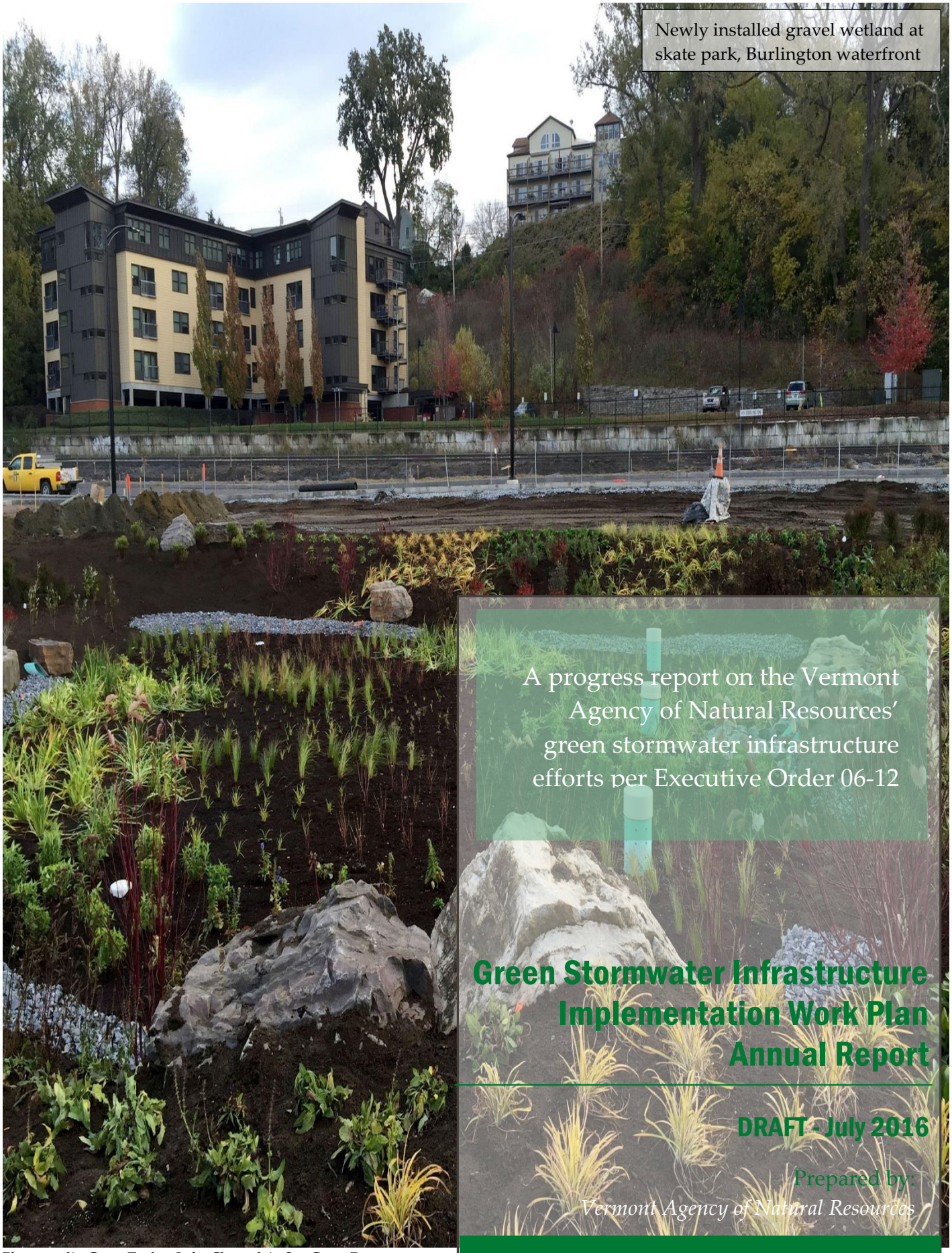

Newly installed gravel wetland at skate park, Burlington waterfront

A progress report on the Vermont Agency of Natural Resources' green stormwater infrastructure efforts per Executive Order 06-12

Green Stormwater Infrastructure Implementation Work Plan Annual Report

DRAFT - July 2016

Prepared by:

Vermont Agency of Natural Resources

Photo credit: Grant Taylor, Lake Champlain Sea Grant Program

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Executive Summary

Green stormwater infrastructure (GSI) represents an innovative and beneficial means of managing stormwater runoff from developed lands and lands undergoing development. Executive Order 06-12 called upon the formation of an Interagency Green Infrastructure Council. The Council, comprised of the State Agencies of Natural Resources, Commerce and Community Development, and Transportation, and the Department of Buildings and General Services, is tasked to identify and seize opportunities to promote, demonstrate, and implement GSI. The following outlines in broad strokes ANR's fourth year accomplishments as a member of the Council. Notable accomplishments for the year include:

- Continued collaboration with the Agency of Commerce and Community Development, the Agency of Transportation, and the Department of Buildings and General Services to identify and act on GSI opportunities;

- Hosted a wide variety of workshops, webinars, and trainings for a diverse group of stakeholders, including citizens, professionals, municipalities, and state employees;

- Created the Green Infrastructure (GI) Collaborative, a partnership between the Department of Environmental Conservation (DEC) and the Lake Champlain Sea Grant Program at the University of Vermont to advance awareness and practice of GI across Vermont;

- Continued the GI Roundtable and ongoing implementation of the Vermont Green Infrastructure Strategic Plan 2014 – 2019;

- Completed and initiated GSI design and implementation projects through DEC's Ecosystem Restoration Grants and new Clean Water Initiative funding;

- Solicited public comment on completed draft update to the revised Vermont Stormwater Management Manual which includes an array of GSI-related practices;

- Defined in State statute (2015 Vermont Clean Water Act) the term, "green infrastructure" as an innovative Best Management Practice (BMP) that uses natural and semi-natural landscape features to manage stormwater runoff;

- As directed in the same statute, developed a stormwater management practices handbook that will further the use of "practical and cost-effective" BMPs (such as green infrastructure) to improve the management of stormwater runoff below the jurisdiction of the state; and,

- Developed a GSI sizing tool, associated fact sheets, and model municipal bylaw to aid with the understanding and adoption by Vermont municipalities of these practices.

- In collaboration with Vermont Association of Planning and Development Association, created the Vermont GI Toolkit to serve as a clearinghouse of information useful to Vermont municipalities when promoting the adoption of GSI policies and practices.[1]

- Department of Forests, Parks and Recreation (FPR) applied for and secured grant funds from USDA Forest Service to develop educational programming and provide technical support to local communities on integrating GSI practices in roadside environments.

[1] The toolkit can be viewed at: http://www.vpic.info/GreenInfrastructureToolkit.html

Introduction

With the signing of Executive Order 06-12 by Governor Shumlin in 2012, the State of Vermont recognized the important role GSI plays in enhancing and protecting water quality. Stormwater runoff from developed lands and lands undergoing development is a significant source of nonpoint pollution. GSI provides a mechanism for sustainably managing through natural processes runoff volume and quality. In addition, GSI also provides myriad other benefits such as carbon sequestration, economic vitality, improved air quality, wildlife habitat, and aesthetic quality. GSI is a relatively new concept in Vermont and faces many barriers to statewide adoption and implementation including a low level of awareness, a lack of technical details, limited incentives, and regulatory barriers at the local and state level.

The Agencies of Natural Resources (ANR), Commerce and Community Development (ACCD), and Transportation (VTrans), and the Department of Buildings and General Services (BGS), as members of the Interagency Green Infrastructure Council, are working together to overcome many of these barriers to promote the use of GI as a strategy to sustainably manage stormwater in Vermont. The agencies developed five-year Implementation Work Plans to identify the tasks each agency will undertake to promote GSI. Since the finalization of the work plans in July 2013, ANR has made steady progress in taking action and toward achieving its goals.

With widespread recognition of the challenges posed by climate change and development, GSI can play a critical role in stormwater management across Vermont's landscape. In terms of prioritization of GSI implementation, GSI is likely to be more cost effective in cases of new development where GI, GSI and low impact development (LID) techniques can be planned, designed, and deployed. Coordination with transportation capital improvement projects can open up opportunities for cost-savings in the concurrent implementation of GSI at those locales. Strategic implementation of GSI practices on developed lands will be best utilized to augment treatment of stormwater and to reduce flows to existing traditional gray stormwater infrastructure.

As ANR moves forward with its work plan, utilizing GSI as the primary tool for stormwater management in Vermont must remain our focus. A notable landmark towards that ultimate goal was achieved this year with the draft update to the state stormwater management manual which now includes GSI practices as the preferred method to manage runoff from most sites. This annual progress report document provides a brief review of this and other major accomplishments by ANR for the July 2015 to June 2016 period.

Fiscal Year 2016 Recap

ANR activities during FY2016 are marked by:

- Education and outreach activities by Stormwater and GSI Initiative staff;
- Collaboration with ACCD, VTrans, and BGS as part of the Interagency GI Council;
- Active collaboration with external partner groups;
- Outreach and delivery of technical assistance materials to municipalities and local communities regarding GSI policies and practices;
- Creation of Green Infrastructure Collaborative with Lake Champlain Sea Grant Program;
- Concerted efforts to assist in updating relevant ANR statutes, policies, and program operations;
- Funding of multiple projects from multiple sources; and
- Timely technical assistance provided to seekers of the latest tools for stormwater management.

Education, Outreach, Training

Success Story: Education and Outreach via the FLOW blog

John Todd, PhD talks with students following his keynote address on using ecological design to manage stormwater runoff at the GSI Student Symposium at UVM.

The GI Initiative is promoting GSI in Vermont using electronic media like FLOW, the official blog of DEC's Watershed Management Division. A key part of GSI education is providing opportunities for design professionals and university students who have an interest in stormwater-related careers. In FY 2016, the Green Infrastructure Collaborative hosted a tour of the UNH Stormwater Center for professionals in Vermont. Over 25 people attended the tour and gained valuable information on the newest advances in GSI science. In March 2016, the Collaborative brought over one hundred college students from across the state to UVM for an afternoon conference on GSI design, engineering, education, outreach, and policy. Both of these events were highlighted on the state's FLOW blog.

In FY2016, the Green Infrastructure Collaborative (GIC) took part in over twenty outreach events. Engagement strategies included in-person presentations to town officers and road crews, webinar delivery of rain garden design and installation details to master gardeners and the role of urban trees for managing stormwater to town arborists, notable GI site tours for

stormwater professionals, and as noted above, an in-depth conference featuring a range of speakers in the GI fields targeting current college students.

In partnership with the Vermont League of Cities and Towns, the GIC presented workshops on implementing GSI at the three Town Officer Education Conference (TOEC) locations – Killington, Stowe and Fairlee. These events offered a targeted opportunity to directly engage with town officials, many of whom are learning about stormwater management for the first time. Thirty town staff and volunteers attended the presentations and over 150 gathered information from resource tables at the events. Seventy-three percent of those who attended the workshops indicated a high level of interest and likelihood to support the implementation of GSI to manage stormwater on municipal property as a result of the information gathered at the TOEC events. Direct and in-person contact with this important stakeholder group is critical for increasing GSI adoption at the town level.

Figure 1. TOEC attendees in Fairlee listen to keynote speaker.

Education, outreach and training continue to be vital components of the GI Initiative. In 2016, ANR provided over 23 unique presentations across the state specifically focused on GI, reaching an estimated 795 people. Presentations included, but were not limited to:

- One webinar on GSI and Human Health with the Vermont Department of Health;
- One webinar on residential rain garden design and implementation;
- One webinar on the role of trees in stormwater management;
- Three tours of Burlington-based GSI sites;
- Six workshops on GSI tools targeting municipal employees;
- Four activities with elementary and middle school students in Chittenden and Washington Counties;

- One field trip to the University of New Hampshire Stormwater Center for Vermont-based stormwater professionals; and,
- Two presentations to Vermont-based watershed groups interested in integrating work on GSI into their work with stakeholders.

ANR also provided education, outreach, and training indirectly through various forms of print and online media. Seven separate articles feature GI on the WSMD Blog. DEC has selected a contractor to update its guide booklet now known as the *Vermont Low Impact Development Guide for Residential and Small Sites.* FPR has selected a contractor to create a guidance document and training materials to support GSI in urban roadside environments and is internally working to update the document *Rural Roadside Vegetation Management Manual* to include GSI practices for use in Vermont's more prevalent rural roadside environment. Additionally, the GI website was updated in 2016 along with a complete update of the DEC website. A number of pages were consolidated and revamped to better portray relevant information in an accessible format based on interest.

Collaboration & Coordination

Collaboration and coordination of activities relating to LID and GSI are at the heart of the ANR's lead role on the Interagency GI Council. To date, this work has largely been championed and coordinated by Vermont Clean Water Initiative staff, housed within DEC's Watershed Management Division.

The Interagency GI Council formally met on one occasion over the year to discuss progress on Implementation Work Plans and opportunities for collaboration. It is important to note that the increased communication resulting from the Council's presence has led to a number of meetings and discussions by subgroups of the council regarding particular projects, outreach efforts, and collaboration opportunities. Highlights of work with partner agencies on the Council include:

- Collaborative efforts by BGS, ANR and VTrans to develop an auditing process for GSI suitability for state lands and buildings. Future plans to augment this process with on-site assessments will feature the Williston I-89 Northbound Welcome Center as a test site.
- Collaborative efforts by ACCD, ANR, VTrans and the regional planning commissions to assist municipalities minimize damages and ensure economic vitality during times of disaster. Recommendations include using GSI practices to reduce the likelihood of impacts from flooding.

Lake Champlain Sea Grant coordinates the GI Roundtable, an ad hoc group of individuals representing various interests focused on the promotion, design, implementation, and maintenance of GSI practices. The Roundtable started in 2009 as a steering committee for GI activities in the state. Roundtable members continue to meet quarterly to discuss issues related to GSI including new research, funding opportunities, trainings, and noteworthy projects. The Roundtable consists of an active core group of 20 - 30 individuals representing a range of non-

profit organizations, state agencies, municipalities, design firms, and citizen action groups. As reported in 2015, the Roundtable successfully drafted and adopted the 2014 - 2019 Green Infrastructure Strategic Plan which outlines seven strategic objectives. Members are actively working to implement the plan with support from ANR staff. Quarterly meetings over the reporting period ensure timely progress on action items and appropriately sharing available resources.

As an extension of the Roundtable, Lake Champlain Sea Grant manages the GI Google Group. The Google Group serves as the primary means of communication among Roundtable members and acts as an interactive listserv interface for robust discussion. To date, the group includes over 200 members. This year alone, there were over 60 posts highlighting GSI webinars, trainings, technical specifications and details, discussions, news articles, funding sources, and announcements that are of interest to members.

Additional collaborative efforts include direct work with a variety of organizations and agencies on specific projects and programs too numerous to count. Of particular note in 2016 is ANR's work on the promotion and adoption of LID bylaws at the local level with the Vermont Association of Planning and Development Agencies and the Vermont League of Cities and Towns (VLCT). Through funding provided by the United States Forest Service and the Vermont Ecosystem Restoration Program (ERP), these project partners developed and are now deploying tools and resources directly to municipalities to make stormwater management using LID principles and GSI practices more accessible, especially in small rural towns. With nearly 50% of Vermont towns lacking any sort of stormwater control strategy or requirements, this is an important step in the right direction.

Statutes, Policies, Programs

GI Initiative staff provided useful input on updates to ANR statutes, policies, and regulatory programs. Act 64 – the 2015 Vermont Clean Water Act (enactment of Vermont General Assembly bill H.35) - defined in statute for the first time the term, "green infrastructure" as best management practices that uses a "wide range of multi-functional natural and semi-natural landscape elements that are located within, around and between developed areas, that are applicable at all spatial scales, and that are designed to control or collect stormwater runoff."

Act 64 also promotes that use of these BMPs by directing ANR to publish in January 2016 a handbook of practical and cost-effective BMPs to improve the management of *unregulated* stormwater runoff. The handbook appears on DEC's website and is structured to accommodate different interests from two distinct groups – general interests held by homeowners and small business owners, and management interests held by municipalities

that might be considering how to regulate stormwater below the regulatory threshold established by the State.[2]

Another key component of this work centered on promoting GSI BMPs as the preferred tool for managing stormwater and reducing the number of Combined Sewer Overflows (CSO).

Many decisions regarding stormwater and the use of BMPs are governed by ANR's Stormwater Program. This program administers a post-construction stormwater permit pursuant to state statute. Regulated projects are required to implement stormwater management in accordance with the Vermont Stormwater Management Manual (VSMM). During the reporting period, ANR updated the manual to better match current trends in stormwater management and better align with the goals of the GI Initiative. The public comment period on the draft VSMM recently ended. After incorporating public input, the revised VSMM is on track to be adopted via through rulemaking later in 2016.

As of the date of this report, the VSMM is continuing to undergo revision. New structural GSI practices that have been incorporated into the draft Manual include permeable pavement, green roofs and rainwater harvesting. A new non-structural GSI practice being added to the Manual is reforestation. Many GSI practices already existed in the 2002 Manual, although some have experienced some revision to design requirements including bioretention/rain gardens, infiltration practices, dry swales and disconnections.

In situations where wastewater and stormwater conveyances are combined and high intensity wet weather events result in overflows, jurisdiction is handled by ANR's Wastewater Program through Vermont's CSO control policy, a policy adopted in 1990. Given the age of this policy, and advances in CSO management, ANR is updating this policy. GI Initiative staff introduced draft language to the policy that would require GSI BMPs to be considered as the primary tool for reducing the volume of stormwater flows to combined sewers and thus reduce CSO occurrences.

Funding

Grant funding through ERP provides roughly $2.5 million in state dollars each year for a variety of projects aimed at reducing sediment and phosphorus loads. ERP places a high value on projects that manage stormwater using GSI practices. In 2015, ERP funded 13 GSI projects for a total of $457,798. These projects include five scoping/design efforts to evaluate if, where, and how GSI practices might be used to manage stormwater. These five projects are taking place in four counties, supported by $90,110 of ERP monies. Eight GSI implementation projects are underway in six counties, supported by $397,688 in ERP funds.

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[2] The handbook can be inspected at: http://dec.vermont.gov/watershed/cwi/green-infrastructure

More recently, DEC has funded a handful of GSI projects that are in the process of receiving grant funds and starting up. The table below highlights these new GSI projects funded by ERP or Clean Water Fund monies.

Fiscal year	Grant recipient	Nature of GSI project	Watershed location	ERP/CWF grant amount
2016	Rutland Natural Resources Conservation District	Green Stormwater Infrastructure Design in the East Creek watershed	East Creek – Otter Creek	$ 17,050
2016	City of South Burlington	Bartlett Brook central stormwater infiltration construction	Bartlett Brook – Shelburne Bay	$400,000
2017	Village of Poultney	York Street stormwater treatment construction	Poultney River	$420,000
2017	Town of Shelburne	Shelburne Road stormwater gravel wetland construction	Shelburne Bay	$219,200
				$1,073,300

Appendix A contains details from a representative sampling of several ERP funded GSI-related projects that were completed between July 2015 and June 2016.

Recent changes to the State Revolving Fund (SRF) and federal law have improved loan fund availability for GSI projects statewide. DEC's Facilities Engineering Division has adopted the nationally accepted Preliminary Engineering Report format for both the Clean Water and Drinking Water SRFs. This format formally encourages the planning and use of GSI on all publicly funded projects. Additionally, federal legislative changes based on the Water Resources Reform and Development Act of 2014 opens up the federal eligibility of watershed based projects and inclusion of GSI.

ANR is turning its attention to creating demand for loans to support GSI, especially for large projects. Currently, there is one GSI project on the current Clean Water SRF priority list and interest is building. ANR will continue to raise awareness of how the SRF program can become a useful and readily available funding source to help support these projects.

Technical Assistance

Efforts by ANR and Lake Champlain Sea Grant to provide technical assistance have resulted in greater implementation of GSI and development of technology-based tools for use across Vermont. Aside from those mentioned in previous sections of this report, the following are representative of technical assistance efforts being furthered under the GI Collaborative:

- By utilizing the assistance of GI Initiative staff, the Vermont Department of Fish and Wildlife has completed parking lot improvements, including the construction of multiple GSI practices, at the John Guilmette Fishing Access Area in South Hero. The site utilizes bioswales, grass channels, bioretention, and vegetation to treat stormwater runoff.
- A contract to develop a simplified sizing tool for GSI BMPs was funded by ERP in April 2015. The tool, completed in February 2016, is intended to provide small and moderately-sized communities who adopt VLCT's improved Vermont LID and GSI bylaw with a suite of tools to size and aid in the review of BMPs associated with new development.
- FPR provided assistance to 20 Vermont communities to help them better understand and manage their forest and tree resources through street inventories, developing management plans and providing training on sound tress care.

Updated Implementation Work Plan Task List

In fiscal year 2017, ANR will continue to promote, demonstrate, and implement GSI by undertaking the following tasks.

Task	Task Description	Progress to Date
1	Review current regulatory barriers to GSI and consider revisions where appropriate. • Stormwater Management Manual • Wastewater System and Potable Water Supply Rules • Combined Sewer Overflow Policy • Underground Injection Control • Act 250	-Stormwater Management Manual update – draft completed & public comment taken. -CSO policy update underway. -Initial coordination with DEC-DWGWPD. -Participation in Act 250 Criterion 9L discussions.
2	Consider the role of GSI in the development of reasonable assurances and implementation of TMDLs. • Research the use of GSI in other states to meet regulatory requirements (e.g. tree credits, stream restoration) • Provide input into Lake Champlain Phase 1 and Phase 2 plans	-LID & GSI included in draft Lake Champlain TMDL Phase 1 Plan. -Tree credit fact sheets developed under contract: ○ Benefits of Trees ○ Site Scale Tree Credits ○ Watershed Scale Tree Credits
3	Review existing state programs, processes, and initiatives and develop a plan for incorporating GSI concepts. • Surface Water Management Strategy • Tactical Basin Planning • Stormwater Master Planning • Corridor Planning • Lake Wise Certification Program • Non-point Source (NPS) Management Program • On-site Installer Certification • Climate Cabinet • Flood Ready Vermont	-Revisions to Surface Water Management Strategy. -Tactical Basin Planning and Stormwater Master Planning processes include consideration of GSI. -Lake Wise Certification Program promoting voluntary use of GSI. -Ongoing conversations with DEC-DWGWPD about on-site installer certification program and tag-on GSI certification. -LID and GSI language included in Flood Ready Vermont website and updated NPS Management Program. -NPS Management Program approved by EPA New England in August 2015.

		-Informal agreement with the Rivers Management Program to carefully address GSI implementation in river corridors to avoid large infrastructure investment in high risk areas. -ANR's new climate change website to feature GSI as a way to improve resilience. -State Parks prioritizes GSI on all new construction and re-development projects.
4	Consider incorporation of GSI concepts as appropriate when developing and implementing new programs.	-Continued discussion about role of GSI in expanded CWSRF. -GSI AmeriCorps member secured through Eco-AmeriCorps Program.
5	Provide training opportunities to ANR staff and external partners to increase knowledge of GSI. • Annual conference/workshop • Webinars • Presentations	-The following methods have successfully been used for GSI, GI and LID outreach: - Webinars & workshops - Conference poster presentations - Tours of demonstration sites - Presentations to municipal boards & educational institutions
6	Investigate the modification and development of funding sources to support the utilization of GSI. • 604b • 319 • ERP • State Revolving Fund (SRF) • Watershed Grants (conservation license plate) • Clean Water Fund	-Continued discussions about incentivizing GSI through various funding sources. -SRF support for GSI implementation. -604b funds awarded to the Northwest Regional Planning Commission to develop an online mapping tool of installed GSI practices.
7	Identify gaps in technical information and guidance and develop a plan for creating additional resources. • Gather additional BMP cost, benefit, and performance information and make it readily available • Work with partners to develop Vermont specific resources	-Nine informational fact sheets created. -Technical guidance posted to GI Google Group on a regular basis. -Coordination with the VLCT on outreach regarding the LID Model Bylaw. -Outreach regarding Vermont-specific GSI BMP sizing tool to support sub-jurisdictional GSI implementation.

		-Selected contractor to develop Green Streets Vermont guidance document and training materials. -Funding received from USDA Forest Service to create outreach materials concerning use of GSI in roadside environments. -Coordination with VAPDA resulting in creation of online GSI toolkit for use by municipalities which also serves as information clearinghouse to facilitate adoption of GSI policies & practices.
8	Support additional research and monitoring opportunities related to GSI. • Tie in with existing efforts such as the Monitoring Strategy Implementation Team and the Vermont Water Quality Monitoring Council. • Work closely with Vermont institutions to develop and gather Vermont specific data	-Lake Champlain Sea Grant (LCSG) staff investigating the application of floating treatment wetland technology to improve stormwater pond performance. -LCSG supporting GSI research by students from UVM, SUNY Plattsburgh, Norwich University. -LCSG staff working with VYCC to develop a maintenance check-list/monitoring tool for crews working on GSI installations.
9	Seek opportunities for greater inter-agency and intra-agency collaboration and cooperation. • GI Council • GI Roundtable	-Shared resources such as technical documents and webinars -Identified future training opportunities. -Inter- and intra-agency project support.
10	Develop a process for auditing GSI on lands owned or managed by ANR (e.g. State parks, wildlife management areas, fishing access areas) and explore opportunities to enhance or utilize additional GSI. • Discuss GSI concepts with ANR Lands Team • Collaborate on capital improvement projects • Leverage experience from other agencies	-GSI assessment protocols developed in NY and MD researched and documented, and a Vermont specific project is in the works. -GI Coordinator involved in FPR Resilient Rights of Way grant project. -Upgrades at Lake Bomoseen State Park including installation of GSI practices.
11	Review GSI applications based on land use. • Lakes and Ponds Lake Wise	-FTW application in natural ponds: literature review presentation provided to Lake and Ponds Program as a result of lakeshore property association requests.
12	Increase coordination between DEC's Facilities Engineering Division (FED), Stormwater, Wastewater Management, and	-Initial meeting of parties hosted by FED. -Update of CSO policy scheduled.

	Monitoring, Assessment and Planning Program in regards to CSO projects. • Bring appropriate parties together during the preliminary engineering phase for CWSRF projects • Update CSO policy	-Draft CSO policy update prepared that specifically requires GSI.
13	Increase collaboration among and capacity of external stakeholders. • Hold quarterly Roundtable meetings • Review and track progress on Strategic Plan • Support Strategic Plan related efforts • Increase participation in Roundtable	-Roundtable meetings held on 11/9/15, 01/27/16, and 05/19/16. -Regular participation in Roundtable meetings has increased from 15 to over 25 persons representing organizations and sectors not previously engaged.
14	Assist external partners in efforts to provide GSI assistance, outreach, and training to municipal entities, private landowners, and design professionals.	-GI Collaborative manager assisted with the fourth year of the Connecting the Drops rain barrel installations, realtor workshops, project development and implementation, residential stormwater audits, trainings and coordination. -FPR's Urban and Community Forestry Program assisted 20 communities with tree inventories, management plan development and tree care training.
15	Revisit GSI Implementation Work Plan and review progress. • Add additional challenges and opportunities as necessary • Continue to assume leadership role on Interagency GSI Council.	-Annual progress report submitted July 2015. -GI Council meeting held 4/25/16.

Green Stormwater Infrastructure Annual Report Contributors

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Appendix A. Illustrative Sampling of Completed State Funded GSI Projects

1. GSI Implementation – Burlington
2. GSI Design – Cabot
3. GSI Design – Colchester
4. GSI Design – Middlesex
5. GSI Design – Middletown Springs

GSI Implementation - Burlington

Due to high pedestrian traffic and narrow sidewalk widths, sidewalks in Downtown Burlington are frequently constructed of impervious surface extending from the curb line to the edge of adjacent buildings. In places where the city has tried to maintain a vegetated green belt, vegetation often fails due to trampling and ends up being a source of stormwater runoff (due to compaction), sediment, and phosphorus. While Burlington may not be able to afford wholesale and city-wide replacement of concrete and (non-permeable) brick pavers from curb to building front with a solid band of permeable paver surfaces, the city believed it could optimize a design which leverages the need for an aesthetically pleasing, safe pedestrian travel-way while also providing for self-contained stormwater management of this functional surface by creating a "stormwater belt." While larger scale streetscape projects can and should evaluate additional opportunities for capturing additional stormwater (through stormwater planters with curb cuts), this standard is meant to apply for less invasive sidewalk improvements – particularly for those areas where there is an existing "green" belt which is non-functional – compacted and eroding.

This project involved developing a new, stormwater friendly standard for sidewalk replacement in the highly urbanized downtown core of Burlington, followed by implementation of about 220 feet using this design.

An existing degraded section of paver laid sidewalk on the west side of South Winooski Avenue between Main Street and King Street, which had been identified for repair and provided the perfect opportunity to explore this concept. Without the benefit of this grant opportunity, the likely option for replacing this sidewalk would be a continuous strip of non-permeable concrete, which not reduce stormwater. Additionally, this area of sidewalk had several trees removed due to tree mortality/illness, and there was interest from the parks department to leverage the permeable paver excavation opportunity for the provision of adequate tree soil volume in this urban environment.

Demolition of the existing sidewalk and excavation for the installation of the Silva Cells, paver sub-base, and the installation of the concrete sidewalk occurred in late September and into October. The pavers were laid at the beginning of November 2015.

This project, with assistance from ERP grant funds, met its primary goal of utilizing an existing site as an opportunity for the development and implementation of a permeable paver based stormwater sidewalk design. The design process engaged Burlington DPW's more traditional streetscape engineers in the creation of a sidewalk system that meets both traditional needs of pedestrians and innovative needs of stormwater treatment and sustainable urban forestry. The site will provide a long-term example of an aesthetically pleasing, sustainable option for

downtown sidewalks while reducing flows directed to the combined sewer system and the Main Wastewater Treatment Plant.

Figure 2. Sidewalk before construction.

Figure 3. Sidewalk after constuction.

GSI Design – Cabot

The Cabot School generates runoff that enters the local stormwater system before being discharged to the nearby Winooski River. Some of this runoff is actually generated by nearby properties including 900 feet of Danville Hill Road. The goal of this project was to complete a stormwater master plan for the Cabot School. The plan incorporates not only the property itself but accounts for 'run on' water to the site including water from a substantial section of Danville Hill Road. The end result is 100% designs for three treatment areas on school property. Also produced was a longer list of other runoff control projects that could be pursued in the future.

Friends of the Winooski River received $8,890 in state ERP grant funds to carry out the design project. Seven possible practices for stormwater mitigation and water quality improvements were identified. Given the small scale nature of all seven practices, the selection process was relatively informal. There were broad considerations in narrowing down the list to three:

- Which of the seven projects were most likely to have the greatest impact on stormwater reduction and water quality?
- Which of the seven projects actually required more detailed engineering design?
- Which of the seven projects did the Cabot School have an interest in pursuing?

This process resulted in the following decisions affecting which of the seven projects to pursue through further design:
Practice A—The swale at the north end of the campus was selected as the third priority because it was deemed easy to do and because other practices, as described below, were eliminated from design consideration for various reasons.
Practice B—Moving the dumpster was eliminated because it simply does not warrant further engineering design. Movement of the dumpsters will be pursued as an internal school project.
Practice C—The rerouting of traffic and protection of storm drain was eliminated for the same reason as Practice B. It will also be pursued as an internal school project.
Practice D—This practice along the parking lot edge was eliminated for a number of reasons. One, soil tests showed poor infiltration capacity so its value would be limited to detention storage. Two, this is the area of the campus that will likely be reconstructed in the next 5-10 years so it did not seem reasonable to pursue it.
Practice E—A catch basin insert at this location would be valuable. However, during the site walk/practice review with the principal there was discussion as to whether this was actually on the school property or on an adjacent property. Either way, the inlet receives runoff from multiple properties. It is likely that the Friends and the School will pursue this project in the future. However, it was eliminated from consideration at this point because the solution does not require much engineering design. The larger issue is social—who owns it and who will maintain an insert. It is likely that the town needs to be involved in this discussion as well.

Practice F—Redesign of stormwater management along the footpath leading from the parking lot to the school was selected as one of the three design priorities. It required additional engineering design and presents an opportunity for sediment reduction.
Practice G—Redesign of the swale along the southeast property line was also selected as one of the three design priorities for the same reasons as Practice F.

Because each of the designs seek to improve an existing area of stormwater conveyance on campus, the basis of design for all practices was twofold:

1. To address on-going erosion occurring as a result of ad-hoc nature of stormwater management; and
2. To treat and manage the first inch of precipitation, while taking into account existing site constraints to arrive at a level of stormwater control acceptable to the landowner.

Site A: this practice will improve the treatment of water drained from the school's athletic area, conveying the water through a grassed swale to a small pooling area that drains into a culvert and the closed pipe portion of the school's drainage system. The grassed swale was observed on three dates and is well-vegetated and in good condition at all times. The pooling area, however, was observed to be poorly vegetated during the fall 2014 and spring 2015. During summer 2015, the area was found to have significant vegetation, dominated by golden rod; upon closer inspection it was clear that there was still significant exposed soils below the vegetative canopy. The proposed design proposes to enlarge, reshape, and plant the area species well-suited to the landscape setting. Although guidance was provided on plant selection and spacing, a specific planting plan for this area was not prepared as Cabot School students will develop the plan as part of their involvement with this practice.
Site F: this practice will address significant erosion along the footpath connecting the main parking area to the high school building, slowing runoff from the gravel lot and using a series of check dams to reduce the effective grade and provide opportunities for settling. Approximately 0.2 acres of parking lot drains to the location of the proposed rock-lined swale, and has an attendant water quality volume of 620 cubic feet. A vegetated swale in this location was not practical given the slope of the area, the existing rock-lined swale is too small to convey the predicted runoff volumes and is choked with sediment from the parking lot. The proposed design includes expanding the swale, to achieve a two-foot bottom width and side slopes of 3H:1V, and installing a series of six check dams.
Site G: this practice is designed to take advantage of some of the available storage within an existing swale, address the over steepened side slopes of the existing swale and improve the condition of the swale bottom to promote filtering. Approximately 1.5 acres drains to this swale, including approximately 900 feet of Danville Hill Road, and has an attendant water quality volume of 1700 cubic feet. The proposed design involves laying back the side slopes of the swale from 1H:1V to 3H:1V to reduce bank slumping, achieving a bottom width of 2.5 feet and installing a series of three check dams to create a modest amount of additional storage

within this very deep channel. Increasing the bottom width of the vegetated swale will address erosion associated with concentrated flow in the narrow swale bottom and the check dams will also provide opportunities for settling. Unfortunately, there is simply not enough room to treat the full WQv given the current swale layout and other site constraints; as designed the swale will provide treatment for approximately 0.75 inches of runoff.

Construction costs were estimated to be:
Practice A – $4,000 includes project management ($750), construction ($1,750) and plant material ($1,500) assuming students or volunteers will carry out the planting.
Practice F – $9,947 includes project management and grant administration ($1,547), engineering oversight ($900) and construction ($7,500).
Practice G – $5,800 includes engineering oversight ($800) and construction ($5,000).

GSI Design – Colchester

The Winooski Natural Resources Conservation District received $18,840 in state ERP grant funds to carry out the 'Colchester High School: Keeping Stormwater out of Malletts Bay Project' involving the identification of stormwater mitigation opportunities and a 100% design for three priority practices on the campus of Colchester High School.

Colchester High School contains approximately 248,965 square feet (about 5.7 acres) of impervious area, representing an ideal site for demonstrating stormwater infiltration. Colchester High School contributes stormwater to the Lake and the proposed project will begin to address issues on site by collaborating with students on the design and development of GSI practices. Specifically, this project includes two main parts: 1) feasibility analysis, and 2) 100% design of three selected alternatives.

After a site inspection and evaluation process to determine existing conditions and constraints, these five opportunity areas on the school campus were defined along with potential runoff control measures:

1. **Infiltration Basin #1: c**ulvert outflow retrofit; sediment control structures; native plantings
2. **Infiltration Basin #2: s**oil amendment & native shrub plantings
3. **Infiltration Basin #3: s**oil amendment & native shrub plantings
4. **Infiltration Basin #5: s**oil amendment & native plantings
5. **Student Parking Lot: c**urb-cut bioretention basin

After some discussion with project steering committee and interested stakeholders regarding maintenance and water quality benefits, site visibility and expected costs, retrofit site #1, 3, and the student lot were selected to further develop into the design phase. The sites chosen for design were considered to be those places most effective at treating stormwater, have high educational value and were considered to be cost-effective. DEC expects to receive the final 100% designs for the three retrofit sites shortly.

GSI Design – Middlesex

The Winooski Natural Resources Conservation District received $8,130 in state grant funds to carry out 'Absorbing the Storm at Rumney Memorial School Project,' an effort resulting in 30% design of practices aimed at reducing the volume and improving the quality of stormwater runoff from impervious surfaces at the Rumney Memorial Elementary School.

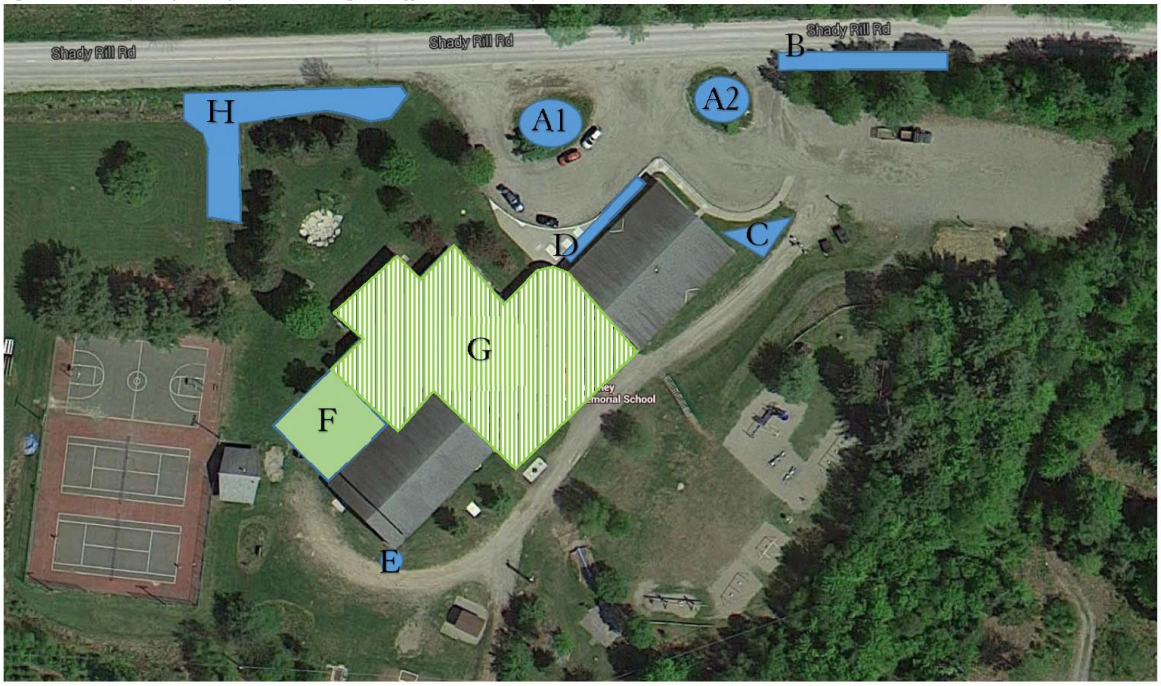
Rumney School is located on Shady Rill Road in Middlesex which runs parallel to Martin's Brook (aka Shady Rill). The campus is composed of a terraced school yard, graveled parking lot and drop off area and, like many schools, a large building footprint. To one side of the building, stormwater from the roof flows out of under-sized gutters, onto the sidewalk then picks up sediment from the drop off area, before making its way towards the roadside ditch; the ditch is actively eroding where it receives stormwater runoff from the school. To the other side of the building, more stormwater runoff flows into a grassed ditch and into a small pipe that runs under the road and into the school's property across the road. After a storm event, the field is saturated with water, where one can hear the water flowing from the field into Martin's Brook. The banks of Martin's Brook at this juncture are eroded and vegetation is failing.

Using grant funding, FWR sought to ultimately address these issues by developing a design that would divert and filter stormwater from the building's roof and hard surface areas before entering any local waterways. In order to achieve this end, FWR agreed to complete a site analysis and feasibility study, evaluate alternatives and develop a conceptual design, which included: developing alternative scenarios; meeting with project stakeholders; justifying a preferred alternative; developing a 30% design; and developing cost estimates.

The results of the site analysis are presented below along with a site map:
A1 and A2: Two 'pods' in the front driveway/ bus turnaround at the front of the school are well situated in the landscape to use GSI as techniques to capture runoff from a significant portion of the gravel driveway. It would be ideal to also direct and capture runoff from the north-western half of the primary wing which is intercepted by a gutter to pod A2.
B: A roadside ditch along Shady Rill Road, located immediately to the east of the school, which shows some of the effects of stormwater runoff from the gravel driveway and parking lot as it is clogged with sediment and badly eroding. The ditch would benefit from being reshaped and from the addition of check dams to address the erosion and help trap sediment from traveling further down. This ditch is cleaned out annually by the Town of Middlesex.
C: The existing area drain in this location captures some runoff from the fire land behind the school which is often flooded, as well as receiving gutter water via a subsurface connection from the primary wing of the school. The area drain is connected by a long culvert to area 'B' ditch. Installing a riser on the grate to temporarily pool water in this area may allow some of

the water to slowly bleed out rather than be conveyed quickly. Planting material around this area that could withstand pooling water would also be beneficial. If this area were to be selected for mitigation, directing roof water from the primary wing overland to this area of temporary storage should be considered.
D: The narrow green space between the front of the building and the sidewalk could potentially be reworked as an infiltration trench to capture excess roof runoff.
E: The southwest corner of the building has a large roof that is part of the gym. Runoff from this area could be captured by a cistern.
F: Integrating a green roof into the planned building addition to the northeast could also help with runoff.
G: Understanding additional roof square footage that will be part of building additions in 2015 and where roof water will go, will help identify additional areas to capture before discharge.
H: Drainage area to investigate along the south side of Shady Rill Road and what restoration and mitigation opportunities might exist.

Figure 1: Preliminary Identification of Stormwater Management Opportunities - Rumney Memorial School, Middlesex, VT



An evaluation of these nine sites identified several constraints based on topography, the location of the school in relationship to the road and the terraced schoolyard. While ideally much of the runoff velocity coming onto the site from non-pervious surfaces would be slowed down before the fire lane at the back of the school, space constraints do not allow for much retrofitting in this area. The two 'pods' in the bus drop off turnaround (A1 & A2) are certainly areas that should be addressed to receive stormwater from the front of the building and the

turnaround in the future, but ongoing facilities improvements posed a constraint for timing for this retrofit. Upon further analysis, it was determined that modifying the ditch of area 'H' would be the most beneficial stormwater migitation project for Rumney at this time, as it receives both surface and roof water and is directly linked to the erosion/ gully forming across the road leading to Martin's Brook. Smaller gestures, such as area 'D' where a small infiltration trench or vegetation would help stop the flow of roofwater from eroding the sidewalk, would be additional improvements the School could undertake or area 'C' could be another potential site to retrofit in the future.

GSI Design – Middletown Springs

The Middletown Springs Volunteer Fire Department was awarded $10,580 in ERP grant funds to undertake a feasibility analysis and develop an engineered bio-infiltration design for a green stormwater infrastructure project in the Town of Middletown Springs. The project, once constructed, would convey stormwater runoff from multiple municipal properties to the town green owned by the Community Church, where runoff would be treated. The Middletown Springs Green Stormwater Mitigation project, once constructed, will avert stormwater runoff from entering the Poultney River.

Through this grant, Long Trail Engineering completed a feasibility analysis of four green stormwater systems intended to capture sediment- and nutrient-laden stormwater runoff from the municipal shed, equipment storage area, and all of the rooftop and parking/driving surfaces near the buildings to the north of the town green, and direct it to a bio-infiltration area located in the town green. Also included in the analysis was one conventional system with catch basins piped directly to the existing stormwater infrastructure, which drains the Poultney River.

In addition to the rain garden in the green, the final project design included a rain garden on private property uphill of the Historical Society Building and Museum. This additional rain garden will capture runoff directly from the town-leased property to the north of the municipal buildings. The final design also called for a water diversion feature installed to drain water from the north side of the Fire Department, past their septic area behind the building, and allow that water to spread and infiltrate in soils to the east of the Fire Department.

The Fire Association partnered with the Poultney Mettowee Natural Resources Conservation District to facilitate completion of this project and the necessary community outreach to ensure that all partners participated in the decision-making process.