEC #44)

Problem Type: Erosion, unmanaged impervious

Identification Source: VT DEC Stormwater Infrastructure Mapping Project

Ownership: Private/State

Classification: 6

Date of Field Data Collection: April 5, 2016

Description of Observed Conditions:

Existing swale along the south-side of Hospital Dr (adjacent to the Price Chopper shows evidence of high flows and sediment transport. Swale could be retrofit to improve stormwater management.

Field Photos

Photo 1: Existing wale south of Hospital Dr, adjacent to Price Chopper

Photo 2. Evidence of sediment deposition in existing swale south of Hospital Dr, adjacent to Price Chopper, at Route 5 crossing

Problem Area Data Sheet

Problem Area ID: PR-12	Latitude 44.431327	Longitude: -72.013622

Watershed: Passumpsic River

Location: Oak St. outfall sewer separation

Problem Type: Retrofit/CSO control opportunity

Identification Source: SWMP field work

Ownership: Town

Classification: 6

Date of Field Data Collection: May 19, 2016

Description of Observed Conditions:

Area is characterized by relatively short, narrow, low-volume residential streets, underlain by HSG A soils. The City is planning to implement sewer separation in this neighborhood in late-2016; a comprehensive GSI retrofit plan could be developed for the neighborhood to see if such an approach would be cost-competitive.

Field Photos

Photo 1: Green space, looking west on Emerson St.

Photo 2. Oak St neighborhood, looking north on Union St. toward St. John

Problem Area Data Sheet

Problem Area ID: PR-13	Latitude 44.425035	Longitude: -72.011044

Watershed: Passumpsic River

Location: Old Concord Ave

Problem Type: Unmanaged impervious

Identification Source: SWMP field work

Ownership: Town

Classification: 6

Date of Field Data Collection: May 19, 2016

Description of Observed Conditions:

The intersection of Concord Ave., Old Concord Ave., and Gilman Ave is overly-wide – measuring more than 90 feet immediately west of the pocket park. Possible options include expanding the existing island/green space in the intersection or expanding the pocket park between Concord Ave and the Passumpsic River; either design should offer the dual benefits of improved traffic management and incorporating improved stormwater management.

Field Photos

Photo 1: Looking west at intersection of Concord and Old Concord Aves and Gilman Rd.

Photo 2. Looking east toward existing green space and overly-wide pavement section

Appendix C. Restoration Plans

Path: O:\Proj-15\WRM\15-215 St Johnsbury SWMP\GIS\MapDocuments\PresentationsAndReports\Restoration_plans\StJ_RestorationPlan_PR-01.mxd

Legend

- PR-01 Problem Area Location
- Proposed PR-01 Practice Area(s)
- Approximate PR-01 Drainage Area

N

0 25 50 Feet

STONE ENVIRONMENTAL
535 Stone Cutters Way / Montpelier / VT / 05602 / USA
802.229.4541 / info@stone-env.com / www.stone-env.com

PR-01 Restoration Plan
Pearl St. Municipal Parking

Date: 11/1/2016 Figure C.1

Path: O:\Proj-15\WRM\15-215 St Johnsbury SWMP\GIS\MapDocuments\PresentationsAndReports\Restoration_plans\StJ_RestorationPlan_PR-06.mxd

Legend

- PR-06 Problem Area Location
- Proposed PR-06 Practice Area(s)
- Approximate PR-06 Drainage Area

N

0 100 200 Feet

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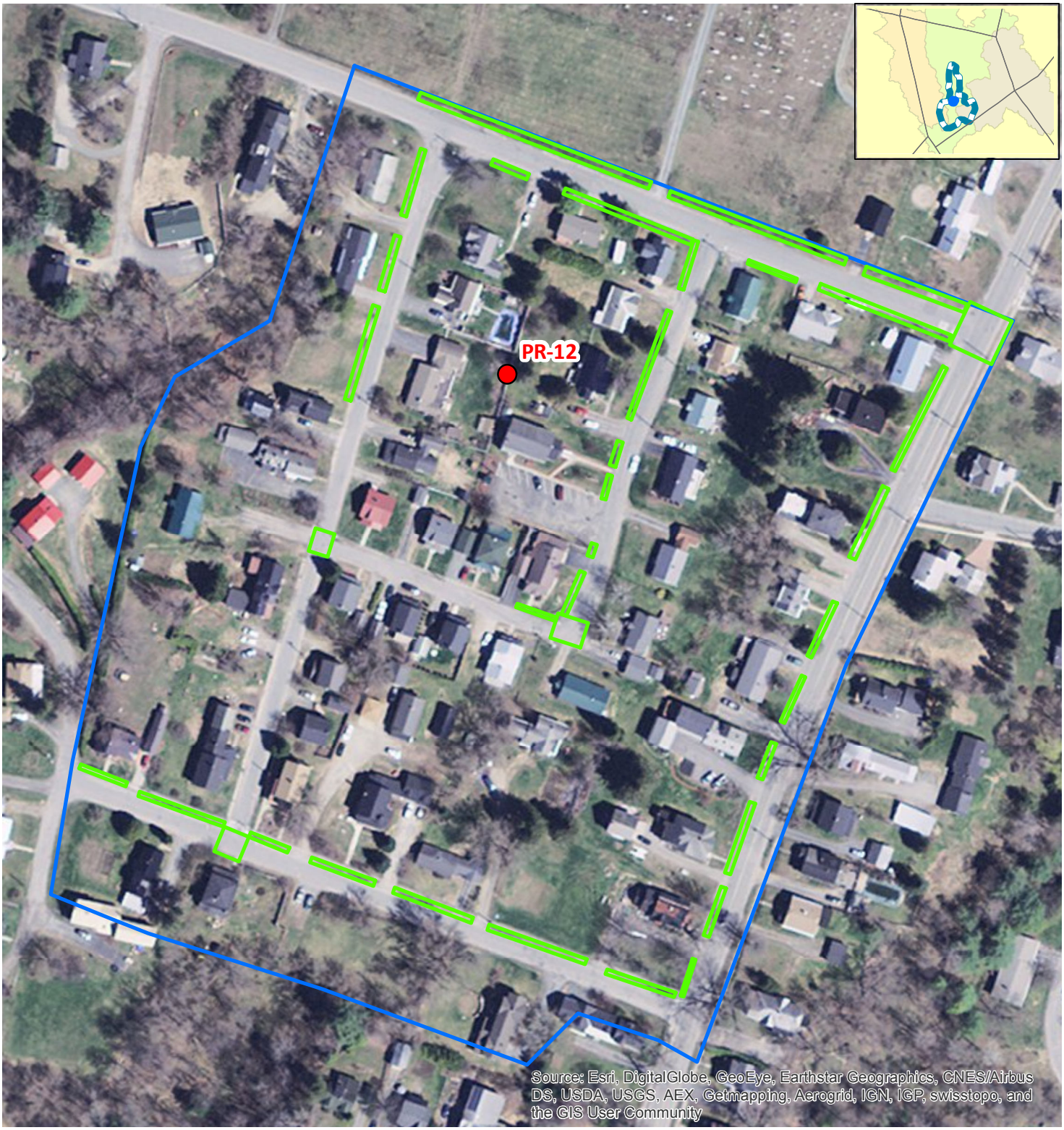
802.229.4541 / info@stone-env.com / www.stone-env.com

PR-06 Restoration Plan
Lackey Hill Road

Date: 11/1/2016 Figure C.2



Path: O:\Proj-15\WRM\15-215 St Johnsbury SWMP\GIS\MapDocuments\PresentationsAndReports\Restoration_plans\StJ_RestorationPlan_PR-12.mxd

Legend

- PR-12 Problem Area Location
- Proposed PR-12 Practice Area(s)
- Approximate PR-12 Drainage Area

N

0 100 200 Feet

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PR-12 Restoration Plan
Oak Street Drainage Area

Date: 11/1/2016 Figure C.3

Path: O:\Proj-15\WRM\15-215 St Johnsbury SWMP\GIS\MapDocuments\PresentationsAndReports\Restoration_plans\StJ_RestorationPlan_PR-13.mxd

Legend

- PR-13 Problem Area Location
- Proposed PR-13 Practice Area(s)
- Approximate PR-13 Drainage Area

N

0 25 50 Feet

STONE ENVIRONMENTAL
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802.229.4541 / info@stone-env.com / www.stone-env.com

PR-13 Restoration Plan
Fred Mold Park

Date: 11/1/2016 Figure C.4

Path: O:\Proj-15\WRM\15-215 St Johnsbury SWMP\GIS\MapDocuments\PresentationsAndReports\Restoration_plans\StJ_RestorationPlan_SR-03.mxd

Legend

- SR-03 Problem Area Location
- Proposed SR-03 Practice Area(s)
- Approximate SR-03 Drainage Area

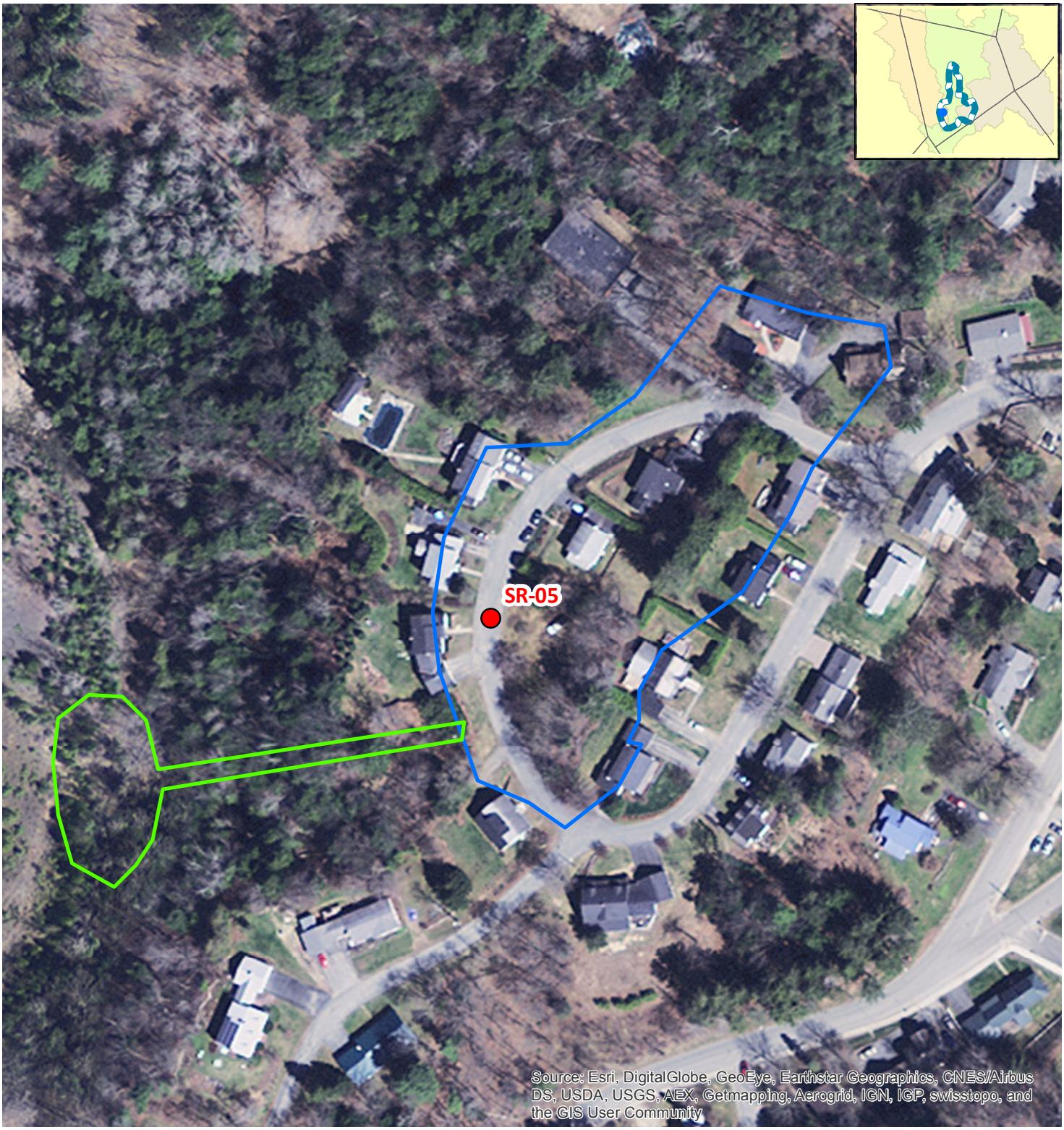
N

0 25 50 Feet

STONE ENVIRONMENTAL
535 Stone Cutters Way / Montpelier / VT / 05602 / USA
802.229.4541 / info@stone-env.com / www.stone-env.com

SR-03 Restoration Plan
Kiwanis Pool & Tennis Courts

Date: 11/1/2016 Figure C.5



Path: O:\Proj-15\WRM\15-215 St Johnsbury SWMP\GIS\MapDocuments\PresentationsAndReports\Restoration_plans\StJ_RestorationPlan_SR-05.mxd

Legend

- SR-05 Problem Area Location
- Proposed SR-05 Practice Area(s)
- Approximate SR-05 Drainage Area

N

Feet
0 50 100

STONE ENVIRONMENTAL
535 Stone Cutters Way / Montpelier / VT / 05602 / USA
802.229.4541 / info@stone-env.com / www.stone-env.com

SR-05 Restoration Plan
Underclyffe Road

Date: 11/1/2016 Figure C.6

Path: O:\Proj-15\WRM\15-215 St Johnsbury SWMP\GIS\MapDocuments\PresentationsAndReports\Restoration_plans\StJ_RestorationPlan_SR-06.mxd

Legend

- SR-06 Problem Area Location
- Proposed SR-06 Practice Area(s)
- Approximate SR-06 Drainage Area

N

0 50 100 Feet

STONE ENVIRONMENTAL
535 Stone Cutters Way / Montpelier / VT / 05602 / USA
802.229.4541 / info@stone-env.com / www.stone-env.com

SR-06 Restoration Plan
St. Johnsbury Academy

Date: 11/1/2016 Figure C.7

Path: O:\Proj-15\WRM\15-215 St Johnsbury SWMP\GIS\MapDocuments\PresentationsAndReports\Restoration_plans\StJ_RestorationPlan_MR-03.mxd

Legend

- MR-03 Problem Area Location
- Proposed MR-03 Practice Area(s)
- Approximate MR-03 Drainage Area

N

Feet
0 50 100

STONE ENVIRONMENTAL
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802.229.4541 / info@stone-env.com / www.stone-env.com

MR-03 Restoration Plan
Almshouse Road - Ball Fields

Date: 11/1/2016 Figure C.8

Path: O:\Proj-15\WRM\15-215 St Johnsbury SWMP\GIS\MapDocuments\PresentationsAndReports\Restoration_plans\StJ_RestorationPlan_MR-04.mxd

Legend

- MR-04 Problem Area Location
- Proposed MR-04 Practice Area(s)
- Approximate MR-04 Drainage Area

N

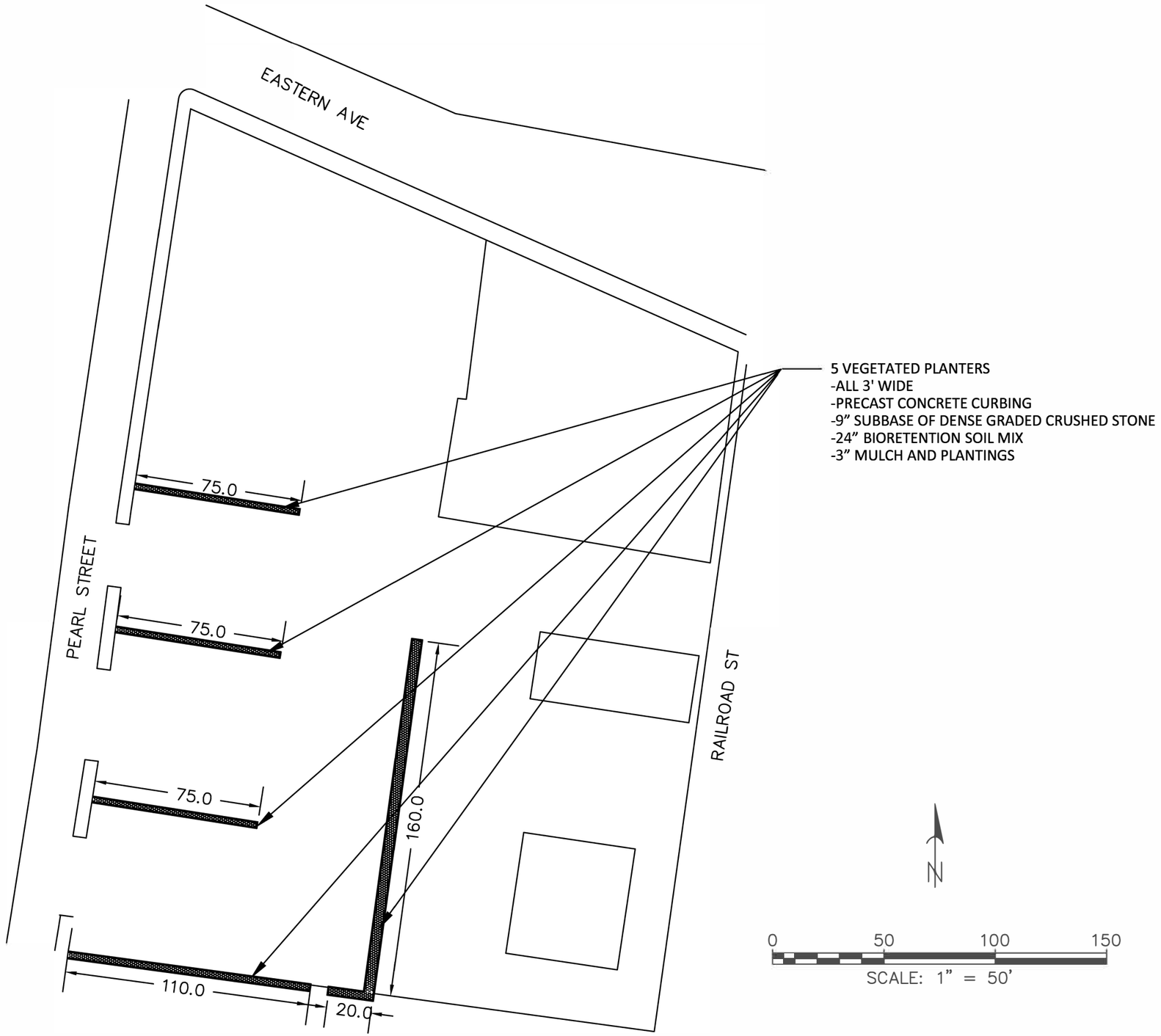
Feet
0 50 100

STONE ENVIRONMENTAL
535 Stone Cutters Way / Montpelier / VT / 05602 / USA
802.229.4541 / info@stone-env.com / www.stone-env.com

MR-04 Restoration Plan
Almshouse Road - Town Garage

Date: 11/1/2016 Figure C.9

Appendix D. Concept Designs for Priority Stormwater Problem Areas



VEGETATED PLANTER COST ESTIMATE

ITEM	PRICE	TOTAL	
		QUANTITY	SUBTOTAL
Durable 4" White Line, Polyurea (LF)	$0.51	116.00	$59.16
Excavation of Surfaces and Pavements (CY)	$21.85	19.35	$422.84
Trench Excavation (CY)	$14.43	159.17	$2,296.78
Subase of Dense Graded Crushed Stone	$34.30	42.92	$1,472.04
Bioretention Soil Mix (CY)	$27.10	114.44	$3,101.90
Mulch (Woodchips) (CF)	$5.00	14.31	$71.53
Precast Reinforced Concrete Curb, Type B (LF)	$25.08	740.00	$18,559.20
Plantings (SY)	$135.00	171.67	$23,175.00
SUBTOTALS		**TOTAL**	**$49,158.44**
Final Engineering Design		1	$8,000.00
Construction Site Stake-Out		1	$500.00
Bid Walk		1	$450.00
Construction Oversight		2	$800.00
SUBTOTAL		**$58,908.44**	
20% CONTINGENCY		**$11,781.69**	
GRAND TOTAL		**$70,690.13**	

File: FILE LOCATION

DRAWING CREDITS
Drawn On: 10-31-2016
Drawn By: CAG
Checked On:
Checked By:
Project No.: 15-215

REVISIONS

#	Date	Drwn	Chk'd	App'd	Description

DRAWING SCALE

STONE ENVIRONMENTAL
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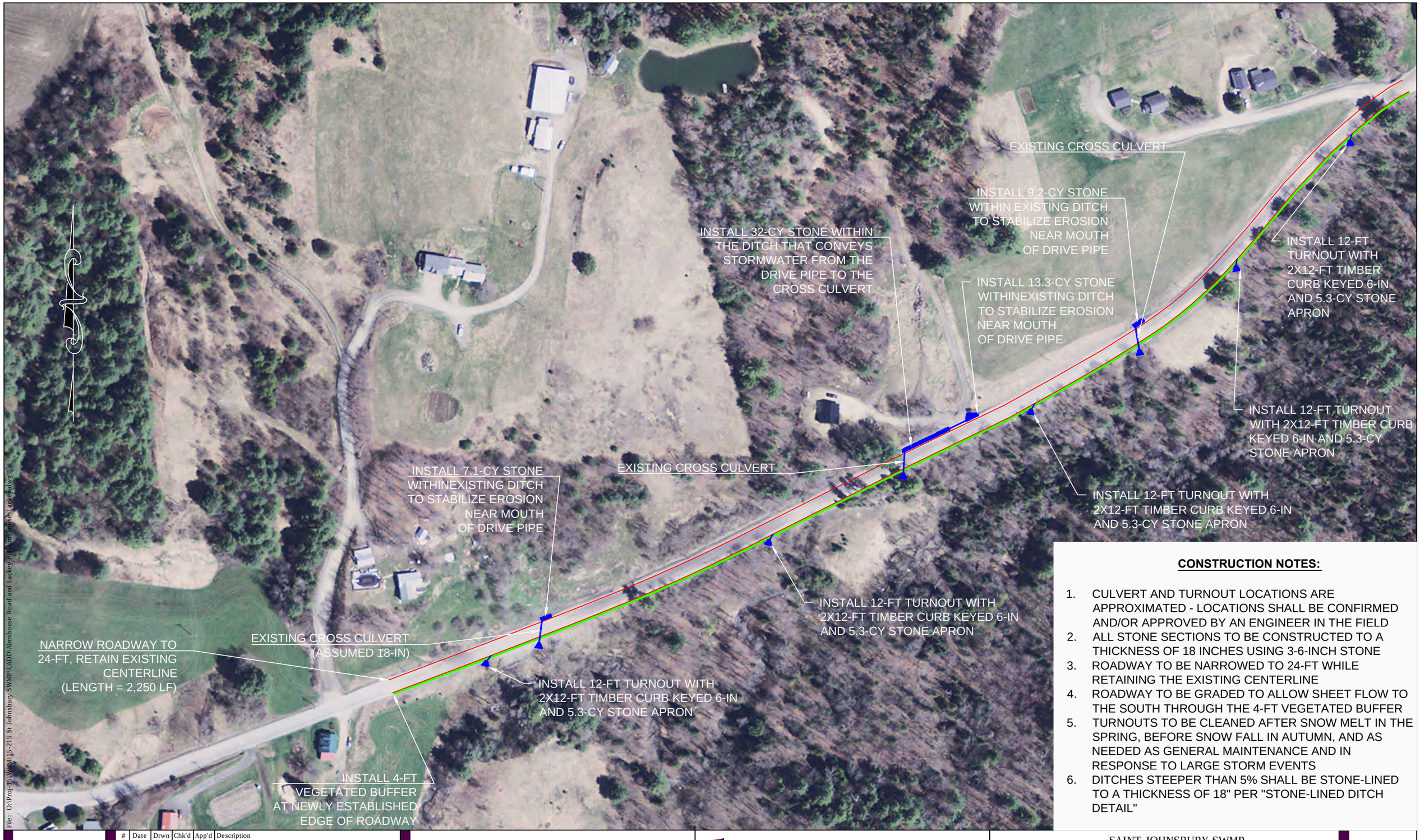
Saint Johnsbury SWMP
PR-01 Pearl Street Municipal Parking Lots
Stormwater Improvements
Saint Johnsbury VT

FIGURE NO.
D-1



CONSTRUCTION NOTES:

1. CULVERT AND TURNOUT LOCATIONS ARE APPROXIMATED - LOCATIONS SHALL BE CONFIRMED AND/OR APPROVED BY AN ENGINEER IN THE FIELD
2. ALL STONE SECTIONS TO BE CONSTRUCTED TO A THICKNESS OF 18 INCHES USING 3-6-INCH STONE
3. ROADWAY TO BE NARROWED TO 24-FT WHILE RETAINING THE EXISTING CENTERLINE
4. ROADWAY TO BE GRADED TO ALLOW SHEET FLOW TO THE SOUTH THROUGH THE 4-FT VEGETATED BUFFER
5. TURNOUTS TO BE CLEANED AFTER SNOW MELT IN THE SPRING, BEFORE SNOW FALL IN AUTUMN, AND AS NEEDED AS GENERAL MAINTENANCE AND IN RESPONSE TO LARGE STORM EVENTS
6. DITCHES STEEPER THAN 5% SHALL BE STONE-LINED TO A THICKNESS OF 18" PER "STONE-LINED DITCH DETAIL"

File: O:\Proj-15\WM\15-215 St Johnsbury SWMP\CADD\Almshouse Road and Lackey Hill\Almshouse_Lackey.dwg

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Drawn On: 09/19/2016
Drawn By: BAM
Checked On: Date
Checked By: Initials
Project No.: 15-215

REVISIONS

#	Date	Drwn	Chk'd	App'd	Description

DRAWING SCALE

0 160 320 Feet

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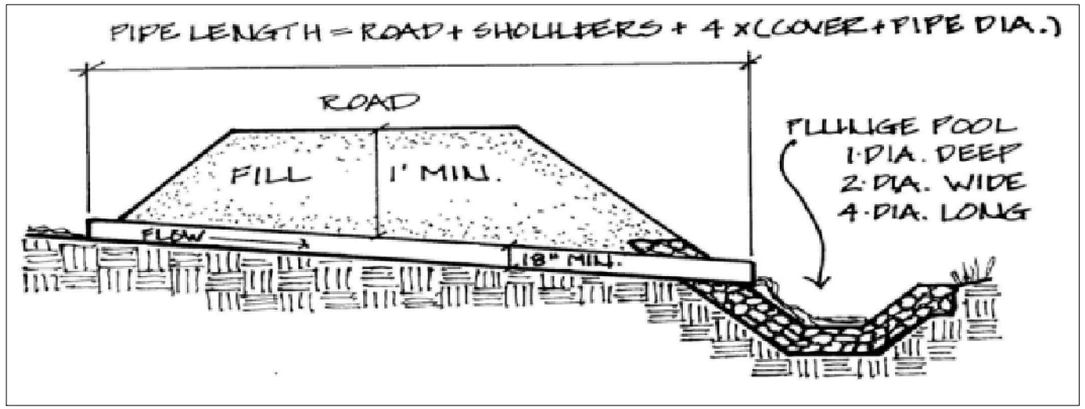
SAINT JOHNSBURY SWMP
PR-06 LACKEY HILL ROAD
STORMWATER IMPROVEMENTS LAYOUT
SAINT JOHNSBURY VERMONT

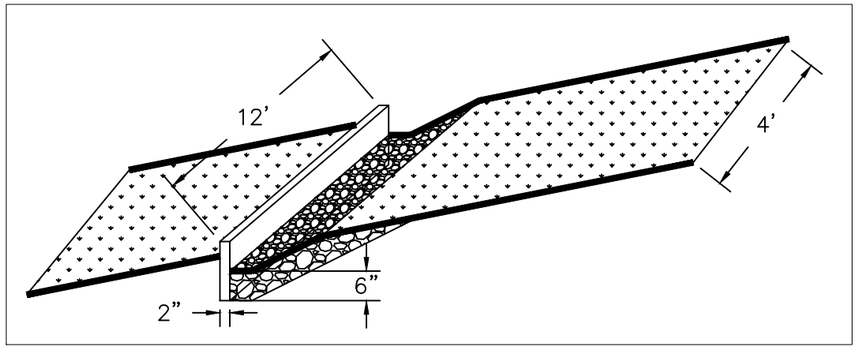
FIGURE NO. D-2 (1)



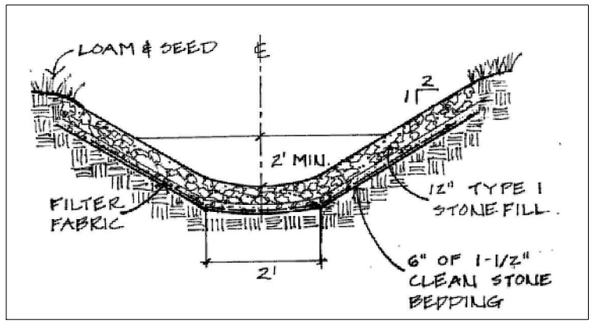
CULVERT CROSS SECTION DETAIL

MATERIALS ESTIMATE

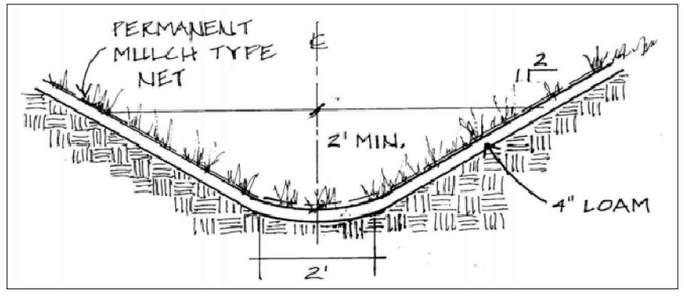
PR-06 LACKEY HILL ROAD STORMWATER IMPROVEMENTS			
ITEM NO.	ITEM	ESTIMATED QUANTITY	UNIT
1	COMMON EXCAVATION	70	CY
2	DITCHING	2250	LF
3	PRESSURE TREATED 2"x12"	60	LF
4	STONE FILL, TYPE II	104	CY
5	TOP SOIL (4")	112	CY
6	GRASS SEED	1000	SY
7	MULCH	1000	SY



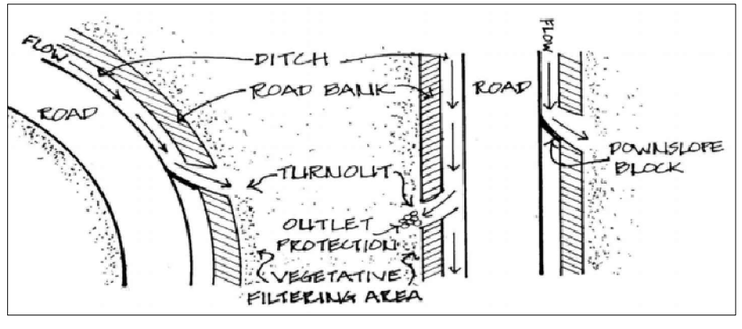
TURNOUT AND VEGETATED BUFFER DETAIL



STONE-LINED DITCH DETAIL



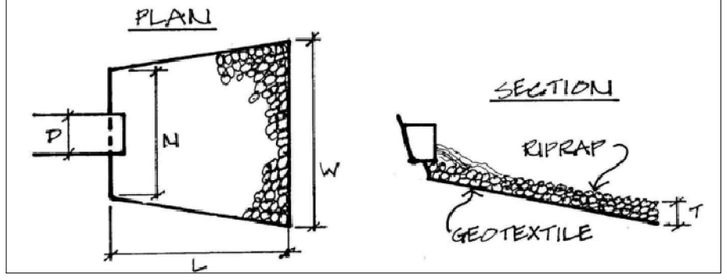
GRASS LINED DITCH DETAIL



TURNOUT DETAIL

Rock Apron Specifications					
Culvert Diameter (D)	Riprap Size	T (in.)	N (ft.)	W (ft.)	L (ft.)
18 inches	(3-12 inch)	18	4.5	14.5	10.0
24 inches	(3-12 inch)	18	6.0	20.0	14.0

D= diameter of culvert
T= depth of stone in apron
N= width of apron near culvert
W= width at downhill end of apron
L= length of apron



STONE APRON DETAIL

http: //vtrans.vermont.gov/sites/aot/files/highway/2009%20Better%20Backroads%20Manual.pdf

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Drawn By: BAM
Checked On: Date
Checked By: Initials
Project No.: 15-215

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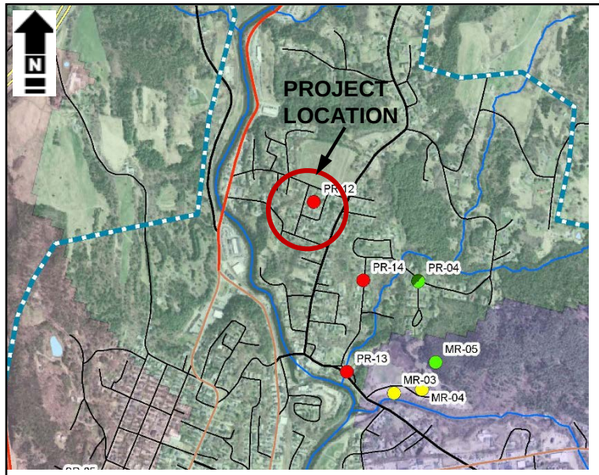
SAINT JOHNSBURY SWMP
PR-06 LACKEY HILL ROAD
STORMWATER DETAILS

SAINT JOHNSBURY VERMONT

FIGURE NO. D-2 (2)



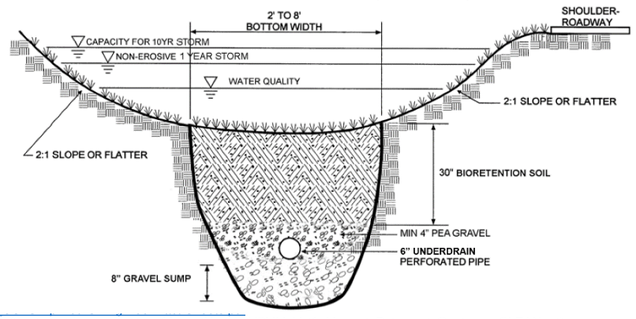

Existing catch-basin, Union St. – St. John St. intersection


Existing street and tree-lawn, Emerson St., facing west

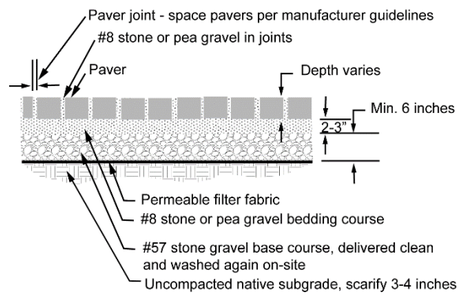
DESIGN GUIDANCE:

- GREEN STORMWATER INFRASTRUCTURE IMPROVEMENTS IN THIS NEIGHBORHOOD SHOULD BE IMPLEMENTED IN COORDINATION WITH A SEWER SEPARATION AND FULL-DEPTH ROADWAY RECONSTRUCTION PROJECT, NOW IN DESIGN AND SCHEDULED FOR IMPLEMENTATION IN 2017-8.
- 3,000 SF OF AREA WITHIN ROW SUITABLE FOR CONSTRUCTION OF UP TO 18 VEGETATED SWALES WAS IDENTIFIED BY DUFRESNE GROUP.
- RUNOFF CAN BE MADE TO FLOW TO THESE SWALE AREAS FROM 54,920 SF OF PUBLIC STREETS AND 36,400 SF OF PRIVATE DRIVES AND ROOFS.
    - THE PUBLIC ROADWAY ESTIMATE ASSUMES THAT FINAL GRADING OF EMERSON, SOUTHARD, UNION, AND RUSSEL STREETS FOLLOWING RECONSTRUCTION IS SUCH THAT ALL RUNOFF FROM THE ROADWAYS FLOWS TO DESIGNATED SWALES. THIS ESTIMATE INCLUDES 8,600 SF OF ST.JOHN ST. THAT COULD BE DIRECTED INTO A SWALE AT THE NE END OF UNION ST.
    - THE PRIVATE DRIVEWAY/ROOFTOP ESTIMATE INCLUDES ALL DRIVES THAT DRAIN TO EXISTING STREETS, AND THE CHURCH PARKING LOT ON SOUTHARD STREET. AN ALTERNATE METHOD MAY BE NECESSARY TO CAPTURE RUNOFF FROM THE CHURCH PARKING LOT, SUCH AS LIMITING THE DRIVEWAY ACCESS AND CREATING A RAIN GARDEN OR SWALE ON THE ON THE WEST SIDE OF THE ROAD.
- PREMEABLE UNIT PAVER SYSTEMS ARE PROPOSED AT INTERSECTIONS AND CORNERS WITHIN THE RECONSTRUCTION PROJECT LIMITS, WHICH WOULD EFFECTIVELY REMOVE 1,600 SF OF IMPERVIOUS COVER COMPARED TO CURRENT CONDITIONS.
- A PROPOSAL FOR FUNDING TO ADVANCE THIS CONCEPTUAL DESIGN TO FINAL DESIGN AND CONSTRUCTION IS CURRENTLY BEING SUBMITTED FOR CONSIDERATION UNDER VERMONT'S CLEAN WATER INITIATIVE PROGRAM - ECOSYSTEM RESTORATION GRANTS.

VEGETATED SWALE PROFILE VIEW (TYPICAL)



PERMEABLE PAVER SYSTEM PROFILE VIEW (TYPICAL)



Site plan and potential swale areas: Dufresne Group, October 2016.
Additional effective impervious area draining to streets, potential permeable paver areas: Stone, September 2016.
Permeable paver system schematic from the Vermont Simplified GSI Sizing Tool, 2015, http://www.vlct.org/assets/M/
Vegetated swale schematic from the DRAFT Vermont Stormwater Management Manual, 2016. http://dec.vermont.gov/sites/dec/files/wsm/stormwater/docs/ManualUpdate/VSMM_Vol1_Merged_Rule_and_Guidance_CLEAN.pdf

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St. Johnsbury
Stormwater Master Plan

Oak Street Drainage Area:
Green Infrastructure Improvements (PR-12)

DESIGNED BY:	CG, ANM	DATE:	9/21/2016
DRAWN BY:	ANM	DATE:	10/28/2016
CHECKED BY:	JSM	DATE:	10/28/2016

SHEET: D-3
PROJECT NO.: 15-215

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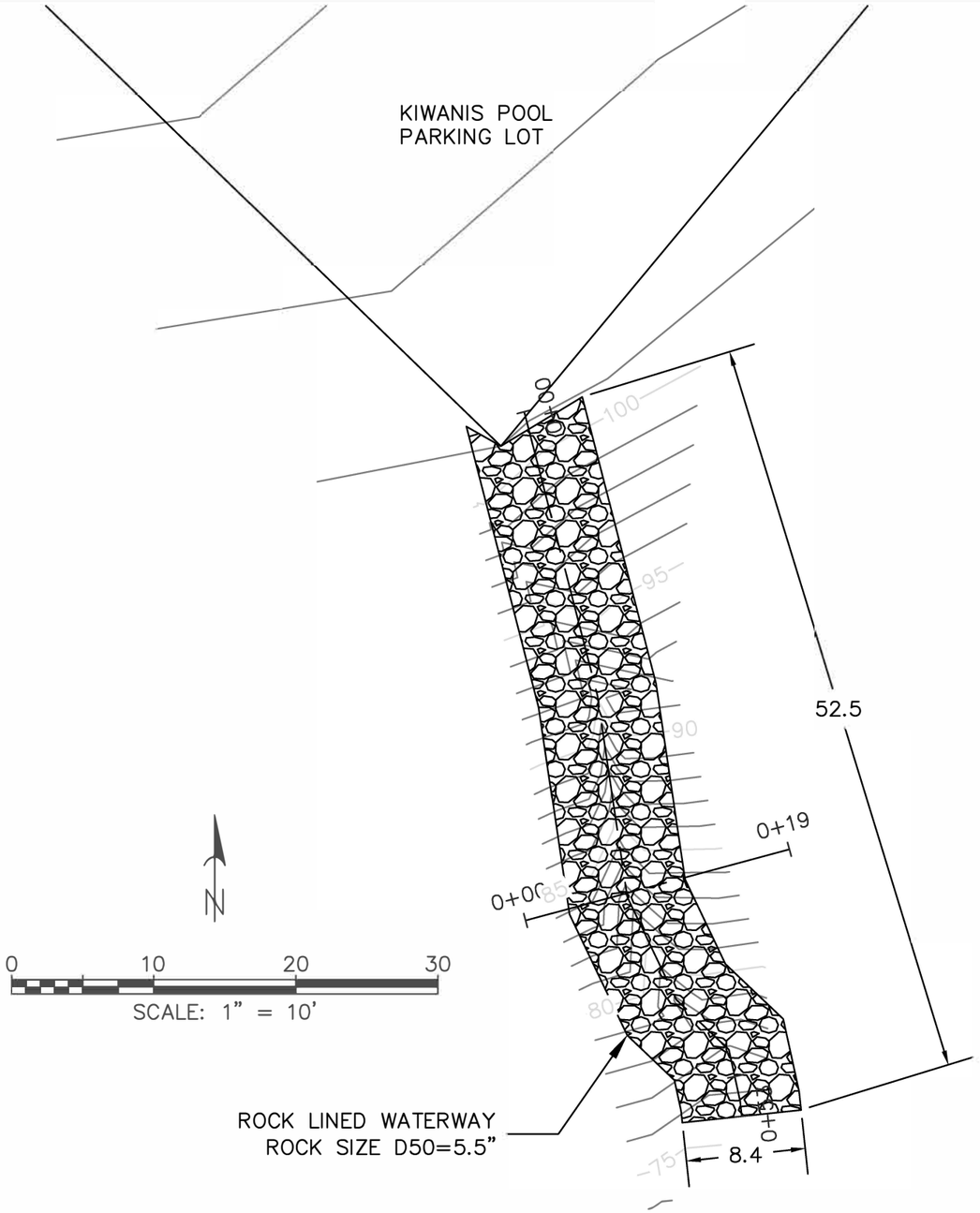
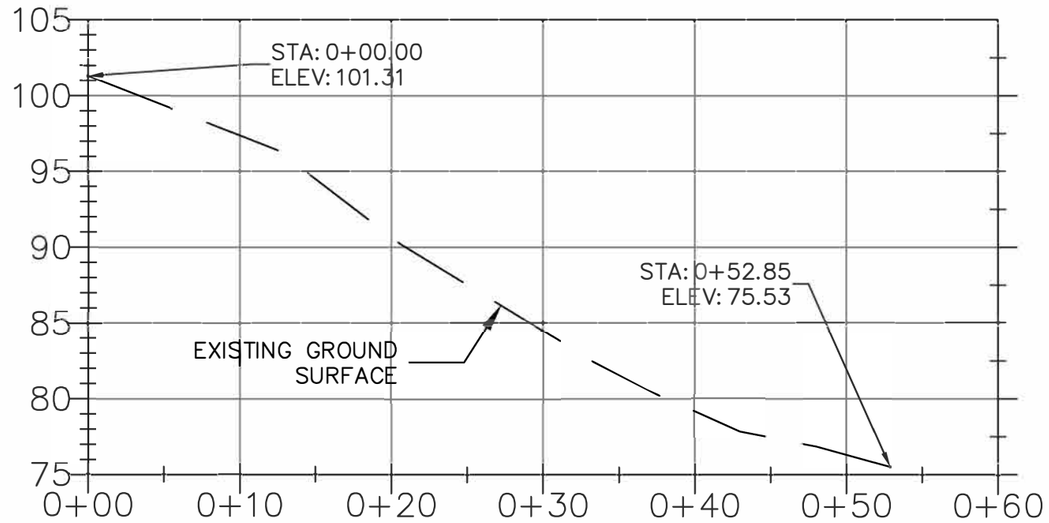
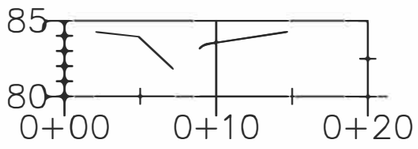




Gully Profile



Gully Cross Section

COST ESTIMATE

ITEM	QUANTITY	UNITS	UNIT COST ($)	TOTAL COST ($)
MOBILIZATION	1	EA	250	250
EXCAVATION	8	CY	5	40
ROCK (D50=5.5")	14	CY	30	420
ROCK PLACEMENT	14	CY	5	70
GEOTEXTILE	70	SY	3	210
SEED & MULCH	0.1	ACRE	2,000	200
CONTINGENCY				500
CONSTRUCTION OVERSIGHT				200
			Total =	**$1,890**

File: FILE LOCATION

DRAWING CREDITS
Drawn On: 10-24-2016
Drawn By: CAG
Checked On:
Checked By:
Project No.: 15-215

REVISIONS

#	Date	Drwn	Chk'd	App'd	Description

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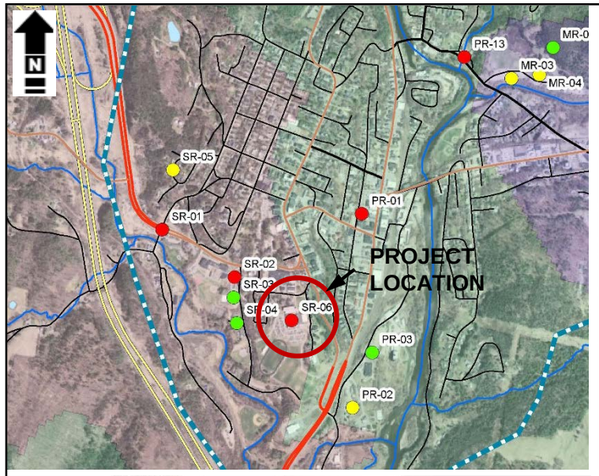
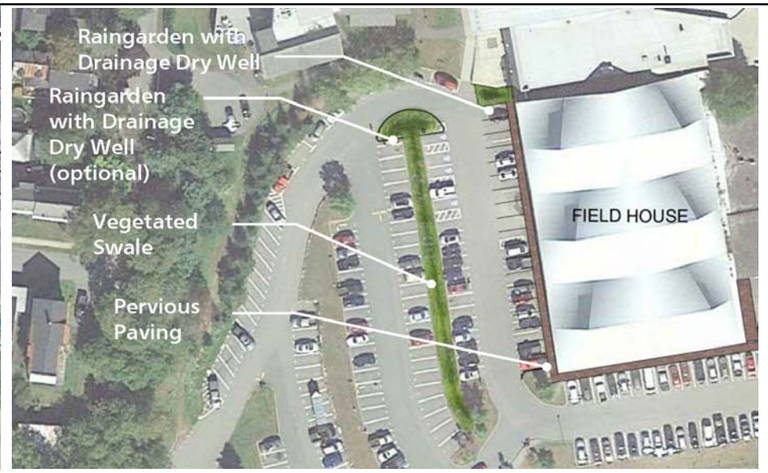
Saint Johnsbury
SR-03 Kiwanis Pool Parking Lot
Stormwater Improvements
Saint Johnsbury VT

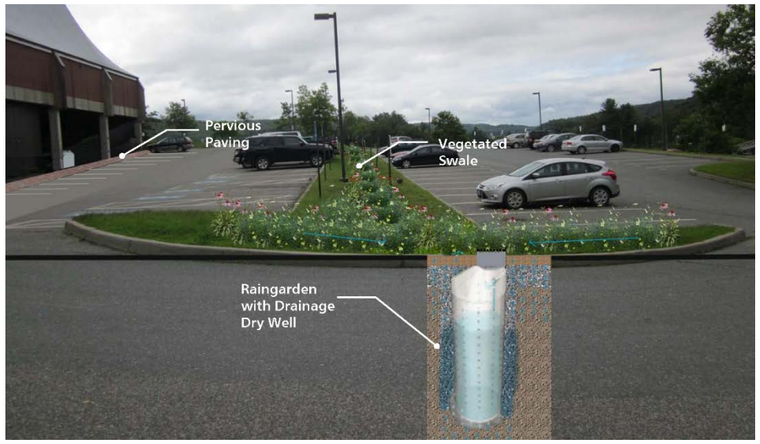
FIGURE NO.

D-4



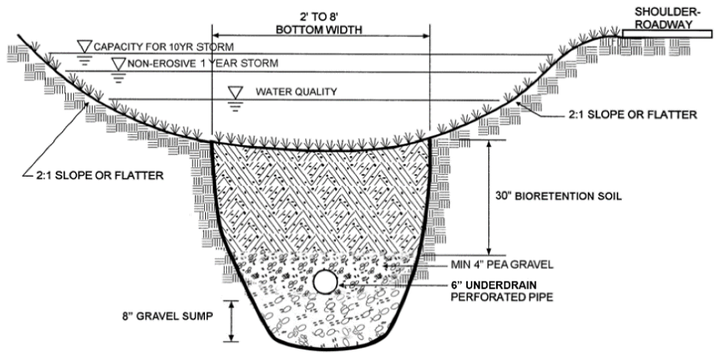



Existing gravel walkway west of fieldhouse




Existing parking island, west of fieldhouse, facing south

VEGETATED SWALE PROFILE VIEW (TYPICAL)



Site concept plan and potential rain garden, drainage well, and permeable paver areas: Greenman-Pedersen, inc. September 2016.
Permeable paver system schematic from the Vermont Simplified GSI Sizing Tool, 2015, http://www.vlct.org/assets/MAC/2015_GSI-Simplified-Sizing-Tool-Fact-Sheets.pdf
Vegetated swale schematic from the DRAFT Vermont Stormwater Management Manual, 2016. http://dec.vermont.gov/sites/dec/files/wsm/stormwater/docs/ManualUpdate/VSMM_Vol1_Merged_Rule_and_Guidance_CLEAN.pdf

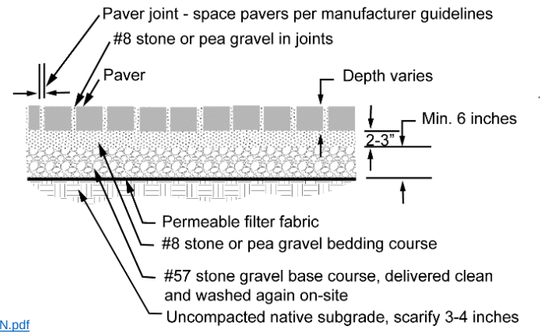
DESIGN GUIDANCE:

- RETROFITS TO EXISTING GRAVEL WALKWAYS, PARKING AREAS, AND PARKING ISLANDS MAY BE COMPLETED AS A STAND-ALONE PROJECT, OR AS PARKING AREAS ARE POTENTIALLY RE-PAVED IN THE FUTURE.
- AT THE NORTHWEST CORNER OF THE FIELDHOUSE, MOVING THE DUMPSTER AND DE-PAVING THIS CORNER OF THE PARKING AREA WOULD ALLOW A 16'X46' RAINGARDEN TO BE INSTALLED AND NEARBY PARKING LOT/SIDEWALK RUNOFF COULD BE RE-DIRECTED TO THE FACILITY.
- THE EXISTING 7.5'-WIDE GRAVEL WALKING PATH ALONG THE SOUTH AND WEST SIDES OF THE FIELDHOUSE COULD BE REPLACED WITH A PERMEABLE PAVER SYSTEM, EFFECTIVELY REMOVING 2,700 SQ. FT. OF IMPERVIOUS SURFACE.
- THE EXISTING PARKING ISLAND LOCATED TO THE WEST OF THE FIELDHOUSE COULD BE RECONFIGURED AS A 3'-WIDE BY 260'-LONG VEGETATED SWALE THAT ACCEPTS RUNOFF FROM UP TO 9,000 SQ. FT. OF COMBINED FIELDHOUSE AND PARKING LOT AREA.
- THE RAINGARDENS AND VEGETATED SWALES IDENTIFIED ABOVE COULD BE FURTHER RETROFITTED WITH DRYWELLS TO EXPAND INFILTRATION AND RUNOFF STORAGE.
- A DETAILED EVALUATION OF THE IMPERVIOUS SURFACES POTENTIALLY DRAINING TO THE VEGETATED SWALE SHOULD BE CONDUCTED PRIOR TO FINAL DESIGN. THE RELATIVELY LARGE AREA DRAINING TO THIS PRACTICE MAY NECESSITATE CAREFUL ENGINEERING TO AVOID OVERHWELMING THE FACILITY DURING LARGER AND/OR MORE INTENSE STORM EVENTS.

CONSTRUCTION COST ESTIMATES (INCLUDING 20% CONTINGENCY):

- RAIN GARDEN AND VEGETATED SWALE (1,515 SF): $30/SF OR $45,450, WHICH INCLUDES
  - REMOVAL OF PAVEMENT
  - EXCAVATION
  - BIORETENTION SOIL MIX
  - MULCH (WOODCHIPS)
  - PLANTINGS
  - PRECAST REINFORCED CONCRETE CURB
- PERMEABLE PAVER SYSTEM (2,700 SF): $26/SF OR $70,200, WHICH INCLUDES
  - EXCAVATION
  - BASE GRAVEL AND BEDDING SAND
  - INSTALLATION OF "HEAVY DUTY" PAVERS
- DRAINAGE DRY WELLS (ONE PER SWALE OR RAIN GARDEN AREA): $8,200 EACH OR $16,400, INCLUDING:
  - REMOVAL OF PAVEMENT
  - EXCAVATION
  - (2) CYLINDRICAL CONCRETE DRYWELLS, 8'X8'X4' (1,200 GAL. CAPACITY)
  - GRAVEL JACKET, 1 1/2" CLEAN STONE (12" AROUND 8' DEEP DRYWELL)
  - INLET STRUCTURE - RAIN GUARDIAN
  - PRECAST REINFORCED CONCRETE CURB
- SUBTOTAL CONSTRUCTION COSTS: $132,050
- ENGINEERING: $19,500
- TOTAL: $151,550

PERMEABLE PAVER SYSTEM PROFILE VIEW (TYPICAL)



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802.229.4541 / info@stone-env.com / www.stone-env.com

St. Johnsbury Stormwater Master Plan

St. Johnsbury Academy: Green Infrastructure Improvements (SR-06)

DESIGNED BY:	CR, CG, ANM	DATE:	10/21/2016
DRAWN BY:	ANM	DATE:	10/31/16, rev. 12/1
CHECKED BY:	JSM	DATE:	10/31/2016

SHEET: D-5
PROJECT NO.: 15-215

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Drawn By: BAM
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Checked By: Initials
Project No.: 15-215

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DRAWING SCALE

0 80 160 Feet

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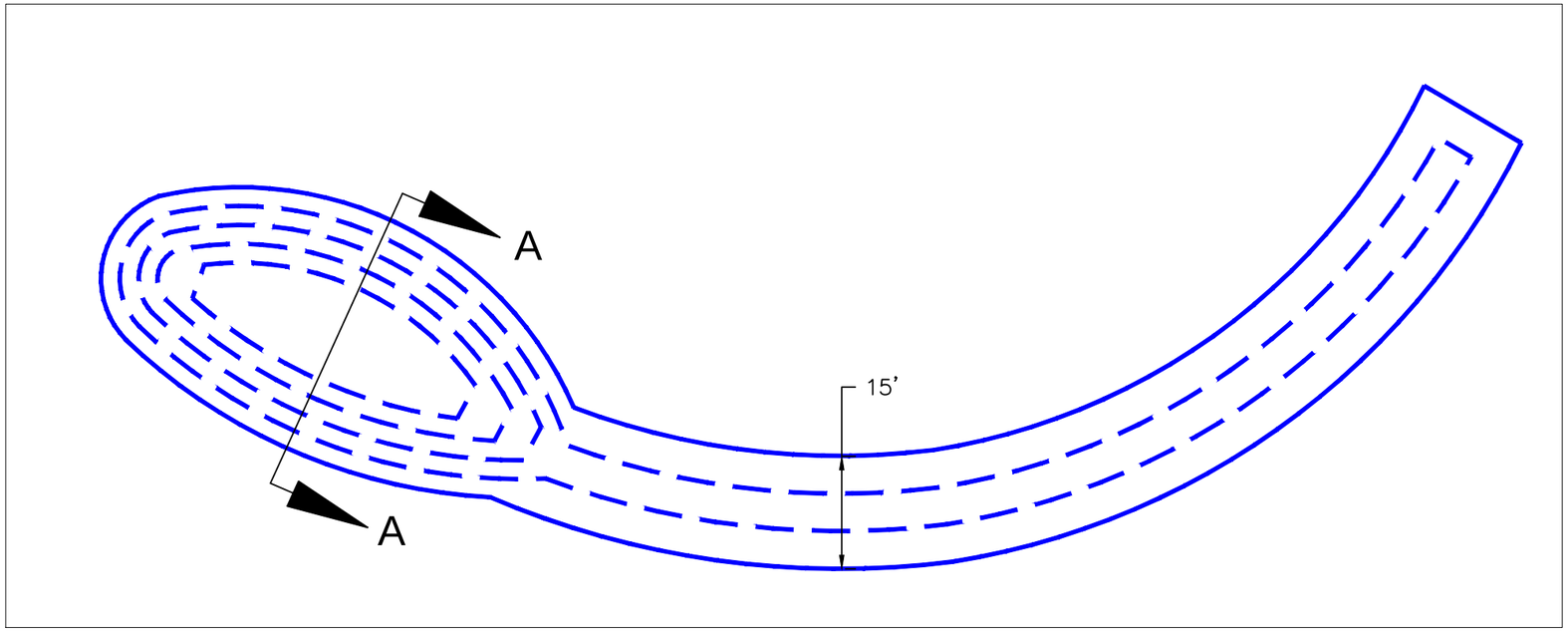
SAINT JOHNSBURY SWMP
MR-03 ALMSHOUSE ROAD
STORMWATER IMPROVEMENTS LAYOUT

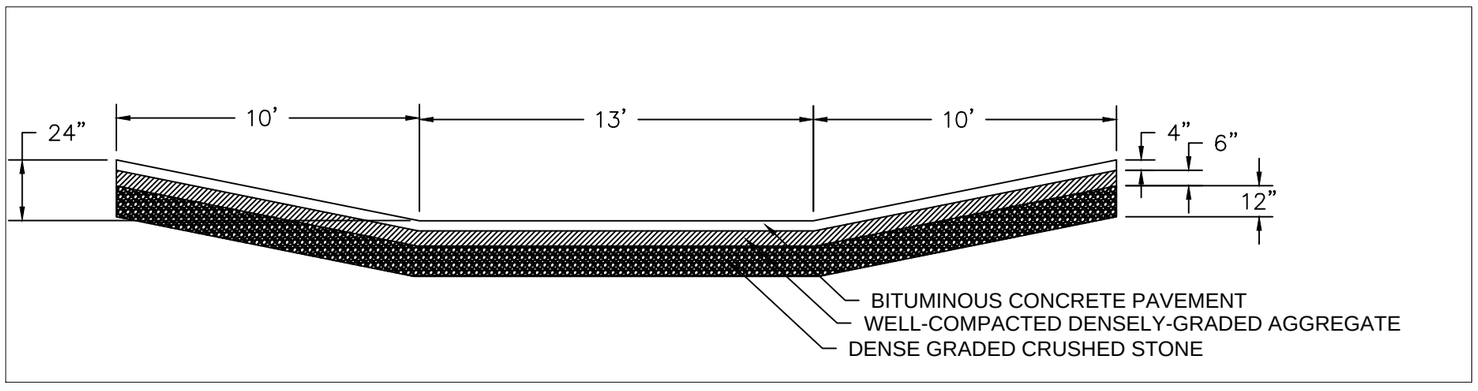
SAINT JOHNSBURY VERMONT

FIGURE NO.

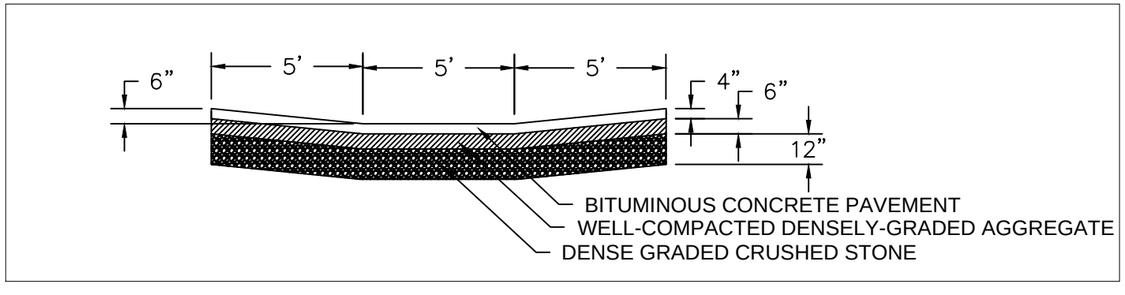
D-6 (1)



PAVED SWALE AND DETENTION BASIN DETAIL



DETENTION BASIN DETAIL (A-A)



PAVED SWALE DETAIL

NOTES:

1. ALL ELEVATIONS AND GRADES TO BE FIELD VERIFIED BY AN ENGINEER.
2. THE PAVED SWALE AND SEDIMENTATION BASIN WILL BE INSPECTED AND CLEANED AFTER EACH SIGNIFICANT RAINFALL EVENT.
3. A 12-INCH SUBBASE OF CRUSHED STONE AS WELL AS A 6-INCH LAYER OF WELL-COMPACTED DENSELY-GRADED AGGREGATE SHOULD BE INSTALLED IN ALL NEWLY PAVED AREAS. ADDITIONAL STABILIZATION MEASURES (I.E. GEO-FABRIC) SHOULD BE INSTALLED IN AREAS WITH HIGHLY COMPRESSIBLE SOILS.
4. DUE TO THE PROXIMITY OF THE RIVER, A STREAM ALTERATION PERMIT MAY BE REQUIRED IN ORDER TO PROPERLY ESTABLISH STONE-LINED OUTFALLS. VTDEC STREAM ALTERATION ENGINEER SHALL BE CONSULTED PRIOR TO CONSTRUCTION INITIATION.

MATERIALS ESTIMATE

MR-03 ALMSHOUSE ROAD STORMWATER IMPROVEMENTS			
ITEM NO.	ITEM	ESTIMATED QUANTITY	UNIT
1	COMMON EXCAVATION	240	CY
2	SUBBASE OF DENSE GRADED CRUSHED STONE (12")	144	CY
3	WELL-COMPACTED DENSE GRADED AGGREGATE (6")	72	CY
4	BITUMINOUS CONCRETE PAVEMENT (4")	94	TON
5	12-18" STONE SPILLWAY (STONE FILL, TYPE II)	66	CY
6	BOULDERS	91	EA
7	TOP SOIL (4")	106	CY
8	GRASS SEED	953	SY
9	MULCH	953	SY

File: O:\Proj-15\WRM\15-215 St Johnsbury SWMP\CADD\Almshouse Road and Lackey Hill\Almshouse_Lackey.dwg

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SAINT JOHNSBURY SWMP
MR-03 ALMSHOUSE ROAD
STORMWATER DETAILS
SAINT JOHNSBURY VERMONT

FIGURE NO.
D-6
(2)