Colchester
VERMONT

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www.colchestervt.gov

January 11, 2019

Christy Witters
Vt. Department of Environmental Conservation
Watershed Management Division
1 National Life Drive, Main 2
Montpelier, Vermont 05620-3522

Dear Ms. Witters:

Attached is the Town of Colchester's 2019 permit application for General Permit 3-2014 (2018) National Pollutant Discharge Elimintation Systems (NPDES) Number VTR040000. Included in this application are the following documents:

- NOI Amendment Form Signed by Town Manager
- Town's SWMP
- Permit Incorporation Form
- Sunderland Brook FRP
- Morehouse Brook FRP – Please note the revised construction schedule seen on page 17 of this document
- Stormwater Impaired Waters Flow Monitoring – Signed Memorandum of Agreement dated March 21, 2016

Please give me a call at 264-5620 if you require any additional information or have any questions.

Sincerely,

Bryan K. Osborne
Director of Public Works
E: bosborne@colchestervt.gov
P: 802.264.5620 | F: 802.264.5503

Signed NOI Amendment Form

Notice of Intent (NOI) - Amendment

for Stormwater Discharges from
Municipal Separate Storm Sewer Systems (MS4)
General Permit 3-9014

VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WATERSHED MANAGEMENT DIVISION

For Dept. Use Only
Notice of Intent No:

Submission of this Notice of Intent (NOI) constitutes notice that the entity in Section A intends to be authorized to discharge pollutants to waters of the State under Vermont's Municipal Separate Storm Sewer Systems (MS4) permit. Submission of the NOI also constitutes notice that the party identified in Section A of this form has read, understands and meets the eligibility conditions; agrees to comply with all applicable terms and conditions; and understands that continued authorization under the MS4 General Permit is contingent on maintaining eligibility for coverage. In order to be granted coverage, all information required on this form and the Minimum Control Measure attachments must be completed and a complete Stormwater Management Program (SWMP) Plan must be submitted.

A. Permittee Information

Name of MS4: Town of Colchester

Name of Principle Executive Officer (PEO) or Chief Elected Official (CEO): Aaron Frank

Title: Town Manager

Mailing Address:
Street/P.O. Box: 781 Blakely Rd

City/Town: Colchester State: VT Zip: 05446

Phone: (802) 264-5501 Email: afrank@colchestervt.gov

B. Primary contact responsible for overall coordination of SWMP, if different than PEO/CEO

Name: Bryan K. Osborne

Mailing Address:
Street/P.O. Box: 781 Blakely Rd

City/Town: Colchester State: VT Zip: 05446

Phone: (802) 264-5625 Email: bosborne@colchestervt.gov

C. Partnering organization responsible for Minimum Control Measure implementation (if applicable)

If you are participating in the CCRPC MOU to implement MCM1 &/or MCM2 check here: ☒ MCM 1 ☒ MCM 2

Or, if you are relying on another entity to implement a MCM, please complete the following:

Organization: CCRPC Contact: Dan Albrecht

Minimum Control Measure being implemented: MCM 1 & 2

Mailing Address:
Street/P.O. Box: 110 West Canal St, Suite 202

City/Town: Winooski State: VT Zip: 05446

Phone: (802) 846-4490 Ext 29 Email: dalbrecht@ccrpcvt.org

Organization: _____ Contact: _____

Minimum Control Measure being implemented: _____

Mailing Address:
Street/P.O. Box: _____

City/Town: _____ State: _____ Zip: _____

Phone: _____ Email: _____

D. Municipal Separate Storm Sewer System (MS4) Information

Estimate of the square mileage served by the MS4: 13

Identify the names of all know waters that receive a discharge from the MS4:

Receiving water	# of outfalls	Impaired status	Nature of impairment
Sunderland Brook	42	☒ Yes ☐ No	Stormwater
Indian Brook	4	☐ Yes ☒ No	
Pond Brook	3	☐ Yes ☒ No	
Gilbrook	3	☐ Yes ☒ No	
Morehouse Brook	2	☒ Yes ☐ No	Stormwater
Smith Brook	6	☐ Yes ☒ No	
Winooski River	15	☐ Yes ☒ No	
Winooski River Tributaries	3	☐ Yes ☒ No	
Lake Champlain	2	☐ Yes ☒ No	
Malletts Bay	15	☐ Yes ☒ No	
Malletts Bay Tributaries	5	☐ Yes ☒ No	

E. Stormwater Impaired Waters Information

Does the MS4 discharge into a stormwater impaired water? ☒ Yes ☐ No

If yes, the MS4 must comply with all requirements listed in Part IV.C. of the permit, including the requirement to develop a Flow Restoration Plan (FRP) for the stormwater impaired water.

Please see the attached FRP documents as required.

F. Incorporation of Previously Permitted Stormwater Systems

As part of this application, is the MS4 incorporating a stormwater system that was previously authorized under a State stormwater permit? ☒ Yes ☐ No

If yes, the MS4 must complete and attach an MS4 Incorporation Form for each permit it is incorporating.

List permit numbers here: 3416.9010.AR, 3760.9010, 4134.9010.R, 4231.9010.R.

G. Certification

This NOI shall be signed by a principal executive officer, ranking elected official or other duly authorized employee consistent with 40 CFR §122.22(b) and certified as follows:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name: Aaron Frank Title: Town Manager

Signature: [signature] Date: 1/11/19

Colchester’s SWMP

Stormwater Management Program

The following represents the Town of Colchester's Stormwater Management Program, (SWMP) as required by the State of Vermont, Agency of Natural Resources, Department of Environmental Conservation, National Pollutant Discharge Elimination System, (NPDES), General Permit 3-9014 (2018) for Stormwater discharges from Small Municipal Separate Storm Sewer Systems. The SWMP contains measurable goals for the development and implementation of the six minimum measures described in Subparts IV.F and G of the permit, and additional measures necessary to protect water quality described in Part IV of the permit. unless otherwise noted, Colchester's Public Works Department is responsible for implementing this Stormwater Management Plan including the implementation of included Best Management Practices (BMPs).

WATER QUALITY BASED REQUIREMENTS

Pursuant to Clean Water Act 402(p)(3)(B)(iii), the permit includes provisions which require the permittee to reduce the discharge of pollutants to the maximum extent practicable, protect water quality, and to satisfy the Clean Water Act.

REQUIREMENTS TO MEET WATER QUALITY STANDARDS

Discharges shall not cause or contribute to an exceedance of applicable water quality standards for the receiving water. Applicable water quality standards are the Vermont Water Quality Standards that are in place upon the effective date of the permit.

Except for discharges addressed by part IV.C.1 of the permit, if at any time the Town becomes aware that a discharge causes or contributes to an exceedance of applicable water quality standards, the Town shall within 60 days of becoming aware of the situation eliminate the conditions causing or contributing to the exceedance of water quality standards. If elimination within 60 days is infeasible the Town shall document in its SWMP measures and anticipated timeframes to eliminate the conditions causing or contributing to the exceedance. Within 30 days of eliminating the condition, the Town shall document the measures used to correct the condition in the SWMP. The Town shall include in its annual report a description of any such discharges identified during the reporting period; a description of measures taken to eliminate conditions during the reporting period or the basis of a finding that elimination is infeasible; and a timeframe for completion of all steps necessary to eliminate such discharges. The Town shall comply with any additional requirements or schedules established by the Secretary,

including any requirements to submit additional information concerning the potential cause of the exceedance.

DISCHARGES TO IMPAIRED WATERS

The Vermont Agency of Natural Resources has identified both the Morehouse and Sunderland Watersheds as being impaired by stormwater. The Town of Colchester intends to achieve compliance through the implementation of the Stormwater Management Plan, (SWMP) contained on the following pages, to include specific actions outlined within the six minimum control measures.

The Vermont Agency of Natural Resources considers several of the unnamed tributaries into Malletts Bay, as well as Smith Hollow Brook and Crooked Creek to be impaired by e-coli. To minimize this pollutant, the Town's SWMP contains several strategies aimed at controlling e-coli contamination. These strategies include controlling sediment through the implementation of Construction Site Stormwater Runoff Controls, and Post-Construction Stormwater Management in New Development and Redevelopment. The plan also works toward the control of illicit discharges through the implementation of the Town's Illicit Discharge Detection and Elimination Program. The Town also intends to continue existing programs associated with animal control to facilitate the removal of dead animals from the roadway system, and programs to minimize dog waste in Town parks and along multi-use paths. The Town will also continue its Water Quality Monitoring Program which has been in existence now for almost two decades, to continue improving the Town's understanding of e-coli contamination in Malletts Bay. These efforts have been supplemented by a Microbial Source Tracking Program completed as part of the Town's Integrated Water Resources Management Plan.

DISCHARGES TO IMPAIRED WATERS WITH AN APPROVED TMDL

Flow Restoration Plans - The Town has developed comprehensive Flow Restoration Plans (FRP) for the impaired portions of the Sunderland and Morehouse Brook watersheds within the Town's boundaries. The Town has partnered with the Town and Village of Essex, the VT Agency of Transportation, and the University of Vermont for the Sunderland Brook Watershed, which is currently in compliance with all requirements. The Town has partnered with the City of Winooski for the Morehouse Brook Watershed for which stormwater BMPs will be constructed per the implementation schedule in the FRP. The approved FRPs contain the following;

- An identification of the suite of necessary stormwater BMP's that will be used to achieve the flow restoration targets.
- A design and construction schedule for the stormwater BMP's that has been identified as necessary to achieve the flow restoration targets.

- A financing plan that estimates the cost of implementing the FRP.
- A regulatory analysis that identifies and describes what, if any, additional regulatory authorities will be needed to implement the FRP.
- An identification of regulatory assistance that will be needed to implement the FRP.
- An identification of any third party that is responsible for implementation of the FRP.

Phosphorus Control Plan: The Town is in the process of developing a Phosphorus Control Plan in accordance with permit requirements outlined in Section 8.2 of the MS4 Permit. The Town is prepared to follow the prescribed timeline for PCP implementation also outlined in the permit, including the first annual PCP report due on April 1, 2019. A brief description of the work to be completed is below:

- Review of PCP requirements and phosphorus reduction targets for Colchester,
- Classification of the sources of phosphorus loading in our community using TMDL guidance,
- Identification of projects that have the potential to result in reductions in phosphorus loading,
- Evaluation of which projects will result in significant reductions in phosphorus loading,
- Consideration of improvements that strike the appropriate balance between cost and efficiency,
- Selection of projects most suited to Colchester,
- Estimation of the cost of full compliance with permit requirements based on selected projects,
- Development of an implementation plan in accordance with permit requirements,
- Preparation of a Road Stormwater Implementation Table in accordance with MRGP requirements,
- Preparation of the final report and executive summary for public consumption.

Landowner Technical Assistance –The Town's Planning and Zoning Office offers opportunities for property owners to come and ask questions about site development through Technical Review Committee Meetings. These are free for property owners and technical staff from both the Planning and Zoning Department and the Public Works Department provide advice and guidance for how to develop the property in ways that protect natural resources, conform to Town zoning regulations, and best achieve the landowner's development goals.

Protection and Regulation of Development in Stream Corridors – The Town has previously developed and submitted a plan to the VANR outlining options for enhanced protection of stream corridors of stormwater impaired waters. The plan includes a map of stream corridors depicting areas that have been converted to impervious surface and areas that are undeveloped or have not been converted to impervious surface, (updated for this application), a Stream Corridor Buffer Ordinance and other applicable Zoning Regulations, and the development and

adoption of Stormwater Control Ordinances. The preparation of the plan was developed after review of the riparian buffer and stream fluvial geomorphological information provided by the VANR as a result of the Agency's preparation of TMDL's as set forth in 10 V.S.A § 1264 (f)(3).

Flow and Precipitation Monitoring Program – The Town will continue to jointly implement or otherwise fund a flow and precipitation monitoring program, subject to approval by the Secretary, within its watersheds impaired by stormwater in collaboration with other MS4 communities.

Six Minimum Control Measures – The Town has developed a SWMP which contains the required Six Minimum Control Measures to reduce pollutants to the Maximum Extent Practical.

Impervious Surface Minimization – In 2016, the Town revised zoning regulations along West Lakeshore Drive, which has a number of permitted direct discharges to Lake Champlain, in regards to impervious surfaces and stormwater runoff mitigation. There were two new zoning districts that were created (Lakeshore 1 and Lakeshore 2), replacing the underlying zoning districts previously in the area. Lakeshore 1 includes all properties on the "Lake side" of West Lakeshore Drive, and Lakeshore 2 includes properties with frontage on the "Non-Lake side" of West Lakeshore Drive. The allowable lot coverages for LS1 and LS2 were reduced over the previous district requirements; to increase lot coverage beyond the new limit a property owner must utilize green infrastructure techniques to mitigate runoff from the additional impervious surfaces. Most of the lots in these two districts exceed the new allowable lot coverage limits, so it is likely that any substantial development occurring in these areas will be offset by GSI installations. The permitted and conditional land uses in LS1 were drastically limited in terms of intensity, when coupled with the instability of the steep slopes and small lot sizes, will protect further degradation of these sensitive environmental areas along Lake Champlain.

DISCHARGES TO IMPAIRED WATERS WITHOUT AN APPROVED TMDL

Erosion Controls - Within the Town's SWMP, erosion controls have been adopted. Past efforts have included the design and construction of a stormwater outfall treatment structure which collects sediment before stormwater is discharged to Malletts Bay, two large river bank stabilization projects on the lower Winooski River located at the Heineberg Access off Heineberg Drive, and along River Road in Colchester, and eight stormwater outfall upgrade projects located in the Indian Brook, Colchester Pond Brook, Winooski River, Inner Malletts Bay and Sunderland Watersheds. In 2009, a large stormwater outfall project was constructed in Fort Ethan Allen within the Sunderland Watershed. A number of culvert upsizing and stabilization projects have been completed or are currently in the design phase, including the upsizing of a culvert on East Road in 2018 and the planned upsizing of an existing pair of undersized culverts serving Hercules Drive.

Gravel Road Maintenance - Although Colchester's limited gravel road system represents only about 25% of the state average, the Town has taken several steps to minimize the runoff from this portion of the transportation system. The Town has developed an alternative methodology to perform Traffic and Engineering studies on gravel roads for the establishment of speed limits. This allows the Town to post speed limits that do not exceed 35 mph along gravel roads, which in turn, significantly reduces the degradation of the gravel surface. Our equipment operators continue to receive regular training on the proper grading of gravel roads which allows less gravel to be applied to the roadways, and minimizes the amount of gravel that enters roadside ditches. The technical specifications of the Town's equipment have been revised to facilitate these proper grading procedures. The Town has also completed several erosion control projects along gravel roads to reinforce roadside ditches to minimize erosion of the ditch lines and the edge of the roadways during periods of high runoff. As a part of new development, the Town's design review process includes assessing the adequacy of stormwater culverts, both public and private to avoid flood damage due to high runoff. The Town also cleans roadside ditches of debris and buildup on an as needed basis to ensure that blockages do not result in washouts within the drainage system. Finally, the Town's gravel road system serves primarily agricultural areas, where the Town has taken deliberate steps to preserve this land use, which generally prevents high density development within these areas.

Riparian Buffers - Several years ago, the Town of Colchester developed and adopted a stream bank protection ordinance. Generally, the ordinance does not allow development within 85 feet of major streams and tributaries throughout the community. Supplemental information for this ordinance has been developed and submitted to the ANR. The Town has also developed a Street Tree Master Plan which is aimed at re-establishing the community's urban forest. All new development in Colchester is required to submit for review and approval, a vegetation and landscape plan. In areas adjacent to water bodies, such as project sites located within the

Shoreland Overlay District, no more than 25% of existing trees on a project site can be removed.

Impervious Surface Minimization - The Town has adopted revisions to its Technical Roadway Standards. The revised standards allow for most roadways to be constructed at a narrower width, and as well, allow increased options for open drainage systems to promote pre-treatment of stormwater runoff. New standards have been developed to support High Density Mixed-Use Development, which requires that pedestrian areas contain a minimum of 25% green space. The Town has also revised its Zoning Regulations reducing the allowable impervious surfaces in front yards from 50% to 30%.

Chloride Response Plan – With a 1.2 mile section of Sunnyside Brook listed on the State's 303(d) List, Part A for chloride impairment, the Town is required to develop a Chloride Response Plan. This Plan will include specific actions that are designed to achieve salt reduction on municipal roads and facilities within the impaired stream's watershed. Staff will review and document existing snow and ice removal policies, purchasing procedures, and staff training activities on the topic to identify opportunities for salt reduction. The Town will investigate whether ordinances regulating storage or application of salt within properties discharging to the MS4 are appropriate and necessary. The Town would look to state-established guidance on application rates if an informational brochure to property owners is called for within the Plan. The Salt Reduction Plan will be developed by Town Staff and adopted during this permit cycle (prior to February 2024).

Six Minimum Control Measures – The Town has developed a SWMP which contains the required Six Minimum Control Measures to reduce pollutants to the Maximum Extent Practical.

MINIMUM CONTROL MEASURES

Minimum Control Measure #1: Public Education and Outreach on Stormwater Impacts

BMP 1-1 *Maintain Stormwater Web Site* - The Town of Colchester has developed a stormwater website which contains local stormwater information. The Department's site will be updated as needed to include general, as well as locally relevant information relating to stormwater and water quality. The Town's web site is located at www.colchestervt.gov. The Town also maintains a stormwater utility website that describes utility projects, funding, and goals. The utility website is located at www.colchestervt.gov/1837/stormwater-utility.

Measureable Goal: Permittee will keep annual budget information current on the webpage and promote website's existence and use in stormwater utility newsletters (See BMP 1-4). **Rationale**: Permittee websites are often the place where residents first go to obtain information on stormwater issues. Provision of basic information on such websites will help form a strong initial form of engagement to site visitors.

BMP 1-2,3 *Landowner Technical Assistance –* The Town's Planning and Zoning Office offers opportunities for property owners to come and ask questions about site development through Technical Review Committee (TRC) Meetings. These are free for property owners and technical staff from both the Planning and zoning Department and the Public Works department provide advice and guidance for how to develop the property in ways that protect natural resources, conform to Town zoning regulations, and best achieve the landowner's development goals. The Town's website also provides information regarding the several agencies and organizations in Chittenden County performing these services.

Measureable Goal: Continue to provide TRC reviews for land owners on an as-requested basis and ensure any web links provided are accurate annually. **Rationale**: TRC Meetings assist property owners in considering development on their site, allows staff to offer design guidance and water quality recommendations, and avoids a lengthy DRB process for applicants. There are several organizations and agencies operating in the Chittenden County MS4 region that provide a range of technical assistance options for interested parties. By providing such links, the visitor can figure out which entity is best suited to provide technical assistance.

BMP 1-3 *Participation in RSEP -* The Town of Colchester will continue to participate in the regional stormwater education and outreach strategy described in the 2018 Memorandum of Understanding between designated MS4's, and the Chittenden County Regional Planning Commission. A copy of this MOU associated with this regional initiative is contained within the appendix of this application and is effective until June 30, 2022.

Measurable Goal: Participation in and financial support for the operation of the Rethink Runoff program. **Rationale**: A regional approach to stormwater education allows for a wider "reach" of promotional materials and a larger funding pool to support those efforts.

Additional BMPs adopted for Minimum Measure 1

Below is the only additional BMP considered or selected for compliance with MM-1.

BMP 1-4 *Newsletters* – The stormwater utility is committed to funding the design and mailing costs associated with an annual newsletter discussing stormwater projects, issues, concerns, and updates. These hard-copy newsletters are mailed to each postal customer in the community. Color versions are shared on the Town's website and social media platforms after mailing.

Measureable Goal: Send one community newsletter to the public annually. **Rationale**: Utility newsletters are an opportunity to communicate directly with our residents about locally relevant water quality issues and augment the outreach performed by ReThink Runoff.

Minimum Control Measure #2: Public Involvement and Participation

BMP 2-1,2,3 *Participate in RSEP* - The Town of Colchester will continue to participate in the regional stormwater education and outreach strategy described in the 2018 Memorandum of Understanding between designated MS4's, and the Chittenden County Regional Planning Commission. A copy of this MOU associated with this regional initiative is contained within the appendix of this application and is effective until June 30, 2022.

Measurable Goal: The permittee will participate in and provide financial support for operation of the Rethink Runoff Stream Team. Via an annual report provided by the Chittenden County RPC's subcontractor, the permittee will document on an annual basis the number of participants and/or persons contacted by outreach events and hands-on activities through the Rethink Runoff Stream Team. **Rationale:** Through support of the Stream Team, the Town will support the engagement of local residents in the MS4 area via outreach events and via hands-on participation events.

Additional BMPs adopted for Minimum Measure 2

Below are the only additional BMPs considered or selected for compliance with MM-2.

BMP 2-4 *Catch Basin Stenciling* - The Town is committed to organizing and overseeing a catch basin stenciling project at least once a permit cycle. In prior years partners have ranged from the Colchester Boy Scouts, Cub Scouts, community volunteers, and Colchester High School students. In the fall of 2018, with Colchester High School as a project partner, junior and senior environmental science students stenciled catch basins in the Julie Drive, Jason Drive, and Fox Run areas using stencils owned by RSEP. Where possible, the stenciling is scheduled as part of a lecture or other educational event focusing on water quality. Events similar to the fall 2018 stenciling event will be organized by Town staff, with support by the Conservation Commission as needed.

Measurable Goal: Complete one stenciling event during length of permit cycle. **Rationale**: These projects seek to educate students and residents about the importance of understanding how storm drains work and as a result assist in keeping our waterways clean of trash and debris.

BMP 2-5 *Community Stream Corridor Cleanup* – As a part of the Town's Green Up Day activities, the Town works with its Conservation Commission to specifically target its cleanup efforts toward high priority areas. These high priority areas include a total of 25 significant stream crossings of the Town's transportation system. The Town intends to continue supporting and coordinating these significant public involvement initiatives.

Minimum Measure #3: Illicit Discharge Detection and Elimination

BMP 3-a *Develop and enforce a program to detect and eliminate illicit discharges* – The Town has previously developed a program to detect and eliminate illicit discharges. The program elements include the development and maintenance of a GIS map of the storm sewer system, the development of an illicit discharge ordinance, an illicit discharge detection plan, a public informational component, a mechanism to address specific categories of illicit discharges if necessary, and an annual reporting process.

BMP 3-1 *Develop and maintain a storm sewer GIS map* – The Town currently maintains a storm sewer GIS data layer for the entire community that indicates the location of all Town-owned stormwater lines and outfalls and labels the waters of the state that receive discharges from those outfalls. The Town has recently embarked on a Town-wide Stormwater Condition Assessment project, where one of the data tasks is associated with confirming the accuracy of this existing dataset. While the focus of the project is not our GIS layer, a secondary result of the project's completion will be a totally up to date GIS layer for Town infrastructure. To maintain this database, a three tiered approach has been developed to document 1) existing stormwater infrastructure, 2) additional stormwater infrastructure added through the Town's maintenance efforts and/or capital improvement projects, and 3) additional stormwater infrastructure associated with new development and plan for their digitization within the GIS database maintained by the Town.

Existing Stormwater Infrastructure – The existing GIS data layer is currently under review for accuracy and will be up-to-date by the end of that project, expected in late 2019.

Future Town Installed Stormwater Infrastructure – As a part of any future project completed by the Town, an as-built drawing in digital form will be required in order to document additions or changes to the system.

Future Developer Installed Stormwater Infrastructure - The Town has approved amendments to its sub-division regulations to require that developers provide the Town with as-built information associated with new development, in digital form.

BMP 3-2 *Develop and implement an Illicit Discharge Ordinance* – The Town has developed and implemented an Illicit Discharge Ordinance. The ordinance regulates the contribution of pollutants to the MS4 from stormwater discharges by any user, prohibits illicit connections and discharges to the MS4, and establishes legal authority to carry out the IDDE Plan, including conducting inspections, monitoring, and enforcement procedures to ensure compliance with the ordinance. The ordinance was adopted by the Colchester Select Board on July 26, 2005.

BMP 3-3 *Develop and implement an illicit discharge detection plan, focus on impaired waters and random dumping* – The Town developed a IDDE Plan in 2008 containing the following sections;

Sec. 1.0 Introduction
Sec. 2.0 Illicit Discharges Defined
Sec. 3.0 Additional Exemptions
Sec. 4.0 Illicit Discharge Ordinance
Sec. 5.0 Development of Storm Sewer Map
Sec. 6.0 Locating Priority Areas
Sec. 7.0 Tracing the Source of an Illicit Discharge
Sec. 8.0 Removing the source of an Illicit Discharge
Sec. 9.0 Evaluation of the IDDE Program
Sec. 10.0 Outreach to Employees, Businesses, and the General Public
Sec. 11.0 BMP's and Measurable Goals

BMP 3-4 *Inform public of illicit discharge and disposal hazards* – Section 10.0 of the Town's IDDE plan outlines the Town's efforts to address this requirement. On an annual basis, the Town's maintenance employees receive training relating to Pollution Prevention/Good Housekeeping for Municipal Operations as part of the Town's Phase II plan. The Department of Public Works has developed an informational brochure designed for local businesses to improve their understanding of illicit discharges. The Public Works Department implements a stormwater stenciling program with a goal of raising awareness that storm drains are not for dumping. The Town is a member of RSEP, which provides

informational campaigns targeted at the general public covering a wide variety of stormwater issues. The Town maintains its own stormwater and stormwater utility web sites providing additional stormwater education materials to the community. The Town has also implemented a Water Quality Hotline where community members can report any activities, express concerns, or generally inquire about the Town's illicit discharge program.

BMP 3-5 *Address specific categories of Illicit Discharges, if necessary* – The Town has not found the list of non-stormwater discharges contained in the permit to be a significant contributor of pollutants to the MS4, and therefore have not addressed these categories within the IDDE plan.

BMP 3-6 *Prepare annual report of monitoring and corrective actions taken* - The Town has established files to maintain all documents relating to the management of illicit discharges. A complaint system has also been established to receive citizen complaints through a stormwater hotline. The hotline is posted on the Town's web site. Annual monitoring of pre-selected outfalls as outlined in the Town's IDDE plan are performed and reported in the Town's annual report to the DEC. When illicit discharges are detected through this program, or come to be known by the Town through other means, the Town takes the appropriate steps to address them under the authority of local ordinances.

Measurable Goals & Rationale for Minimum Measure #3

The BMP's identified under this minimum control measure are aimed primarily at improving total species numbers and species density in receiving waters through the reduction of toxins in stormwater runoff.

There were no major alternative BMP's examined under this minimum control measure.

The implementation of this measure will require the continued support of both the community and its legislative body to support the enforcement of a local ordinance to regulate and prohibit illicit discharges.

The expected water quality outcomes under this minimum control measure are improvements in total species numbers and species density within receiving waters through the reduction of toxins in stormwater runoff.

Minimum Measure #4: Construction Site Stormwater Runoff Control

BMP 4-1 *Develop and implement procedures to ensure MS4 construction activities are properly permitted.* - The Town will continue to perform plan review of all projects involving land disturbance as a part of the site plan review process and the issuance of building permits. All activities involving land disturbances will continue to require a permit from the Town. All permits issued from the Planning and Zoning Office are evaluated by staff, either as an Administrative Review, or through the Town's Development Review Process. Through the permit application process, a determination will be made by the Planning and Zoning Office regarding the total area of land disturbance. This Office will determine whether the one-acre and five-acre state regulatory thresholds are met, and report such activities to the Secretary of the Agency of Natural Resources to assure all such projects are properly permitted.

BMP 4-2 *Review existing MS4 regulations for effectiveness in managing construction related E & S and consistency with state construction permits* - The Town relies upon the technical specifications within the Public Works Ordinance and the Town's Stormwater Ordinance as the mechanism to require erosion and sediment controls at construction sites. The language within these documents works to ensure effectiveness in managing construction related erosion and sediment and other wastes generated from construction activities that may cause adverse impacts to water quality. These documents also ensure consistency with the requirements of the Secretary's general permits for stormwater runoff from large and small construction sites. The erosion control requirements within these documents apply to all land disturbances requiring a permit as required in the Town's Zoning Regulations. Currently, all land disturbances require a permit. Inspection responsibilities for all such permits issued are assigned to the Town's inspectors. Any local violations would be noticed by the inspectors, with enforcement action, if necessary, taken by the Town of Colchester based upon the construction site erosion control requirements within the Town's Public Works and Stormwater Ordinances. The Town will endeavor to inspect all construction sites as often as possible, with emphasis on larger projects, and those projects that are located in areas where run off to receiving waters is more likely. Inspections will also be targeted at phases of the construction that may be more susceptible to problems relating to construction site run off. During regular inspections, Town inspectors will inspect for obvious signs of non-compliance such as eroding soils and turbid waters on state permitted projects. Town inspectors will report any suspected violations on these projects to the Vermont Agency of Natural Resources.

BMP 4-3 *Develop and implement an erosion control ordinance that regulates development not subject to state permitting* – The Town has developed a

stormwater ordinance which contains a section on construction erosion control requirements that effectively regulates development activities that are not subject to state or federal erosion control requirements.

Measurable Goals & Rationale for Minimum Measure #4

The BMP's identified under this minimum control measure are aimed primarily at improving the nutrient index within receiving waters by reducing the discharge of phosphorous and nitrogen, improving clean water species counts by reducing stormwater runoff volume during construction before stormwater controls are completed, and improving total number of species and species density by reducing the discharge of sediment and toxins that are generated by construction activities.

There were no major alternative BMP's under this minimum control measure.

The implementation of this measure will require the support of both the community and its legislative body to support the enforcement of local ordinances to regulate run off from construction sites.

The expected water quality outcomes under this minimum control measure are improvements in the nutrient index, clean water species, total species numbers, and species density within receiving waters through the reduction of phosphorus, nitrogen, sediment and toxins in stormwater runoff.

Minimum Measure #5: Post-Construction Stormwater Management in New Development and Redevelopment

BMP 5-1 *Review existing MS4 regulations for effectiveness in managing stormwater runoff from new development and redevelopment projects* - The Town performs plan review of all projects involving land disturbance as a part of the site plan review process and the issuance of building permits. All permit conditions associated with projects involving land disturbance are included in the approved Findings of Fact and Order approved by the Development Review Board. This document becomes the instrument for enforcing the Board's approval. Town Staff feels the current regulations are effective in preventing adverse impacts to water quality as a result of new or redevelopment.

BMP 5-2 *Review existing MS4 regulations for consistency with State rules and permits* – The Town relies upon the technical specifications within the Public Works Ordinances and the Town's Stormwater Ordinances as the mechanism to address post-construction runoff from new development and redevelopment that result in a land disturbance of greater than one acre and that have less than one

acre of impervious surface. The Ordinances contain a combination of structural and non-structural BMP's which are appropriate for the community and consistent with the Agency's 2017 Vermont State Stormwater Management Manual (and any amendments thereto). Additionally, the Ordinances ensure consistency with the requirements of the Secretary's general permits regulating stormwater runoff from new development and redevelopment projects that have one or more acres of impervious surface. These post-construction stormwater controls and requirements apply to all land disturbances requiring a permit as required in the Town's Zoning Regulations. Through the Town's Public Infrastructure Ordinances, Stormwater Ordinances, Sub-division Regulations and Zoning Ordinances, the Town's requirements related to Post Construction Runoff Control are consistent with and as stringent as state requirements.

BMP 5-3 *Assess whether changes can be made to MS4 regulations to support low impact design options*- The Town has taken several steps in support of Low Impact Development. These include the design of parking lots, roadways, the development of stream bank buffer ordinances, homeowner educational efforts through RSEP, as well as offering and/or coordinating public workshops associated with the use and construction of rain barrels, rain gardens and other LID strategies. The Town has also adopted Lakeshore 1 and Lakeshore 2 Zoning Districts that require the use of green stormwater infrastructure to increase lot coverage. The Town is continuing to explore grant opportunities to fund residential education programs related to minimizing impervious surfaces and mitigating residential stormwater runoff.

BMP 5-4 *Assess changes to regulations to minimize impervious surfaces through street & parking design* – The Town has made significant revisions to its technical specifications for public infrastructure allowing significantly reduced roadway widths for smaller scale development, as well as allowing the option of open drainage plans to promote improved treatment of stormwater runoff. Within the Town's Zoning Regulations, the Town requires the design and construction of parking areas to promote stormwater management through the use of trees, vegetation and stormwater filtration areas all intended to reduce the amount of impervious services and improve overall stormwater treatment. The Town will continue to assess other improvements to these and other regulations to determine whether additional improvements can be made.

BMP 5-F1,2,3 *Stormwater Management for sites not subject to regulation under the Agency's permitting programs* – The Town has developed a stormwater ordinance that regulates post construction runoff controls for new development or redevelopment projects that disturb greater than or equal to one acre that are

part of a larger common plan of development or sale and may not be subject to regulation under the Agency's post-construction stormwater management permit program. Projects that intend to create more than half an acre of impervious surface must provide a Stormwater Management Plan with their development application. Such a Stormwater Management Plan must be prepared by a licensed engineer and demonstrate conformance to applicable water quality standards. This includes sufficient engineering analysis to show that the proposed stormwater treatment practices are capable of controlling runoff from the site, hydrologic and hydraulic design calculations demonstrating that post-development stormwater runoff flows shall be limited to equal or less than pre-development stormwater runoff flows for a twenty-five year, twenty-four hour storm event, and indicate areas where maintenance easements will be needed. The applicant must execute a maintenance agreement and any associated easements binding on all subsequent owners of land served by any on-site stormwater measures, record those documents in the land records prior to issuance of a building permit, and specify any and all required maintenance for practices along with a maintenance schedule specifying when and how often maintenance is performed. The applicant is required to maintain records that verify maintenance was performed for at least three years.

BMP 5-G1 *Develop and implement procedures for inspecting development for compliance*– The Town's Zoning Regulations require all ground disturbing activities to obtain a permit, and all permits require inspections by the Town's Building Inspector for compliance with conditions of approval before the project receives a Certificate of Occupancy. Through the review of permit applications, the Planning and Zoning Office identifies which regulations are applicable and condition each approval based on conformance with any applicable regulations.

BMP 5-G2 *Develop and implement procedures to assure that development and redevelopment activities undertaken by the permittee are properly permitted and maintained.* – The Town has adopted Construction Standards Applicable to Land Development, also known as Chapter 14 of the Colchester Code of Ordinances. Chapter 14 specifies that: *"The requirements, specifications and standards contained in this Chapter are applicable only to public improvements associated with new development, or, the expansion or extension of existing public improvements. No public improvements, except municipal maintenance, shall occur or be constructed or altered, except in conformance with the requirements set forth and incorporated herein. The Colchester standards contained in this Chapter are considered the minimum acceptable standard specifications for the Town of Colchester."* Additionally, The Town's Zoning Regulations require all ground disturbing activities to obtain a permit, and all

permits require inspections by the Town's Building Inspector for compliance with conditions of approval before the project receives a Certificate of Occupancy. Through the review of permit applications, the Planning and Zoning Office identifies which regulations are applicable and condition each approval based on conformance with any applicable regulations.

Measureable Goals & Rationale for Minimum Measure #5

The BMP's identified under this minimum control measure are aimed primarily at improving clean water species counts by reducing or attenuating stormwater runoff volume and by reducing the effects of stormwater scouring and flooding.

There were no major alternative BMP's under this minimum control measure.

The implementation of this measure will require the support of both the community and its legislative body to support the enforcement of local ordinances to regulate post-construction stormwater runoff.

The expected water quality outcomes under this minimum control measure are improvements to the clean water species by reducing or attenuating stormwater runoff volume and by reducing the effects of stormwater scouring and flooding.

The regulatory mechanisms used by the Town to address post-construction runoff from new development and re-development include the Public Works Specification and Standards, the Colchester Stormwater Ordinance, the Town's Sub-Division Regulations and the Town's Zoning Regulations. These mechanisms were selected as the most effective approach to managing post construction runoff.

All land disturbances require a permit from the Town. Through the issuance of a permit, the appropriate conditions are attached to the permit, that require the post-development landowner to perform the proper long-term operation and maintenance of the BMP's required through the review and approval process that are not taken under public ownership.

The Town has developed and will continue to use local Zoning Regulations to provide the legal authorities and strategies to protect and regulate development in the stream corridors of stormwater impaired waters as defined by 10 V.S.A § 1264 (a)(13).

The Town has developed and submitted a plan to the VANR outlining options for enhanced protection of stream corridors of stormwater impaired waters. The plan includes a map of stream corridors depicting areas that have been converted to impervious surface and areas that are undeveloped or have not been converted to impervious surface. The preparation of the plan was developing after review of riparian buffer and stream fluvial geomorphological

information provided by the VANR as a result of the Agency's preparation of TMDL's as set forth in 10V.S.A § 1264 (f)(3).

For those areas of stream corridors that have been developed or otherwise converted to impervious surfaces, the plan for enhanced protection of stream corridors of stormwater impaired waters identifies options for stream corridor restoration as outlined.

The Town of Colchester, through both its Public Works Department and Planning and Zoning Department are responsible for the overall management and implementation of the post-construction stormwater management program. The Directors from these departments have the primary responsibilities, with specific tasks delegated to the Public Works Operations Manager, Town Engineer, and Town's inspectors.

The success of this minimum measure will be evaluated through developing and achieving measurable goals. The selection of measurable goals has been completed in a manner that allows the Town to gauge program effectiveness. Additionally, the measurable goals have been based upon the needs and characteristics of the Town and the area served. Finally, they have been selected to ensure an integrated approach that fully addresses the requirements and intent of this minimum control measure.

Pollution Prevention/ Good Housekeeping for Municipal Operations

BMP 6-1 - 4 *Implement an operation and maintenance program that includes a training component and has ultimate goal of reducing pollutant runoff*– Town maintenance crews shall receive annual training associated with the correct procedures to minimize the discharge of sediments, toxins, phosphorus, nutrients and other harmful contaminates, that may be caused through the Town's municipal operations. Training exercises shall contain at a minimum, an understanding of the location and characteristics of the natural resources that may be vulnerable to municipal operations, sources of contamination that may be generated from the municipal operations, and how they may impact natural resources, procedures to minimize the potential effects of municipal operations on natural resources, the specific requirements and conditions of the Town's Phase II permit, and procedures for complying with any applicable state and federal laws for proper disposal of wastes.

The Town of Colchester has four municipal functions that are impacted by our operation and maintenance program. These include the following:

Highway Maintenance:

Snow Removal Activities: - The Town's snow and ice removal procedures are designed to minimize the use of de-icers and abrasives that may ultimately enter receiving waters. Colchester does not have a "bare roads" policy. The application of de-icers is limited to specific phases of storms and types of weather conditions. During snow events, de-icers are applied when precipitation is beginning to prevent compaction and bonding of snow to the roadway. Under ordinary circumstances, de-icers will not be applied again until the storm has ended to restore the paved surface. To avoid excessive use of de-icers, these materials are not applied at temperatures below their optimal effectiveness range. During freezing rain, or ice storms, de-icers are applied as needed throughout the entire storm event.

The use of abrasives is limited to non-paved roads in rural sections of the community, and paved roads when temperatures are too low for de-icers. The application of abrasives on paved roads is typically limited to critical areas such as steep grades, sharp corners and roadway intersections.

All primary snow removal equipment operated by the Town is equipped with on-board computers that control and regulate the application rates of materials. The Town operates no snow storage areas.

De-icers are stored in an enclosed facility. Abrasives are stored in an open pile on the ground at the Public Works Maintenance Facility. Minimal amounts of de-icers are added to the stock pile to prevent freezing. A silt fence is erected and maintained around the stock pile and an earthen berm and vegetative buffer strip has been constructed at the downstream end of the site.

Street Sweeping – The Town owns its own street sweeper. The equipment removes debris from the roadways by vacuum which reduces airborne dust. Town roads are cleaned both in the spring and fall of the year.

Basin Cleaning – Stormwater basins are currently cleaned on an as needed basis. Emphasis is placed on stormwater basins located on steep grades, and structures located near outfalls to receiving waters. Basins are inspected during cleaning.

Stormwater Outfalls – The Town has inventoried, assessed and mapped all of its stormwater outfall structures. These structures have been placed on a regular inspection schedule as outlined in the Town's Stormwater Outfall Assessment Program. Inspection forms are used to record any damage or signs of failure. Observations of flow characteristics are also recorded.

Drainage Ways – Roadside ditches and drainage ways are inspected routinely during other highway maintenance operations such as street sweeping, grading of gravel roads and roadside mowing. Solid wastes are removed from these drainage ways annually as a part of the Town's Green-up day activities. Roadside mowing is completed 3-4 times per year, or as needed, to keep the drainage ways clear. Regrading of drainage ways is only done on an as-needed basis to minimize any unnecessary soil disturbance.

Dust Control – Dust control material for gravel roads is limited to one application per year. Diluted liquid chloride is used for dust control. Applications are carefully applied to avoid any overspray into roadside drainage ways. The application of dust control material is coordinated with weather conditions to avoid excessive runoff into drainage ways.

Material Storage – Construction materials are stored within the Public Works Maintenance Facility yard. An earthen berm and vegetative buffer strip has been constructed at the lower end of the site to prevent any runoff or discharge of sediment from the site.

Buildings and Grounds Maintenance:

Sanitary Facilities and Wastes – All Town facilities and primary parks are equipped with bathroom facilities. All facilities are served by on-site wastewater systems, which are pumped and inspected every two to three years depending on the facility and size of tank.

Solid Wastes – All solid wastes from Town facilities are removed regularly on a contractual basis. Solid wastes from park lands are collected daily by Town maintenance crews. All solid wastes are properly disposed of in approved landfills.

Stormwater Runoff – Most Town facilities are located on relatively flat ground where no concentrated discharge occurs. On facilities that have concentrated discharges, a mixture of BMP's including grass lined swales, stormwater ponds, stormwater control berms and vegetative buffer strips are used. These controls are monitored regularly during grounds maintenance operations.

Fertilization – All types and quantities of fertilizers applied to Town owned grounds are in compliance to all state and federal guidelines regulating the use of fertilizers. To prevent over application of phosphorus, soil tests are conducted in advance of applications. Nitrogen is controlled through the use of slow

release materials which allow the nitrogen to be used by the soil before reaching ground water. Fertilizers are applied primarily to athletic fields with general open space receiving only limited applications. Any over spray of fertilizers onto impervious surfaces are swept off after each application. Fertilizers are only purchased on an as-needed basis, and are stored inside under cover within approved containers before application.

Pesticides – All types and quantities of pesticides applied to Town owned grounds are in compliance to all state and federal guidelines regulating the use of pesticides. The Town uses Integrated Pest Management within its pesticide program for Town owned grounds. This involves testing of soils before applications to determine whether the application of pesticides is necessary.

Any over spray of pesticides onto impervious surfaces are swept off after each application. Pesticides are only purchased on an as-needed basis, and are stored inside under cover within approved containers before application.

Animal Waste – Town parks and recreational paths are equipped with supplies to allow pet owners to remove and dispose of pet waste within Town parks.

Equipment Maintenance:

Equipment Repair – All Town owned equipment is maintained and repaired within the Town's Public Works Maintenance Facility. Waste oils are collected and burned within an approved waste oil furnace within the maintenance facility. Coolants are recycled through equipment at the facility. All uniforms and rags that may be contaminated with oils, greases and other materials are collected within approved containers and cleaned on a contractual basis by an industrial cleaner. All other solid wastes, including batteries, discarded parts, and oil absorption materials, are collected and stored in approved containers, and disposed of at the appropriate facilities. Where fluids are stored that may be subject to accidental spills, double containment is provided. Aerosol products are managed to minimize the number of containers actively in use within the shop area.

Equipment Storage – The majority of the Town's equipment is stored inside. The Town operates a Capital Equipment Program that allows all equipment to be replaced on a regular basis. Together with the facilities computerized work order and maintenance systems, the Town's equipment is in very good condition, and is generally free of fluid leaks, rust, paint flakes and other

possible contaminates that may be washed from the site during stormwater flow conditions.

Equipment Washing – The facilities floor drains are connected to an oil and grease/water separator, which is connected to a holding tank. The tank is pumped on an as-needed basis, with the material disposed of in the Town's sewer system. The washing area outside is located such that wash water runs to a vegetated area and dissipates into the ground. Total outside equipment washing does not exceed thirty vehicles per week. There is no steam cleaning or engine degreasing performed during outside equipment washing.

Fueling Facility – The Town's fueling facility is served by two UST's with secondary containment. The facility is covered by a fueling canopy to avoid the collection of rain water and subsequent run off from the fueling pad. The fueling pad is slightly elevated to avoid contact from any other site run off that may be directed to the pad. The overall site is graded such that runoff is not directed toward the pad. The fueling system is equipped with both spill and vapor recovery systems. The system is also equipped with an electronic monitoring system that automatically reports fuel levels on a daily basis, and is equipped with an audible alarm connected to a leak detection system.

Wastewater System Maintenance:

Overflow Controls – All Town wastewater pumping stations are equipped with either auxiliary power capability, or emergency storage to prevent overflow conditions. All waste water pumping stations are inspected daily. In the event of an over flow, all practical steps are taken to prevent a discharge including but not limited to, erecting containment systems, flow diversion or emergency pumping and tanker truck operations.

Chemical Pre-treatment – All pumping stations equipped with chemical pre-treatment systems store their chemicals in above ground double containment tanks. All waste water pumping stations are inspected daily to ensure both the normal operation of the facilities, as well as the integrity of chemical storage tanks and other systems. Any problems are either repaired immediately by maintenance personnel, or if immediate repairs are not possible, reported to the Public Works Operations Manager to develop and implement a repair plan.

BMP 6-C *<u>For municipal facilities where fertilizers are applied, prohibit the use of fertilizers containing phosphorus unless warranted by a soil test</u>* - All types and quantities of fertilizers applied to Town owned grounds are in compliance to all state and federal guidelines regulating the use of fertilizers. To prevent over application of phosphorus, soil tests are conducted in advance of applications.

Nitrogen is controlled through the use of slow release materials which allow the nitrogen to be used by the soil before reaching ground water. Fertilizers are applied primarily to athletic fields with general open space receiving only limited applications. Any over spray of fertilizers onto impervious surfaces are swept off after each application. Fertilizers are only purchased on an as-needed basis, and are stored inside under cover within approved containers before application.

BMP 6-D *For municipal garages, an MS4 may participate in ANR's Municipal Compliance Assistance Program* - On September 19, 2010, John Daly, Environmental Assistance Specialist within the Vermont Department of Environmental Conservation, conducted an inspection of the Town's Public Works Maintenance Facility. The Town is in compliance with each of the Direct Compliance Issues identified in the report. Spent diesel and gas fuel filters are being disposed of as outlined. The Town discontinued the use of clay absorbents several years ago. The Town has previously tested its sand blast waste for heavy metals with negative results. No changes in procedures or materials have been made since that time. Debris from both street sweeping and catch basin cleaning is currently being stored on site at the maintenance facility. The charges from landfills to accept the material as cover material have become cost prohibitive. Subsequently, the Town has had these materials tested and determined that they can be safely disposed of at alternative sites. The Town intends to continue working with the MCAP to ensure continued compliance.

BMP 6-E *Provide a list of all industrial facilities that the MS4 owns or operates that are subject to the MSGP* – Currently there are none. The Town understands from the VANR Legal Council that MSGP's are not required for Public Works Garages. The Town has however completed several improvements which would be required under a MSGP if one were required. These include the covering of construction materials such as asphalt, manhole frames and covers, and scrap metal. The sand blasting area has been paved to facilitate the cleanup of the waste material after each occurrence. A holding tank has been installed which is connected to the floor drains within the maintenance facility to capture wash water associated with cleaning equipment. The waste water is periodically removed and discharged into the Town's municipal sewer system. Voters of Colchester approved bonds to allow improvements to several Town buildings, including $750,000 for the Public Works Maintenance Facility. As a part of this project, a 3,720 square foot cold storage facility has been constructed, allowing much of the Town's equipment and construction materials to be placed under cover. This project also included the replacement of an aging salt storage facility.

BMP 6-F Copy of O&M program – Please see Section 6.1 of this document.

Rationale

The BMP's identified under this minimum control measure are aimed primarily at improving the nutrient index within receiving waters by reducing the discharge of phosphorous and nitrogen, and improving the total number of species and species density by reducing the discharge of sediment and toxins that can be generated by municipal operations.

There were no major alternative BMP's under this minimum control measure. Measurable Goals include documenting staff training hours within Annual Reports; annually documenting the volume of material removed from the stormwater system through catch basin cleaning and street sweeping; and providing a copy of soil tests completed prior to the application of pesticides as a part of municipal operations.

The implementation of this measure will require an increased level of awareness on the part of public employees of how the Town's municipal operation can contribute to water quality both positively and negatively.

The expected water quality outcomes under this minimum control measure are improvements in the nutrient index, total species numbers, and species density within receiving waters through the reduction of phosphorus, nitrogen, sediment and toxins in stormwater runoff.

Permit Incorporation Form

MS4 Incorporation Form for State Issued Stormwater Permits

Please complete this form for each previously issued state stormwater permit that the MS4 plans to incorporate into the MS4 authorization. The stormwater management practices associated with the permit(s) listed below shall be listed in the MS4's Stormwater Management Program (SWMP) under Minimum Control Measure 5, Post-Construction Management.

Stormwater System Name	SW Permit No.	Current Permit Status	Stormwater Treatment Practice(s) (ie, Pond, Basin, Swale)	Upgraded or altered from previously issued permit (if so, include the final plan with the SWMP)	Current Compliance Status ("Compliant with previously issued permit" or detail the plan for compliance)	Legal Responsibility Secured
Arbor Lane	3416.9010.AR	Active	Curbed road with catch basins discharge to infiltration system and overflow discharge to Pond Brook.	No	compliant with previously issued permit	Yes
Logan Drive	3760.9010	Active	Dry swale infiltration to groundwater	No	compliant with previously issued permit	Yes
Country Meadows	4134.9010.R	Active	Curbed road with collection of stormwater catch basins and pipes, outfall discharge to Crooked Creek.	No	compliant with previously issued permit	Yes
Sunderland Hollow Industrial Park	4231.9010.R	Active	roadside swales and two catch basins served by 15" pipe, discharges to unnamed trib of Sunderland Brook.	No	compliant with previously issued permit	Yes

Sunderland Brook FRP

SUNDERLAND BROOK FLOW RESTORATION PLAN

MS4 General Permit Requirement (IV.C.1)

July 24th, 2015

In Partnership with:

Town of Essex, VT
Village of Essex Junction, VT
Town of Colchester, VT
Vermont Department of Transportation

Prepared for:
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I. Disclaimer

The intent of this plan is to present the data collected, evaluations, analysis, designs, and cost estimates for the Sunderland Brook Flow Restoration Plan (FRP) Project, completed under a contract between the Town of Essex and the hired consultant team, Watershed Consulting Associates, LLC and Aldrich & Elliott, PC. The Sunderland Brook FRP was prepared to meet the compliance requirement for the Sunderland Brook impervious surface owners, including the Town of Essex, Village of Essex Junction, Town of Colchester, University of Vermont, and the Vermont Agency of Transportation (VTRANS) under the National Pollutant Discharge Elimination System (NPDES) General Permit 3-9014 (VTDEC 2012) for stormwater discharges to impaired waters. The presented plan is in draft form, and will be revised by the Town of Essex and MS4 partners, as needed. **At this time, the MS4s are not bound in any way to the proposed BMP list.**

1 Executive Summary

Watershed Consulting Associates, LLC, and partners Aldrich and Elliott, PC (A+E) were commissioned to develop the following Flow Restoration Plan (FRP) for the Sunderland Brook watershed under contract with the Town of Essex, in partnership with the Village of Essex Junction, Town of Colchester, University of Vermont (UVM), and the Vermont Department of Transportation (VTRANS). The plan was developed in accordance with the MS4 General Permit #3-9014 Subpart IV.C.1 as a part of the participating MS4's Stormwater Management Program (SWMP). The purpose of the FRP is to provide a planning tool for the MS4 entities to implement stormwater Best Management Practices (BMP's) over a twenty (20) year timeframe, in an effort to return Sunderland Brook to its attainment condition.

As a part of the FRP development, an assessment was completed to determine to what extent current stormwater controls have reduced high flows (flows occurring less than 0.3% of the time) from the pre-2002 condition, as required by the Sunderland Brook Total Maximum Daily Load (TMDL) for stormwater. The Vermont Best Management Practice Decision Support System (BMPDSS) model, a GIS-based hydrologic model used to assess the impact of various stormwater Best Management Practice (BMP) scenarios, was used for the assessment. Several revisions to existing BMP drainage areas and BMP design configurations were identified during field inspections and accounted for in the revised models. After the existing model scenarios were reviewed, new BMPs were identified, inspected, and assessed in the BMPDSS.

According to the review completed under this contract, Sunderland Brook is currently meeting its attainment condition with a considerable factor of safety. The MS4's **do not need to implement any new stormwater controls under the MS4 permit requirement IV.C.1.** Therefore, the FRP prepared under this contract provides the MS4 entities a list of possible projects, in the event future biomonitoring of the stream reveals non-compliance with the Vermont Water Quality standards, but there is no requirement to implement any of the projects at this time.

The final evaluated BMP list includes 7 sites—three (3) new infiltration basins, three (3) new underground retention chamber systems, and one (1) green stormwater infrastructure (GSI) practice. The proposed BMPs were assessed with the BMPDSS model, and determined to provide a -17.85% reduction in the high-flow which addresses 482% of the TMDL high-flow target (Q0.3%), through reduction of runoff from the 1-year Design storm. While not an actionable target, the low-flow (baseflow) was estimated to increase by 8.33%, which addresses 231% of the low-flow target. The planning level total cost for implementation of the proposed projects is $2,072,800.

The proposed projects were ranked using a comprehensive matrix. Four (4) projects were selected from the top ranked projects for 30% engineering including 1) an infiltration basin at the VTRANS garage along Tracy Rd, 2) an underground storage chamber system at Fort Ethan Allen, 3) runoff mitigation from Outfall 31 with an infiltration gallery, located at 6 Morse Dr. and 4) an infiltration basin in the ROW at 292 Morse Dr. to manage runoff to Outfall 199. Itemized planning

level cost estimates were developed for the top two (2) projects, while a spreadsheet cost calculator was used for all other cost estimates. Sketch plans were developed for all other proposed BMPs.

2 Background

Sunderland Brook is currently on the State of Vermont's impaired waters EPA 303(d) list with the primary pollutant determined to be stormwater runoff. In the effort to restore Sunderland Brook and lift its impaired designation, a flow-based Total Maximum Daily Load (TMDL) was developed for Sunderland Brook. This TMDL outlines required reductions in stormwater high flows and an increase in baseflow. The flow targets are the basis for the FRP, developed in accordance with the Municipal Separate Storm Sewer (MS4) General Permit Subpart IV.C.1 as a required part of the MS4s Stormwater Management Program (SWMP).

The purpose of the FRP is to outline a plan for the retrofit of existing impervious cover with stormwater management BMPs (e.g. detention basins, bioretention filters, etc.) to meet the TMDL flow targets. The TMDL set forth that watershed hydrology must be controlled in the Sunderland Brook Watershed to reduce high flow discharges and increase base flow in order to restore degraded water quality and achieve compliance with the Vermont Water Quality Standards (VWQS). Components of the FRP, as outlined in the MS4 general permit include the identification of retrofits to existing BMPs with expired State stormwater permits, new BMP controls, a construction and design (C&D) schedule, a financial plan, and a regulatory analysis.

The four MS4's contributing impervious cover runoff to Sunderland Brook, including the Town Essex, Village of Essex Junction, Town of Colchester, and the Vermont Agency of Transportation (VTRANS) agreed to prepare a joint FRP for the watershed, with consideration of the individual MS4s flow-target allocation based on impervious ownership. The University of Vermont owns land at the Fort Ethan Allen. However, the University of Vermont is a non-traditional MS4 and therefore VT DEC did not consider UVM to be a jurisdictional MS4 within the Sunderland Brook watershed, and is not included as a contributing MS4 to the Sunderland Brook TMDL.

2.1 TMDL Flow Targets

Vermont developed TMDLs for impaired watersheds using flow as a surrogate for pollutant loading. The basis for the TMDL development was the comparison of modeled Flow Duration Curves (FDCs) between impaired and attainment watersheds. The Program for Predicting Polluting Particles Passage through Pits, Puddles, and Ponds, Urban Catchment Model (P8) was used to model gauged and ungauged watersheds in Vermont and develop Flow Duration Curves (FDCs) from which a normalized high flow and low flow per drainage area in square miles (cfs/sqmi) were extracted. An FDC is a curve displaying the percentage of time during a period that flow exceeds a certain value, with the "low" flow represented by the 95th percentile ($Q_{95\%}$) of the curve and the "high" flow represented by the 5th percentile ($Q_{0.3\%}$). The high and low flow values from the FDCs were then compared between "impaired" watersheds and comparable

"attainment" watersheds to determine a percent change (i.e. reduction of high flow, increase of low flow). The percent change was reported in the Environmental Protection Agency (EPA) approved TMDL for each impaired watershed.

The high-flow ($Q_{0.3\%}$) was determined to be relatively equivalent to the 1-year Design storm flow. Therefore BMPs designed to meet the State of Vermont Stormwater Management Manual's Channel Protection volume (CP_v) Storage standard were used to address the required high-flow reduction target.

Future Growth

The VT DEC added a future growth factor to the TMDL flow targets to account for future non-jurisdictional impervious growth. Non-jurisdictional growth was defined as impervious area that is not subject to a state stormwater permit and is therefore not managed by a state permitted stormwater BMP. This type of growth is typical of a small project, which involves the addition of new impervious below the state threshold of 1 acre. This future growth factor was developed under the assumption that no local zoning or land use rules would be in place to require stormwater management for smaller projects. VT DEC used a future non-jurisdictional growth estimate of 8 acres, provided to VT DEC based on local development and projected growth. Documentation for this estimate was not provided to VT DEC.

To develop the TMDL target with future growth, the estimated future impervious growth (8 acres) was added to the watershed's existing impervious cover, to simulate the watershed conditions at the end of the FRP implementation timeframe (20 years), which at the time was projected to be 2025. With the projected non-jurisdictional future growth, the high-flow target reduction changed by -0.2% and the low-flow target was not changed (Table 1). The approved TMDL flow targets are as follows:

Table 1: TMDL Flow Restoration Targets

Flow Target	Target High Flow Q 0.3 (%) **Reduction**[1]	Target Low Flow Q 95 (%) **Increase**[2]
TMDL Targets (Stormwater allocation only)	-3.5%	3.6%
TMDL Targets with **8 acres** of Non-Jurisdictional Future Growth	-3.7%	3.6%
[1] The High Flow target is negative (-), indicating there needs to be a reduction in high flow from the baseline condition. The Low Flow target is positive (+), indicating there needs to be an increase in low flow from the baseline condition.		
[2] The low flow target is not actionable under the TMDL, but is included because improving base flow in the watershed is still a water quality goal.		

While the low-flow goal is important to ensure flow during the dry summer months, it is not an actionable requirement in the EPA approved TMDL, and therefore was not the primary focus of the FRP BMP identification for this study.

2.2 MS4 Allocation of Flow Targets

Allocation of the high-flow flow targets between MS4 entities was approximated based on relative impervious ownership and impervious cover currently managed with a BMP which meets the Channel Protection Volume (CPv) design standard. This includes BMPs which detain the 1-year storm for 12-hours in cold-water fish habitat and 24-hours in warm-water fish habitat. However, there are limitations to this method because the BMPDSS model is an aggregate model, in which upstream BMPs affect downstream flow, and runoff doesn't necessarily follow political boundaries. A correction factor was applied based on the flow target to account for the relative error in separation of the BMPDSS results by MS4.

Approximately 34.9% of the impervious cover in the Sunderland Brook watershed is within the Town of Essex, 25.5% within the Village of Essex Junction, 36.6% of the Town of Colchester, and 3.1% in the VTRANS Right-of-Way (Table 2). The TMDL flow targets were then re-allocated to each MS4 based on their impervious ownership (Table 3).

Table 2: MS4 Impervious Breakdown

MS4 Impervious Owner	Total Area w/in Watershed (acres)	Impervious Area (acres)	% of Watershed Impervious Cover
University of Vermont*	----	----	----
Town of Essex	318.32	123.14	37.6%
Village of Essex Junction	173.58	86.5	26.4%
Town of Colchester	867.07	107.18	32.8%
VTrans	17.83	10.42	3.2%
Watershed Total	**1376.80**	**327.24**	
*Determined to not be an MS4 according to VT DEC and EPA for Sunderland.			

Table 3: Sunderland Brook TMDL Flow Target Allocation by MS4

MS4 Impervious Owner	Target High Flow Q 0.3 (%) **Reduction**[1]	Target Low Flow Q 95 (%) **Increase**[2]
University of Vermont	NA	NA
Town of Essex	-1.3%	1.3%
Village of Essex Junction	-0.9%	0.9%
Town of Colchester	-1.3%	1.3%
VTrans	-0.1%	0.1%
Watershed Total[3]	**-3.7%**	**3.6%**
[1] The High Flow target is negative (-), indicating there needs to be a reduction in high flow from the baseline condition. The Low Flow target is positive (+), indicating there needs to be an increase in low flow from the baseline condition.		
[2] The low flow target is not actionable under the TMDL, but is included in the assessment because improving base flow in the watershed is still a water quality goal.		
[3] Watershed delineation from file "Sunderland_post_watershed_101714"		

3 BMPDSS Model Assessment

The Vermont DEC worked with an external consultant to develop a VT-specific BMPDSS hydrologic model to predict progress toward the TMDL flow targets based on proposed BMP implementation scenarios. The BMPDSS model is used to predict peak flows at the watershed outlet for a base condition (pre-2002), existing condition (post-2002), and a future BMP implementation scenario, all compared on a percent change basis.

In order to complete the assessment, VT DEC developed "Base" condition models for all impaired watersheds. The base scenario includes all stormwater BMPs installed prior to issuance of the VT Stormwater Standards in 2002, and impervious cover extracted from Quickbird high-resolution satellite imagery. A "Post2002" model scenario was then developed with all existing BMPs designed to the VT Stormwater standards, providing credit toward the flow target. Results from the BMPDSS model output are provided as unadjusted cubic feet per second (cfs) and normalized flow (flow per drainage area, cfs/sq.mi). The unadjusted flow is used in the determination of progress towards the TMDL targets to eliminate the effect of watershed area in the percent change comparison.

3.1 Existing Condition Review

Permit Review

As per subpart IV.C.1 of the approved MS4 general permit, all expired stormwater permits in the watershed were acquired and reviewed for inclusion within the BMPDSS model assessment. The expired permits were sorted into two groups- Group 1) existing stormwater systems with a CPv BMP which provides extended detention of the 1-year design storm (Table 4), and Group 2) those without a CPv BMP (e.g. system of catchbasins with no outfall management). The Group 1 list was compared to the current BMP list included in the BMPDSS models to check for omissions. Only expired permit systems that include a BMP with CPv storage were included in the BMPDSS model, because only BMPs with CPv storage provide credit toward meeting the flow targets. Field assessments were then completed at each site with an existing CPv detention structure to determine if the practice was operating according to the approved expired permit and if there was opportunity for an upgrade to the 2002 Vermont Stormwater Design Standards. A full list of Expired Permits in each MS4's jurisdiction is included in Appendix 2 (Table A-2-1).

Table 4: "Group 1" Expired Permit Stormwater BMPs

Permit #	Project/BMP Name	MS4	BMP Type in BMPDSS	Ownership
1-1469	Mainstay Suites-Handy	Town of Essex	Detention Basin	Private
1-1143	Racquet's Edge drywell 2	Town of Essex	Dry Well	Private
1-1143	Racquet's Edge drywell 1	Town of Essex	Dry Well	Private
1-1527	Highland Village, 65-69 Pearl St.	Village of Essex	Infiltration Basin	Private
1-0674	Wall St- Shepard /Gardener Subdivision	Town of Colchester	Catch basins to 18" perforated PVC, with stone drain	Public
1-0959	Hidden Oaks 2	Town of Colchester	Dry Wells	Private/ Public
2-0762	Westbrook Condominiums	Town of Colchester	Infiltration Basin	Public

*Prepared by Emily Schelley (VT DEC 2014). Revised by WCA (2014)

3.1.2 VTDEC BMPDSS Existing Model Review

The team field-verified the drainage areas and design of the BMPs included in the Base and Post2002 model scenarios and compared the field observations to the DEC model inputs. Updated input files for the Base and Post2002 models were submitted to State DEC Stormwater Section Staff to run updated model scenarios. Input files included revised GIS shapefiles for subwatersheds, BMP locations, BMP drainage areas, as well as HydroCAD® (Version 10.0) model outputs used to model detention times and peak flows. Each BMP design was then converted to the equivalent system in the BMPDSS model, which has a slightly different interface for defining the BMP design than HydroCAD® . Adjustments were made to certain BMP designs, if the BMP design in HydroCAD® was not directly transferrable to the BMPDSS format. A full list of existing BMPs in the base and Post2002 model scenarios is included in Appendix 2 (Table A-2-2).

- Permit #1-1409 Champlain Valley Exposition Historical Drainage:

  It was confirmed as a part of the model review process that the historical drainage changes implemented at the Sunderland Brook headwaters on the Champlain Valley Exposition (CVE) Property were accounted for in the baseline model. The permit 1-1409 was issued in August of 2000 followed by implementation later that fall. The drainage changes included routing an area from Sunderland *to* Indian Brook in an effort to mitigate localized flooding issues around the Essex Automotive Area and the Kinney Drug store.

3.1.2.1 Base model (Pre2002 condition) Revisions

The Baseline condition model (Pre2002), including all BMPs installed after the 2002 stormwater standards was revised as follows:

- Removal of 49.52 acres from the Sunderland impaired watershed on the Camp Johnson property in the Town of Colchester based on field verification.
- Adjustments to subwatershed boundaries to reflect the latest infrastructure mapping near David Dr. Industrial Lot.
- Addition of dry wells at the Post Office Square and Essex Shopping Center on Pearl St.
- Addition of dry wells at the National Guard property along Academy Lane.

3.1.2.2 Existing Condition (Post2002) Model Revisions

The Post2002 existing condition model, including all BMPs installed after the 2002 stormwater standards was revised as follows:

- Addition of stormwater management improvements on Gary Morse's property on Morse Dr. (Constructed as of 2014)
- Addition of a new commercial building and stormwater chamber behind the existing Lowe's Store (#6993-INDS)
- Addition of voluntary stormwater management improvements at 17 Morse Drive.
- Addition of the proposed building under permit #5505-INDS was considered. This permit was for a day-care center behind existing lot 4A on David Dr. The project was determined to be unbuilt and on hold indefinitely, therefore the project was not added to the model.

3.1.2.3 Existing Conditions Model Results

The existing condition (Post2002) model was revised with two iterations resulting in an overall ***increase*** in progress toward the targets from the previous model prepared by VT DEC (Table 5). This is primarily due to changes in the Post2002 condition model, with the addition of several existing BMPs previously omitted. A full list of the existing BMPs in the Base and Post2002 models is included in Appendix 2 (Table A-2-2). The existing condition scenario includes 33 individual BMPs, each managing the 1-year design storm, 28 of which also provide groundwater recharge. The most up-to-date existing condition model scenario (as of 11/12/2014) was estimated to

provide a -7.91% reduction in high flow, calculated as a percent change between the unadjusted flow in the baseline condition (pre-2002) and Post2002 scenario, addressing **214%** of the TMDL high-flow (Q0.3%) target. The low-flow was estimated to increase by 2.08% over the baseline scenario, addressing **57.8%** of the non-actionable low flow (Q95%) flow target. The existing condition provides a 114% factor of safety over the baseline condition. The contributing MS4s are therefore not required to implement additional BMPs according to the modeling assessment. Biomonitoring of the streams will ultimately determine if the Sunderland Brook has reached attainment conditions in compliance with the Vermont Water Quality Standards.

Table 5: Existing Condition BMPDSS Model Assessment Results

Model Run	Description	High Flow **Reduction** (%)	Low Flow* **Increase** (%)	BMPDSS Model Run Date
TMDL Targets *Stormwater Allocation only		-3.7%	3.6%	----
DEC Existing Condition Model	DEC's existing model, includes all Post2002 BMPs	-7.10%	4.10%	1/31/2014
WCA Revised Existing Condition Model (7/31/2014)	WCA revised several subwatersheds, added two new BMPs to Post 2002 condition and revised several existing BMP design entries.	-6.14%	2.04%	7/31/2014
Percent of Target Managed (Existing Condition Model 7/31/14)		166%	56.7%	----
WCA Revised Existing Condition Model (11/12/2014)	WCA removed 49 acres from the base model condition, revised additional subwatersheds, added three infiltration BMPs to the base model, and two new infiltration BMPs to the Post2002 model.	-7.91%	2.08%	11/12/2014
Percent of Target Managed (Existing Condition Model 11/12/14)		**214%***	57.8%	----

*The second review of the existing model resulted in a larger percent difference between the unadjusted flow for the base and Post2002 conditions (-7.91% versus 6.14%). The model revisions included removing 49 acres from the watershed, and adding two significant existing infiltration systems at Post Office Square, Essex Shopping Center and Academy Lane. As a result the base condition unadjusted flow at the watershed outlet was significantly lower than in the previous run (7/31/2014). Two additional Post 2002 infiltration systems were added to the 11/12/14 model, which resulted in a greater difference between the base and Post2002 model scenarios, than for the 7/31/2014 model run. As a result, the Percent of Target Managed increased from 166% to 214% between model runs.

4 Required Controls Identification

The process of BMP identification was initiated with a field assessment on June 26th and 27th of existing CPv BMPs covered by an expired permit to assess the opportunity for upgrade potential to VT 2002 Stormwater Management Manual design standards. During the initial field assessment with the Town and Village of Essex Partners, the team also visited several sites identified by the Town and Village as potential future retrofits. An additional field visit was

completed with the Town of Colchester to identify existing BMPs not previously accounted for on the Camp Johnson Property, as well as opportunities for retrofits. The team then conducted a desktop assessment of the watershed to identify open spaces ideal for BMP implementation with priority on municipally-owned land. In addition the spatial distribution of BMPs was considered to provide storage throughout the watershed. Potential site selection focused on areas with a high-percentage of impervious coverage where flows were expected to be highest and where infiltration was possible.

After an initial list of retrofits was identified, a follow-up field assessment was completed at each site documenting the preliminary engineering feasibility of each retrofit and mapped drainage area for the proposed BMPs. The BMPs were then designed using HydroCAD® to meet the CPv storage criteria for cold waters (12-hour detention standard). The initial model iteration, "Credit 1" scenario, was followed by subsequent iterations of the proposed model in which additional proposed BMPs were added to meet the flow targets.

BMP feasibility was determined based on available space, mapped NRCS soils, existing 1-ft topographic elevation contours derived from LIDAR, and mapped stormwater and wastewater infrastructure provided by the Town, Village, and VTRANS. Supplemental survey data was collected for the top 4 priority projects as needed. An in-depth engineering assessment will still be required at each site to confirm the presence/absence of utilities, natural resource constraints, and potential transportation impacts, as part of the final design process.

Once the final list of proposed BMPs was determined to meet the flow targets, the projects were ranked using a comprehensive ranking matrix, as detailed below in section 5-5. Four (4) projects were selected from the top ranked projects with a preference to include plans for Town and Village projects. The team prepared 30% preliminary engineering designs for the four projects and orthophoto-based sketch plans for all other projects, provided in Appendix 1. The top four projects include:

- **Tracy Rd:** Infiltration Basin at the VTRANS Garage on Tracy Rd (Town of Colchester/VTRANS)
- **Outfall 126:** Outfall 126 at Fort Ethan Allen Retrofit with Underground Infiltration Chamber (Town of Essex)
- **Outfall 31**: Outfall 31 on Morse Dr.- Retrofit with Infiltration Gallery (Town of Essex)
- **Outfall 199**: Outfall 199 on Morse Dr.- Retrofit with Infiltration Basin in the ROW (Town of Essex)

4.1 BMPDSS Model Assessment Results

While the existing condition model scenario meets the high-flow target, a list of possible BMPs was developed for future implementation in the event conditions in the watershed change from what is present today or it is determined that additional management is needed based on biomonitoring results. The final proposed BMP list was developed based on two iterative assessments. The first "Credit1" scenario included seven (7) potential new projects including three (3) new infiltration basins, three (3) new underground retention chamber systems, and one

(1) green stormwater infrastructure (GSI) practice (Appendix 3-Table A-3-1). In combination with the existing BMPs designed to 2002 Vermont design standards, the proposed projects were estimated to provide a -12.86% reduction in the high flow (Q0.3%), addressing **348%** of the high-flow target (Table 6). The second "Credit2" run included the addition of an infiltration BMP at David Dr. and revisions to Outfall 126/Fort Ethan Allen. The "Credit2" run exceeded the baseline condition by **482%**. Sunderland has mostly Hydrologic Soil Group A and B soils, therefore the addition of new BMPs has a significant impact on the estimated high flow reduction in the BMPDSS.

Table 6: BMPDSS Model Runs Summary for Proposed FRP Scenario

Model Run	Description	High Flow[1] **Reduction** (%)	Low Flow[2] **Increase** (%)	BMPDSS Model Run Date
TMDL Targets *Stormwater Allocation only		-3.7%	3.6%	----
Existing Condition Model (11/12/2014)	Addition of several existing BMPs. Remove 42.8 acres.	-7.91%	2.08%	11/12/2014
Percent of Target Managed (Existing Condition Model 11/12/14)		214%	58%	----
Credit1 Proposed Model	Addition of proposed BMPs	-12.86%	6.25%	11/13/2014
Percent of Target Managed (Credit1 run on 11/13/14)		348%	174%	----
Credit2 Proposed Model ***"Proposed FRP Scenario"***	Added David Dr. BMP, and update Outfall 126 BMP	-17.85%	8.33%	1/16/2015
Percent of Target Managed (Credit2 run on 1/16/15)		**482%**	**231%**	----

[1] The High Flow target is negative (-), indicating there needs to be a reduction in high flow from the baseline condition. The Low Flow target is positive (+), indicating there needs to be an increase in low flow from the baseline condition.
[2] The low flow target is not actionable under the TMDL, but is included in the summary because improving base flow in the watershed is still a water quality goal.

4.2 Proposed FRP Model Scenario

The final recommended BMP list is represented in the "Credit2" model run, which includes eight (8) proposed BMPs (Table 7). The proposed FRP scenario addresses **482%** of the modified high-flow target, providing a significant factor of safety (FOS). The additional FOS is included in the recommended BMP list to provide the MS4s additional options in the event conditions in the watershed change from what is present today.

The **individual and cumulative percent of the high-flow target mitigated** is also included in Table 7, calculated based on the CPv volume storage and the BMPDSS model run result ("Credit2" run). The individual and cumulative percent mitigated allows for a quick understanding of the relative benefit of each BMP toward meeting the high-flow target. The CPv volume is used as an indicator of the percent mitigated because it was determined by VT DEC that the high-flow (Q0.3%) is

approximately equivalent to the 1-year storm peak discharge. Essentially, the high-flow is directly reduced in the model by mitigating the CPv volume.

The "Cumulative Percent of Target" addressed allows the MS4s flexibility in the event one of the top projects is determined infeasible and the projects need to be rearranged. The TMDL requires that 100% of the high-flow target be addressed. The ultimate determination for implementation of projects providing benefit beyond the high-flow target (> 100%) will be made by the State based on monitoring data or other relevant information (MS4 General Permit Sec. IV.J.3). Progress toward the TMDL flow targets with the proposed FRP scenario was allocated by MS4 to determine the extent to which the proposed BMPs addressed each **MS4s allocated responsibility** of the flow targets, summarized in Table A-3-2 (Appendix 3).

5 Proposed Implementation Plan

The proposed BMPs are summarized in Table 7, including the impervious cover treated, overall drainage area, and CPv volume storage estimated by the HydroCAD® design model. A map of the proposed BMP locations is included in Appendix 4. The **individual and cumulative percent of the high-flow target mitigated** is also included in Table 7, calculated based on the CPv volume storage and the BMPDSS model run results. An additional table is included in Appendix A-3-1, which separates the projects by the model run to which the project was first added (Credit 1 or Credit 2).

Table 7: Final Proposed BMPs for the Sunderland Brook FRP

Site Name (*Note)	MS4 owner of impervious draining to practice	Ownership of Land where BMP is located	BMP Type (*Key)	Permit #	Drainage Area, DA (acres)	Imp Acres Managed (ac)	Channel Protection Volume (CPv) Managed above Base Condition*		Percent of High-Flow Target Managed %	***Cumulative* Percent of High-Flow Target Managed %**	Retrofit Description
							CF	Ac-ft			
Existing Post2002 BMPs	Varies	Varies	Varies	---	---	74.53	213792	4.908	214%[1]	214%	Varies
Tracy Rd. -Fort Ethan Allen-	VTrans/Colchester	VTRANS	IB	6363-INDS	4.97	3.94	18513	0.425	36%	249%	Long Infiltration Trench/Bioretention
Outfall 126: Fort Ethan Allen	Town Essex/UVM	Public (Town/ UVM)	UIB	NP	20.42	9.84	25134	0.577	48%	298%	Excessively eroded outfall. Constrained by UVM property. Proposed infiltration basin with perforated pipe within existing terraced area upslope the channel.
Outfall 31-Morse Dr.	Town Essex	Private	UIB	NP	4.98	3.56	12937	0.297	25%	323%	Replace pipe and add infiltration gallery.
Outfall 199-Morse Dr.	Town Essex	Private	UIB	NP	8.18	5.18	5924	0.136	11%	334%	Retrofit roundabout upslope from outfall with infiltration practice.
Route 15/Pearl St.	Village of Essex	Private	UIB	2-0950	4.25	2.32	3877	0.089	7%	342%	Redirect Route 15 Stormline to Underground Infiltration BMP.
Forman Dr. Roundabout	Colchester	ROW	IB	NP	3.14	1.34	2047	0.047	4%	346%	Infiltration on edge of existing roundabout. Assess stability of slope as part of project feasibility.
Kimberly Drive (O3, O4)	Town Essex	Private	IB	1-0250	33.06	7.90	9997	0.230	19%	365%	Infiltration basin at outfall.
David Dr. Outfall	Town Essex	ROW	UIB	1-0896, 1-0552, 1-1463	32.21	15.96	61028	1.40	118%	482%	Underground infiltration basin in roundabout up the stormline from the existing outfall.
					TOTAL:	**50.04**		**3.20**			

1. See Table 6. The existing BMP DSS model run estimated 214% of the flow target is addressed with existing BMPs.

*Note: All projects except David Dr. Outfall were included in Credit 1. David Dr. Outfall was added to the Credit 2 run.

*Key: BMP Type: DB: Detention Basin, USC: Underground/Covered Storage Chamber, UIB= Underground Infiltration Basin, IB= Vegetated Infiltration Basin

* Channel Protection Volume Managed above Base condition = New Storage Volume - Existing Volume pre2002

5.1 Town of Colchester/VTRANS Proposed BMP

Tracy Rd/VTRANS Garage

The VTRANS Garage, located off Tracy Rd. in the Town of Colchester, was identified as a retrofit opportunity. The project would involve a retrofit of the existing grass swale on the VTRANS site along Tracy Road. The existing grass swale and attached stormwater system collects drainage from the VTRANS garage site and also from Barnes/Troy Ave. The existing swale would be expanded and a 2 foot deep stone infiltration gallery would be added under the surface. The surface would remain as grass and riser pipes would connect drainage into the deeper stone gallery for easier maintenance. The existing fence would need to be moved closer to the road (Figure 1). This project would benefit high and low flow targets as well as improve water quality discharge from the site.

Figure 1: Existing Dry swale at VTRANS Garage, proposed for retrofit.

Since the contributing drainage comes from the Town of Colchester and VTRANS impervious, a cost share could be set up to allocate resources. On a runoff volume basis, the Town of Colchester contributes 0.195 ac-ft versus 0.23 ac-ft from VTRANS owned land. The split is about 46%/54%.

5.2 Town of Colchester Proposed BMP

Forman Dr.

A neighborhood in the North East region of the watershed, along Forman Dr., was identified as a good opportunity for retrofit. The project would involve retrofitting the existing center island, into a bioretention practice with a deep stone gallery for additional storage. A 3.14 acre area drains to an existing outfall, which would be routed to the center island via a flow splitter, sending the 1-year storm to the practice and high-flows to the existing outfall. Feasibility of maintaining the existing spruce tree in the center island will be investigated, if the project moves to implementation.

Figure 2: Forman Dr. Center Island (Photo Credit: Google Earth)

5.3 Town of Essex Proposed BMPs

Outfall 126- Fort Ethan Allen

The Fort Ethan Allen Property in the Town of Essex is owned by the University of Vermont, with the exception of the road and stormwater collection system, which is owned by the Town of Essex. The Fort was identified as a priority retrofit due to evidence of significant erosion on the bank at the confluence of three stormwater outfalls (Town O126, O125, O124), draining approximately 21.22 acres of residential area.

Figure 3: Additional view of eroded channel at Outfall 126, and bank destabilization.

Several alternative options were investigated for this site. The first option was to construct a detention basin in the existing gully, collecting runoff from all three outfalls. This option would require a portion of UVM owned land, which UVM has set aside for future build-out capacity.

The second option was to create two retrofit systems. One system would mitigate the 1-year storm runoff volume from a 3.13 ac area of Dalton Dr. via a new dry well on the South side of Dalton Drive. Overflow would bypass the practice and drain to the existing collection system and enter the channel via Outfall 126. The second system would include an underground storage chamber installed at the intersection of Ethan Allen Ave. and Ryan St. to store the 1- year storm volume from a 6.57 ac area, with a high-flow bypass to Outfall 126. The erosion in the existing channel would also be stabilized. While this option would avoid using UVM land, there is concern of significant utility issues under the roadway, potentially limiting project feasibility.

The third option assessed, which was selected for 30% design, includes an infiltration basin in the terraced area just uphill of the existing gully, with a network of perforated pipe to increase storage capacity. The system would manage up to the 100 year storm volume from the existing collection system draining to Outfall 126, as well as a new catch basin along Winooski Rd. A separate dry well for the Dalton Dr. drainage is proposed. In addition, the existing catch basin in the UVM owned grass field will be cut off and replaced with a dry well. This option would likely be the most cost effective. Additionally, the work to stabilize the existing erosion in the gully can be completed concurrently to this retrofit alternative, rather than as a separate project.

Outfall 31- Morse Dr.

Figure 4: Outfall 31

Morse Storage, located at 6 Morse Dr. in the Town of Essex was identified as an opportune location for a retrofit given that the site has participatory owners, is an area of concentrated impervious, and has soils with acceptable infiltration capacity. The proposed retrofit would involve construction of a six foot deep infiltration gallery at the end of the stormwater collection system in the storage facility's back parking lot. A porous strip at the back edge of the lot will be the inlet for a portion of surface flow. The rest of the flow will enter the infiltration gallery via an existing 15" subsurface stormline. The outlet to the system will be maintained as the existing outfall (Town Outfall 31). The project will address the CPv volume storage and provide water quality treatment.

A project on the property just North of 6 Morse Dr., owned by Gary Morse has been constructed to provide infiltration of runoff from about ¼ of the site. This project was accounted for in the design of the Outfall 31 project.

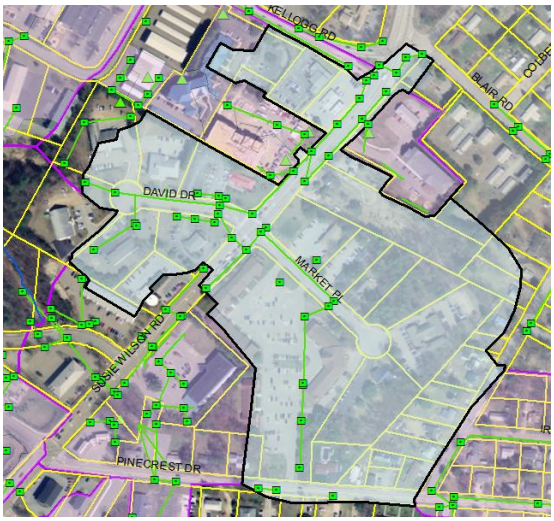
Outfall 199- Morse Dr.

Outfall 199, located off Morse Dr., was identified as a good opportunity for a retrofit to reduce runoff from a 5.92 acre commercial area. There is a roundabout at the end of Morse Dr. with a single catch basin, which offers an opportunity to remove impervious surfaces and add a bump-out infiltration trench. The trench surface would be left as stone to reduce maintenance requirements. The practice would require a portion of private land outside of the ROW.

Figure 5: Retrofit proposed in ROW at end of Morse Dr., upslope of Outfall 199.

David Dr. Outfall

The David Dr. outfall was identified as a priority retrofit site, given the connectedness of the drainage area and evidence of erosion and destabilization of the bank at the outfall. In addition the drainage area includes three expired permits; #1-0896, 1-0552, and #1-1463. The site is characterized by a very deep ravine, a deep outlet pipe and limited right of way at the top of the slope to install an infiltration gallery. The limited right of way is bounded by commercial properties and existing businesses where added land may not be easily available for construction of an infiltration chamber.



Kimberly Drive

A portion of the existing residential neighborhood along Kimberly Dr. is covered under expired permit #1-0250. Two outfalls at the end of Kimberly Dr. and Parizo Dr. were identified as a retrofit opportunity to route two Town outfalls to a single flow-mitigation practice. A retrofit project at this site was studied by UVM Civil Engineering Students in 2007, which involved site investigation, soil testing, survey, and design. The findings from their final report were reviewed and considered.

Figure 7: Kimberly Dr. Outfall

The UVM design recommended a detention pond with a reinforced berm constructed in the existing channel. The design included a seven foot deep pond with a two foot permanent pool to store the water quality volume. Alternative designs were assessed for the site instead of a pond, including an open infiltration basin with surface ponding for larger storms, an expanded underground stone gallery, and an underground chamber system using StormTech SC-740 chambers for CPv mitigation.

The StormTech system was selected as the proposed retrofit design because of the reduced footprint required as compared to the infiltration gallery and pond alternatives. The proposed practice would be located in the terraced area just at the end of the Parizo Dr. ROW. Two flow splitters would route the CPv volume (1-year storm) to the proposed chamber system, with high flow bypass via the existing 24" Kimberly Dr. outfall. Infiltration out the bottom of the chamber system to the native sandy soil would be allowed, based on the soil assessment completed by Lamoureux and Dickinson (L&D) for the nearby Pinecrest Sewer project and confirmed by the UVM study.

5.4 Village of Essex Junction - Proposed BMP

Route 15/Pearl St

The parking lot of Contois School of Music was identified as a possible retrofit opportunity for an underground storage chamber. Upon initial review of the mapped infrastructure the storm line crossing through the parking lot and entering the stream to the North appeared to drain a significant portion of Route 15. After field verification of the site the drainage area for the Village Outfall was remapped and determined to drain much smaller area (4.25 acres) of Route 15/Pearl St.

Figure 8: Contois School of Music Parking lot, proposed location of underground infiltration basin.

The proposed retrofit would mitigate the 1-year storm volume with a high-flow bypass via the existing outfall. Water quality benefit is provided through infiltration. Infiltration would be allowed from the chambers, determined based on the NRCS mapped soils (Hydrologic Soil Group A). The project would require acquisition of approximately 0.034 acres of land.

5.5 Watershed-Wide Project Ranking

A comprehensive ranking matrix was developed in order to rank the proposed projects based on a multitude of criteria grouped into four general categories including:

Category	ID	Criteria
Cost/Operations	A	Relative Project Cost
	B	Ease of O/M
Project Design Metrics	C	Impervious Acres Managed (ac)
	D	Channel Protection Volume (CPv) Mitigated, (i.e. 1-year Storm)
	E	Volume Infiltrated (ac-ft)
	F	Water Quality (WQ) Volume Control
	G	Primary or Secondary BMP
Project Implementation	H	Permitabilty
	I	Land Availability
Category	**ID**	**Criteria**
Other Project Benefits	J	Flood Mitigation (Is existing flooding issue mitigated by project?)
	K	TMDL Flow Target Addressed (Q03, Q95)
	L	Lake Champlain Phosphorus TMDL Metrics Met*
	M	Other Project Benefits/Constraints (Educational, Infrastructure Improvement, Unknown Feasibility)
*For now the Lake Champlain Phosphorus TMDL criteria is a placeholder, until the final TMDL is approved and the compliance metrics are outlined.		

Values for each criteria were identified and assigned a relative score so the projects could be ranked based on a total score. A secondary set of Water Quality criteria were added to the matrix, to rank the BMPs on water quality benefits, using the Source Loading & Management Model (WinSLAMM). WinSLAMM is a very robust, field verified and calibrated model that can accurately predict pollutant loading and BMP effectiveness. WCA modeled the BMPs using WinSLAMM and quantified the annual total suspended soilds (TSS) and total phosphorus (TP) reductions in loads of pollutant per year. Ranges for the TSS and TP removals were identified, and assigned a score of 0-6 points, 6 being the greatest benefit. The final ranking of proposed projects is included in Table 8 below. The criteria key (Table A-5-1), scoring key (Table A-5-2) and the full matrix spreadsheet (A-5-3) are included in Appendix 5. A separate table with the phosphorus and TSS loading reductions for each proposed BMP is provided in Appendix A-5-4.

Table 8: Ranked Proposed FRP BMPs based on comprehensive ranking matrix

Site ID	BMP Type*	Retrofit Description	Total Score
David Dr. Outfall	UIB	StormTech infiltration Chamber system at end of David Dr.	39
Outfall 126: Fort Ethan Allen	UIB	Excessively eroded outfall and channel. Constrained by UVM property. Proposed infiltration basin with perforated pipe within existing terraced area just upslope of the channel.	37
Outfall 31- Morse Dr.	UIB	Infiltration stone gallery at end of pipe.	33
Tracy Rd. -Fort Ethan Allen	IB	Long Infiltration Trench/Bioretention	30
Kimberly Drive (O3, O4)	UIB	StormTech infiltration chamber system at end of Parizo Dr.	30
Outfall 199-Morse Dr.	UIB	Retrofit roundabout upslope from outfall with infiltration practice in ROW. Wetlands near outfall.	29
Route 15/Pearl St.	UIB	Redirect Route 15 Stormline to underground infiltration chambers.	26
*Key: BMP Type: DB: Detention Basin, USC: Underground/Covered Storage Chamber, UIB= Underground Infiltration Basin, IB= Vegetated Infiltration Basin			

6 Design and Construction Schedule

A Design and Construction (D&C) schedule is a required element of the final approved Flow Restoration Plan, outlined for implementation of the proposed FRP over a 20-year timeframe. In Sunderland Brook, the TMDL high-flow target is currently met with existing BMPs, therefore no BMPs are required for implementation. While no new BMPs are required, the proposed BMPs would improve water quality in the watershed. Therefore, a D&C schedule will be prepared as a part of the final FRP, prioritizing the projects for implementation by their flow restoration benefits. Time for acquisition of necessary permits and/or regulatory approvals, as well as limitations of MS4s financial resources on an annual basis will be considered as well.

The flow restoration targets are subject to adjustment by the Secretary, as specified in section IV.C.1.e.3 of the MS4 permit, based on biological monitoring data and/or other confounding information concerning flow reduction progress. Adjustments to the flow targets may impact the schedule and full implementation of the proposed projects.

7 Financial Plan

Subject to the requirements of the MS4 permit, a financial plan is required as a part of the FRP which demonstrates the means by which the plan will be financed, as well as BMP cost estimates. The TMDL is a watershed-wide reduction in the high-flow, and therefore the proposed BMPs are located throughout the watershed. MS4 permittee ownership was considered in the identification of projects. The plan strives to identify BMPs with a sole MS4 owner. Optimal BMP locations did not always follow property boundaries however. For joint ownership projects, the funding responsibility will be negotiated between the involved MS4s.

Town and Village of Essex Junction Stormwater Program Consolidation:

The Town of Essex and Village of Essex Junction Department of Public Works (DPW) decided to consolidate their Town and Village stormwater budgets, as a result of watershed-wide improvement efforts required under the MS4 permit and FRP implementation plans for Indian and Sunderland Brook. The Village and Town storm water activities budgets will be combined into the Town stormwater budget in the Town General Fund. The Town General Fund tax will be used to pay for the service to combine the programs. This merge will avoid duplication of effort and achieve cost savings. Furthermore, the Town and Village previously formed a joint Storm Water Coordinating Committee (SWCC), in the effort to more easily work collectively to develop the watershed-wide FRPs for Indian and Sunderland Brook. The consolidation of the Village and Town budgets provides the SWCC with a financial framework to directly fund FRP projects with joint MS4 responsibility and address current and future permit compliance requirements. Costs will be less under the consolidated, versus separated, program.

The SWCC will determine additional costs for FRP projects on an annual basis to be funded by the combined stormwater activities fund. In the future the SWCC can also recommend to the Village Board of Trustees and the Town Selectboard that a separate charge or fee be developed to cover the costs for stormwater permit compliance and program management, in addition to the Town General Fund.

Town of Colchester: The Town of Colchester has a dedicated Stormwater Program funded by the Town property tax general fund. Stormwater projects are managed and funded through this resource. Colchester is considering the development of a utility fee in the future.

MS4 Funding Sources: The main funding source for the Town of Essex Junction and Village of Essex Junction stormwater projects will be the Town General Fund Tax, paid by taxpayers within the Town and Village. The Town of Colchester will also fund FRP related stormwater projects through their property tax general fund. VTRANS will utilize their budget funds for stormwater-related projects. Several additional funding sources that may be available for larger projects, which may need to be phased over several years, include the Clean Water State Revolving Fund (CWSRF) program and Municipal Bond bank funds.

7.1 BMP Cost Estimates:

Itemized cost estimates were developed for the four top priority projects based on 30% preliminary engineering plans, detailed below. For all other projects a modified spreadsheet method was used as detailed in section 7.1.2.

7.1.1 Itemized Cost Estimates:

The itemized cost estimates for Outfall 126 and Tracy Rd were estimated using a combination of the VTRANS estimator program, RS Means, and local values based on the 30% engineering plans. The full itemized cost estimates are included in Appendix 6. The cost estimates are based on the following criteria:

- **Construction Cost**: The construction costs were developed based on using both VTRANS five year average costs, VTRANS' Estimator Program, and RS Means (where applicable) and vendor estimates as necessary for each of the itemized units.
- **Construction Contingency**: The construction contingency is calculated as 15% of the construction cost.
- **Final Design Engineering**: The final design engineering cost is estimated based on the State Fee Curve Allowance as developed by VT DEC. The equations used are as follows:
    - For construction costs less than $780,000:
        - Construction cost = $1,950+(Construction cost *0.069)
    - For construction costs greater than $780,000:
        - Construction cost = (Construction cost^0.9206)*0.6788*0.30.
- **Construction Engineering**: The construction engineering cost is based on the State Fee Curve Allowance as developed by VT DEC. The equations used are as follows:

  - For construction costs less than $780,000:
    - Construction cost = $3,575+(Construction cost *0.1265)
  - For construction costs greater than $780,000:
    - Construction cost = (Construction cost^0.9206)*0.6788*0.55.
- **Other costs:** These costs are established based on simple percentages of the construction cost for the project as follows:
  - Administrative = 0.5%
  - Easement Assistance = 1.5%
  - Land Acquisition =$120,000 per acre for projects on private land (*Value estimated by local Town Assessor)
  - Legal = 5%
  - Bond Vote Assistance = 0.5%
  - Short Term Interest = 2.5%.

7.1.2 Cost Estimates Using Spreadsheet Method:

For all other projects, a spreadsheet cost estimation tool was developed based on guidance from the US EPA and Center for Watershed Protection (CWP) for stormwater retrofit projects. All estimates were calculated as a base construction cost plus a 30% contingency factor for final design and permitting, site specific factors, and land cost, if applicable. The base cost was estimated on a unit cost basis, using a specified design volume (cu. ft) multiplied by a unit cost ($/cu. ft). Due to the variability in retrofit projects and application of general unit cost values, adjustment factors were applied based on cost research by the CWP and professional engineering judgment. **The cost estimates presented are based on typical values and may vary due to site specific challenges and unforeseen land acquisition costs.**

Unit Costs: Base construction costs were estimated using unit costs, summarized in Table 10 below. Unit costs for existing **pond retrofits, new storage retrofits, and Green Stormwater Infrastructure practices (planters, bioretention, etc.)** were acquired from cost research completed by the Center for Watershed Protection, derived from a synthesis of real retrofit practice construction costs [1] (Table 9). For **underground storage chambers** a unit cost for StormTech MC-3500 chambers was used, accounting for the cost of the chambers and additional site work.

Table 9: Unit Costs for Different BMP Types

BMP Type	Unit Costs ($/cu. ft)
Pond Retrofits	$3
New Storage Retrofits	$5
Underground Chamber Systems (StormTech MC-3500)	$11
Green Stormwater Practices (i.e. Bioretention)	$8

[1] Schueler, T., Hirschman, D., Novotney, M., Zielinski, J. 2007. Urban Stormwater Retrofit Practices Appendices: Urban Subwatershed Restoration Manual Series. Center for Watershed Protection, Ellicott City, MD. Appendix E. Table E-4.

Adjustment factors were applied depending on the type of retrofit. An adjustment factor of 0.5 was used for a pond retrofit involving an upgrade to the outlet structure and basic site work[1]. The CWP found retrofits in developed areas to be one and half to two times more expensive than a new storage practice, and sometimes as great as six times more, due to the higher chance of utility conflicts, space restrictions, additional permitting costs, and/or sensitive site conditions. Engineering judgment and past project experience was used to assign the appropriate adjustment factors.

Storage Volume: The unit costs were multiplied by a design volume (cu. ft), based on a storage volume required. The 100-year storm storage volume was used for above-ground detention and infiltration basins, while the 1-year storm (CPv) storage volume used for underground chamber systems. Underground chamber systems were designed as offline practices, which means only the 1-year storm was routed to the practice. Higher flows were diverted from the system using a flow splitter. Storage volumes were estimated using the HydroCAD® model.

Design and Permitting Contingency: A 30% design and permitting contingency factor was applied, based on cost research provided by the EPA[2] , which found that a typical cost for design and permitting was approximately 30% of the base construction costs.

Land Acquisition Costs: For sites on private land, in which the municipality would need to acquire ownership, an estimate was included based on a general cost of $120,000 per acre. This is based on an Assessors value from a local City.

Table 10, below, includes a summary of the project cost estimates

[2] U.S. Environmental Protection Agency (EPA). 2006. Preliminary Data Summary of Urban Stormwater Best Management Practices, Maryland, MD. Chapter 6. Costs and Benefits of Stormwater BMPs. EPA-821-R-99-012

Table 10: Proposed BMPs Cost Estimates

BMP ID	Impervious acres	Storage Volume		Unit Cost[3]	Retrofit Adjustment	Construction Cost[1]	Site-Specific Costs	Land Owner	Land Cost	Design and Permitting Cost (30%)	Total Project Cost[2]
		acft	cft								
Tracy Rd. -Fort Ethan Allen-	3.94	0.49	21500	30% Cost Estimate							$ 100,000
Outfall 126: Fort Ethan Allen	9.84	0.19	8451	30% Cost Estimate							$ 390,000
Outfall 31-Morse Dr.	3.56	0.31	13335	$5	1.50	$ 100,000		Private	$ -	$ 30,000	$ 130,000
Outfall 199-Morse Dr.	5.18	0.08	3267	$5	1.50	$ 24,500		Private/ Town of Essex	$ 4,320	$ 7,400	$ 36,200
Route 15/Pearl St.	2.32	0.06	2396	$11	1.50	$ 39,500		Private	$ 4,080	$ 15,800	$ 55,500
Forman Dr. Roundabout	1.34	0.05	2047	$19	1.50	$ 58,400		Town of Colchester ROW	$ -	$ 17,500	$ 75,900
Kimberly Drive (O3, O4)	7.90	0.45	19515	$11	1.50	$ 322,000		Private/ Town of Essex	$ 49,200	$ 96,600	$ 467,800
David Dr. Outfall	15.96	0.80	34804	$11	1.50	$ 574,300	$ 20,000	Private/ Town of Essex	$ 33,800	$ 172,300	$ 800,400
	50.04									**Project Total:**	$ 2,072,800

[1] Construction Cost = (Storage Volume*Unit Cost*Retrofit Adjustment)

[2] Total Project Cost = Construction Cost+ Land Cost + Site-Specific Cost + Design & Permitting Cost

[3] Unit Costs were derived from cost research completed by the CWP on stormwater retrofit projects. Pond Retrofits = $3/cu.ft, New Storage Retrofits = $5/cu. ft, Underground Storage systems = $11/cu. ft, Green Stormwater Infrastructure(GSI) = $8/ cu. ft (Schueler, T., Hirschman, D., Novotney, M., Zielinski, J. 2007. Urban Stormwater Retrofit Practices Appendices: Urban Subwatershed Restoration Manual Series. Center for Watershed Protection, Ellicott City, MD. Appendix E. Table E-4)

8 Regulatory Analysis

Town of Essex and Village of Essex Junction:

Under the joint Storm Water Compliance Committee (SWCC), the Town and Village have developed an expired permit compliance ordinance. The latest update to the Town of Essex Title 10.20 Stormwater Ordinance is included in Appendix 7. The ordinance outlines the types of stormwater permits within Sunderland Brook based on varying ownership. For each permit type the corresponding procedure for how the Town and Village has dealt with that permit type in terms of permit responsibility and maintenance of the permitted stormwater infrastructure is included.

As part of this plan, retrofits are being proposed on sites tied to an expired State operational stormwater permit. The ordinance outlines the options for private permittees to either have their permit adopted under the MS4 permit, or to request coverage under a Residual Designation Authority (RDA) permit from the State. The decision as to how the responsibility for the proposed retrofit projects on private land are covered in the future will be subject to discussion and agreement with the private landowners and the MS4 according to the approved Stormwater Ordinance. A list of expired permits within the Sunderland Brook impaired watershed is included in Appendix A-2-1, including whether the existing BMP is proposed for a retrofit under the FRP.

Town of Colchester:

In the Town of Colchester, there are seven expired permits within the Sunderland Brook Impaired watershed. Of the seven expired permits, four were determined to be strictly publicly owned stormwater systems. Two were determined to have shared public and private ownership. For the shared jurisdictions, the Town determined the stormwater infrastructure was within the right of way (ROW) or on a Town easement and accepted the permitted stormwater systems as the Town's responsibility for maintenance. For the two privately owned permits including 1-1609 Westbury Mobile Home Park (MHP) and 2-0843 Pheasant Woods, the Town contacted the property owners about the MS4 permit requirement and referred them to the VT ANR to exercise their RDA authority. This will require the private permittee to take on the responsibility of applying for RDA coverage and the O&M of the permitted stormwater system.

Morehouse Brook FRP

MOREHOUSE BROOK FLOW RESTORATION PLAN

Stone Project ID: 13-239

December 31, 2017

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STONE ENVIRONMENTAL INC

ACKNOWLEDGEMENTS

This project was performed by Stone Environmental, Inc. and Aldrich + Elliott, PC under contract with the City of Winooski.

DISCLAIMER

The intent of this document is to present the data, evaluations, alternatives, preliminary designs and opinions of probable costs needed to support the development of a flow restoration plan for Morehouse Brook, as required by the National Pollutant Discharge Elimination System (NPDES) General Permit 3-9014 (VTDEC 2012) for stormwater discharges to impaired waters from municipal separate storm sewer systems (MS4). The presented plan is in draft form and, at this time, the MS4s are not bound in any way to the proposed BMP list.

EXECUTIVE SUMMARY

Stone Environmental, Inc., and partner Aldrich + Elliott, PC (A+E), were retained by the City of Winooski to develop a Flow Restoration Plan (FRP) for Morehouse Brook. The FRP was developed in accordance with the MS4 General Permit (3-9014), subpart IV.C.1. The purpose of the FRP is to serve as a planning tool for the MS4 entities in the Morehouse Brook watershed (the City of Winooski and the Town of Colchester) to implement stormwater Best Management Practices (BMPs) in an effort to return Morehouse Brook to its attainment condition.

In developing the FRP, an assessment was completed to determine to what extent current stormwater controls have reduced high flows (e.g., flows occurring less than 0.3% of the time) from the pre-2002 conditions as required by the *Total Maximum Daily Load [TMDL] to Address Biological Impairment in Morehouse Brook* (VTDEC 2007). The Best Management Practice Decision Support System (BMP DSS), a GIS-based hydrologic model used to assess the impacts of various BMP scenarios while developing the TMDL, was used to evaluate the impact of current stormwater controls on high flows in Morehouse Brook.

According to the review completed under this contract, Morehouse Brook is much closer to meeting its attainment condition than it was when the TMDL was prepared, largely as a result of the diversion structure installed in the Malletts Bay Ave. storm sewer (sometimes referred to as the Brookside Diversion), which diverts storm flow from more than 65 acres of the watershed directly to the Winooski River. Other practices implemented since preparation of the TMDL include improved BMPs in the Highland Industrial Park, as well as several smaller BMPs implemented by the City of Winooski within their right-of-way.

In addition, as part of this review, a comprehensive evaluation was completed of the future growth allocation contained in the TMDL. This is important because the TMDL requires reductions from currently developed areas that are equal to the future impacts of new impervious surfaces that are not subject to State of Vermont stormwater permitting requirements (and therefore are considered “non-jurisdictional”). The TMDL currently assumes 10 acres of future growth in non-jurisdictional impervious surfaces. Using recent land use trends, our analysis shows that a net increase of less than one acre is a more reasonable estimate of non-jurisdictional impervious surface likely to be constructed between 2010 and 2025.

A suite of potential BMPs and retrofit projects were identified as part of FRP development, including:

- Two stormwater infiltration basins in Landry Park;
- Green stormwater infrastructure (GSI) practices in the neighborhoods along and to the west of North St. (e.g., Dufresne Dr., Brisson Ct., Cedar St.);
- A retrofit of the existing detention pond servicing the Pine Grove neighborhood; and
- A new bioretention area to the west of Brisson Ct.

Sketch plans were developed for each of the potential BMPs and retrofit projects and presented to the MS4s. The infiltration basins in Landry Park and GSI practices within the City’s existing right-of-way (ROW) along Brisson Ct. and southern Cedar St. were prioritized for implementation. These projects could be accomplished wholly within land already owned by the City, and were determined to be sufficient to meet the high-flow target when assessed with the BMP DSS model. A 30% engineering design and planning level cost estimate was prepared for the infiltration basins, while a spreadsheet cost calculator was used to estimate the cost of the GSI practices and the Pine Grove pond retrofit.

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1. BACKGROUND

Morehouse Brook drains a small, highly urbanized 234-acre watershed that straddles the town boundary between the City of Winooski and the Town of Colchester. The majority of the Morehouse Brook watershed is located in the City of Winooski, with a small portion in the Town of Colchester (Figure 1).

The entire stream and its tributaries are Class B waters designated as cold water fish habitat pursuant to the Vermont Water Quality Standards (WQS). Land use in the Morehouse Brook watershed is 88% developed land, 1% open land and 11% forested.

The stream generally flows in an east-west direction to the Winooski River (Figure 1). The lower stream channel, below (west of) Mallets Bay Avenue, has a relatively steep gradient confined within steep valley walls. This section of the stream is characterized by several mass failures of the stream bank, which are contributing large amounts of fine sediment in the stream channel near the mouth. The stream channel to the east of Mallets Bay Avenue is less steep and somewhat less affected by erosion.

Morehouse Brook is currently on Part D of the State of Vermont's 303(d) List of Impaired Waters indicating that it has a completed total maximum daily load (TMDL) that has been approved by the U.S. Environmental Protection Agency (EPA). The pollutants identified as responsible for the impairment in Morehouse Brook are stormwater runoff and erosion. The TMDL, which was developed and approved in 2007, identifies needed changes in watershed hydrology – a reduction in stormwater high flows and an increase in baseflow – to restore water quality. The flow targets are the basis for the flow restoration plan (FRP).

The FRP identifies the scope and scale of the best management practice (BMP) retrofits of existing impervious surface that, when implemented, are projected to meet the flow targets established in the TMDL and ultimately, to attain compliance with the Class B WQS. In addition, the Municipal Separate Storm Sewer System (MS4) general permit (issued December 5, 2012) outlines the following components of an FRP: identification of required controls, a construction and design schedule, a financial plan, regulatory analysis of any additional authorities needed to implement the FRP including support from the Vermont Department of Environmental Conservation (VT DEC), and any third party(ies) that have responsibility for implementing the FRP.

The two MS4s with impervious cover contributing to stormwater high flows in Morehouse Brook – the City of Winooski and the Town of Colchester – have agreed to prepare a joint FRP for the watershed, with flow-target allocation based on the relative share of impervious cover in the watershed, based on 2010 imagery (Table 1).

Table 1: Summary of Impervious Cover in the Morehouse Brook Watershed.

Jurisdiction	2010 Impervious Area (ac) [1]	Fraction of Watershed Area (%)
City of Winooski [2]	27.83	90.7%
Town of Colchester	2.85	9.3%
TOTAL	30.68	100.0%

[1] *Sourced from ESRI's "World Imagery" basemap. Imagery date: 08/28/2010.*

[2] *City of Winooski impervious area does not include area within the City diverted to the Winooski River as a result of the Malletts Bay Ave. diversion structure*

Figure 1. Morehouse Brook watershed boundaries

In considering the flow regime in Morehouse Brook, it is important to understand that the watershed boundary indicated in Figure 1 does not include a significant area within the City of Winooski that historically drained to Morehouse Brook, but has since been diverted to the Winooski River. In 2004, the City was awarded a 319 grant that, among other improvements, funded the construction of a diversion structure in the large-diameter storm sewer at the intersection of Malletts Bay Avenue and Morehouse Drive. The diversion structure was designed to utilize excess capacity as temporary in-pipe storage and to attenuate peak storm flows in Morehouse Brook by shunting flows during storm events up to the 2-year, 24-hour event (2.2 inches of rain in 24 hours) directly to the Winooski River. This area is identified in Figure 2, and is considered as a BMP in the FRP credit scenario because it was constructed after 2002 (see Section 2).

1.1. TMDL Flow Targets

In developing the TMDLs for waters that were determined to be impaired by stormwater runoff, VT DEC chose to use flow as a surrogate. Flow was used as a surrogate because the impacts on streams of increased stormwater flows resulting from urbanization are cumulative and include multiple stressors. Using flow was thought to integrate the effects of multiple stressors all related to stormwater runoff. In general, the basis for the TMDL flow targets was a comparison of modeled flow duration curves (FDCs) between the impaired watershed and attainment watersheds with similar hydrologic characteristics where the WQS are currently met. In the case of Morehouse Brook, there was only one attainment stream with similar hydrologic characteristics. For this watershed, a modified approach was used to develop a range of attainment flows, which produced a more conservative target than simply using the flow of the single attainment stream as the target.

A FDC displays the percentage of time that a flow equals or exceeds a certain value, with low or baseflow represented by the 95th percentile ($Q_{95\%}$) of the curve and stormwater high flows at the 0.3% exceedance interval ($Q_{0.3\%}$). The FDC for the Morehouse Brook and its attainment watershed were compared to determine the percent change (e.g., reduction in high flows and increase in base flows) required from current conditions; the percent change was codified in the TMDL document, and is presented in Table 2 below.

Table 2: TMDL Flow Restoration Targets, with and without Future Growth Allocations.

Flow Target	High Flow ($Q_{0.3\%}$) Reduction Target (%) [1]	Low Flow ($Q_{95\%}$) Increase Target (%) [2]
TMDL Targets	-54.0%	15.0%
TMDL Targets with 10 acres of non-jurisdictional future growth	-65.3%	15.0%

[1] *The high flow reduction target is negative (-), indicating there needs to be a reduction in high flow from the baseline condition*

[2] *The low flow target is positive (+), indicating there needs to be an increase in low flow from the baseline condition; the low flow target is not actionable under the TMDL, but is included because improving base flow in the watershed is also a water quality goal*

The high flow target ($Q_{0.3\%}$) was determined to be relatively equivalent to the 1-year design storm flow, and therefore BMPs sized to manage the channel protection volume (CP_v) as described in the 2002 Vermont Stormwater Management Manual were optimal for sizing BMPs to achieve the required high-flow reductions.

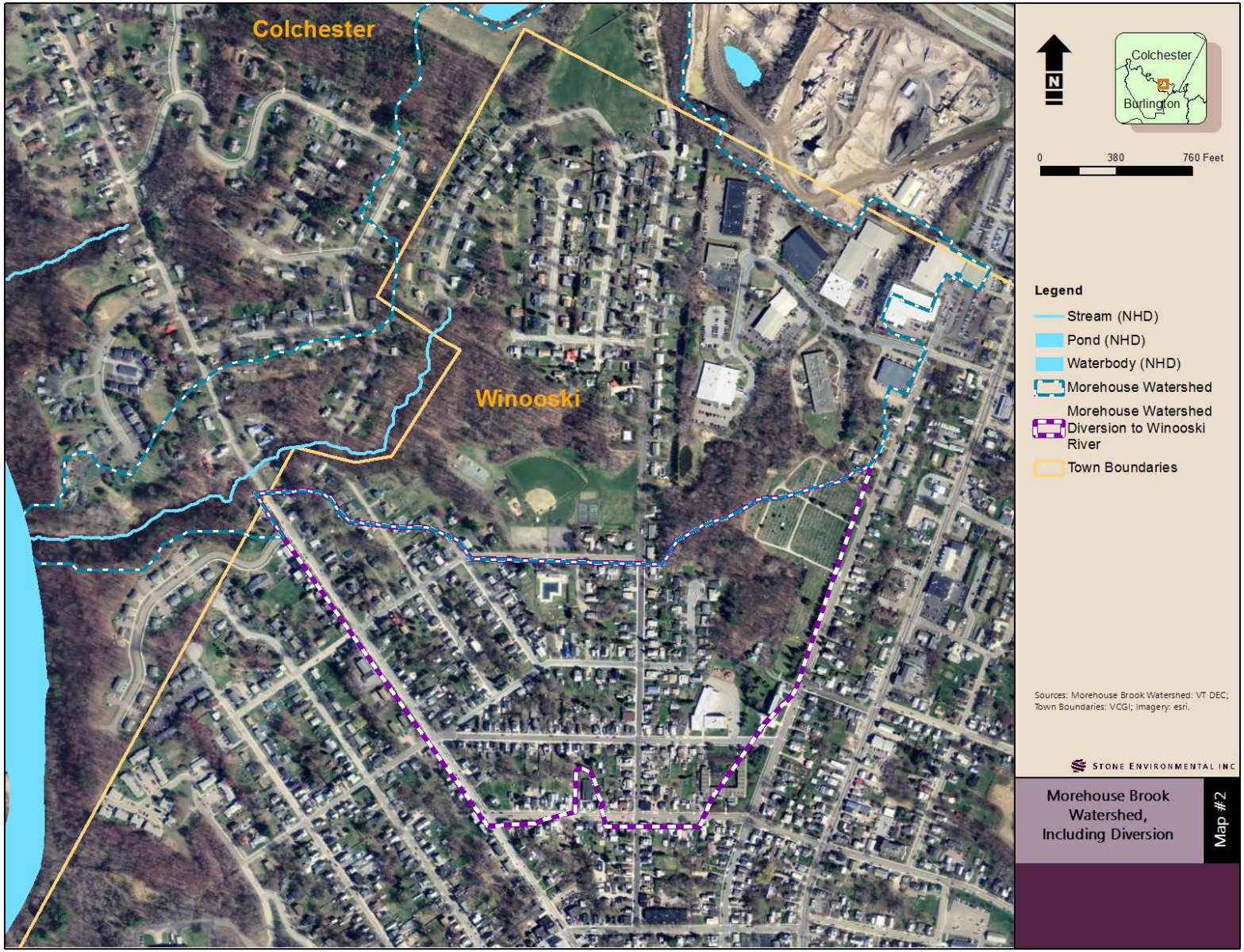

Figure 2. Pre-2004 Morehouse Brook watershed boundaries

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1.2. Future Growth

VT DEC added a future growth allocation to the TMDL flow targets to account for non-jurisdictional (e.g., not subject to state regulation and therefore unlikely to be managed by a BMP) impervious area that could reasonably be estimated to be constructed in the Morehouse Brook watershed during the next 10-15 years while the TMDL is implemented. New, non-jurisdictional impervious surfaces are typically created as a part of smaller projects – such as the construction of a single family home – that are not part of a common plan of development and therefore do not rise to the state regulatory threshold of one acre of post-construction impervious cover. The future growth allocation in the TMDL assumes that no local zoning or land use regulations would be in place that require stormwater management for smaller projects. The Morehouse Brook TMDL assumes that 10 acres of non-jurisdictional impervious surface will be created.

In order to incorporate the future growth estimate into the flow restoration target, 10 acres was added to the watershed's existing impervious cover to simulate projected watershed conditions when the TMDL is fully implemented. With the projected non-jurisdictional growth of 10 acres of impervious surface, the high flow target reduction was changed by -11.3% and the low flow target was unchanged (Table 2).

As a result, the reduction in peak flows required to account for future growth is 17.3% of the total flow reduction required. Given this and existing land use and development patterns in the Morehouse Brook watershed, a careful re-examination of the allocation was completed. Impervious areas that existed in the Morehouse Brook watershed in 2004[1] and in 2010[2] were manually digitized; these years were selected because high quality aerial imagery was readily available. Each parcel in the watershed was categorized in one of three ways:

- Parcels that are less than one acre in size;
- Parcels that are greater than one acre but currently contain less than one acre of impervious surface; and
- Parcels that are greater than one acre and currently have more than one acre of impervious surface.

A summary of impervious cover by parcel type and by municipality, for both 2004 and 2010, is presented in Table 3, below. Roads were not included in this analysis, consistent with the impervious cover analysis conducted by the Chittenden County Regional Planning Commission (CCRPC) during the development of the TMDL. Further, it was assumed that any new roads in this watershed would likely be for access to large future developments on larger parcels. Also, any new road expansions or sidewalk additions are likely to put the impervious area threshold on any roadway parcel over one acre. In either case, the net result would be that the road project would be subject to state stormwater standards.

As shown in Table 3, there was an increase of approximately 0.32 acres of impervious cover in the Morehouse Brook watershed between 2004 and 2010, which equates to an increase of 0.15% per year. More specifically, this net increase includes the construction of approximately 0.56 acres of impervious cover as well as the removal of 0.25 acres of impervious surface; a significant number of residential swimming pools were

[1] Orthophotos downloaded from the VT Center for Geographic Information (VCGI). Imagery shot from 8 May to 12 May, 2004.

[2] Sourced from ESRI's "World Imagery" basemap. Imagery date: 8/28/2010.

decommissioned during the evaluation period. Although the pool itself was considered pervious, the removal of surrounding patio areas accounts for much of the removed impervious surfaces.

The watershed-specific impervious area growth rate (0.15% per year) was applied to impervious areas within the Morehouse Brook watershed to estimate the acreage of non-jurisdictional impervious growth potential using the following equation:

Non-jurisdictional impervious acres = 2010 impervious acres * ((1 + % change per year) $^{\#\ years}$)

= 30.68 acres * $(1 + 0.15)^{15}$) = 31.38 acres or 0.70 acres increase between 2010 and 2025

Table 3: Summary of Impervious Cover by Parcel Type

	Parcel Type	Parcel Count	Total Parcels	Percent of Parcels	2004 Impervious Area (ac)	2010 Impervious Area (ac)	Area Change (ac)	Percent Change
Winooski	Less than one acre	142	159	89.3%	9.78	9.86	0.08	
	>1 acre with <1 acre impervious	9	159	5.7%	2.54	2.71	0.17	
	>1 acre with >1 acre impervious	8	159	5.0%	15.23	15.27	0.03	
	SUBTOTAL				27.55	27.83	0.28	1.0%
Colchester	Less than one acre	48	59	81.4%	1.98	1.99	0.01	
	>1 acre with <1 acre impervious	11	59	18.6%	0.83	0.86	0.03	
	>1 acre with >1 acre impervious	0	59	0.0%	0.00	0.00	0.00	
	SUBTOTAL				2.81	2.85	0.04	1.5%
Watershed-wide	TOTAL				30.36	30.68	0.32	1.1%

This estimate is conservative because it does not consider whether each parcel could actually add more impervious area given site and/or zoning constraints, nor were parcels within the watershed that are already subject to a state stormwater permit identified. Even with these conservative assumptions, it was estimated that a net increase of less than one acre of non-jurisdictional impervious cover could reasonably be estimated to be constructed between 2010 and 2025.

Based on this analysis, a future growth allocation of one acre was carried through the VTBMPDSS model assessment and identification of required controls. Reducing the estimated future growth in non-jurisdictional impervious surface to one acre changed the high flow target reduction; the specific impact of the proposed reduction in future growth is presented in Section 2.

In the unlikely event that the 10-acre future growth allocation assigned by VT DEC in the TMDL to account for non-jurisdictional impervious area estimated to be constructed in the Morehouse Brook watershed during the next 10-15 years is actually constructed, an estimated additional 6.75 acres to 8.69 acres of impervious surface would need to be treated to meet the full high flow target. At five-year intervals during the implementation of this FRP (beginning in 2020 and depending upon the availability of high-quality aerial imagery), VT DEC and the MS4s will assess changes in actual non-jurisdictional impervious cover within the Morehouse Brook watershed, to determine whether the one-acre projection remains appropriate. If more non-jurisdictional growth is found to be occurring than was projected, additional BMPs may be required to be developed and implemented to meet the high flow target in future years of the design and construction schedule (see Section 3 and Section 4).

2. VTBMPDSS MODEL ASSESSMENT

The VTBMPDSS model is a continuous hydrological simulation model that estimates the effect of land use changes and stormwater BMPs on streamflow. This model was applied to the Morehouse Brook watershed to predict progress toward the TMDL flow targets based on proposed BMP implementation scenarios. The most important inputs to the model for this study are the GIS layers of land use, impervious cover, and soil, as well as the locations, configuration, and connections of the BMPs themselves. The VTBMPDSS model is used to predict stormwater high flows and baseflows at the watershed outlet for a base condition (pre-2002) and then a future BMP implementation condition. VT DEC requires the use of the model to document compliance with the TMDL flow restoration targets. VT DEC established both a base and a credit (existing conditions) model scenarios to determine the remaining high flow reduction needed under the flow restoration plan. As described below, the Base and Credit Scenarios were updated to correct errors, add BMPs constructed since the VTBMPDSS was last updated, and make minor subwatershed boundary adjustments.

The Base Scenario establishes watershed conditions and flows against which the 2007 Morehouse Brook TMDL flow restoration targets are applied. The original Base Scenario uses impervious cover data extracted from QuickBird high-resolution satellite imagery, and includes stormwater BMPs installed prior to the issuance of the 2002 Vermont Stormwater Management Manual, when only large storms (i.e. 10-year storm events) required flow reduction. In coordination with VT DEC, an updated Base Scenario was developed to reflect lessons learned in modeling other watersheds, including resampling the land use and slope layers that define how runoff is generated in the model, and updating soils data for Landry Park based on the results of field investigationVT DEC also adjusted a number of subwatershed boundaries within the model as better information became available. Taken together, these adjustments to the VTBMPDSS Base Scenario resulted in updated flow restoration targets presented in Table 4, below.

Table 4: Updated Base Scenario Flow Restoration Targets, With and Without Updated Future Growth Allocations.

Flow Target	High Flow ($Q_{0.3\%}$) Target (%) [1]	Low Flow ($Q_{95\%}$) Target (%) [2]
Updated Targets	-54.0%	15.0%
Updated Targets with 1 acre of non-jurisdictional future growth	-55.1%	15.0%

[1] *The high flow reduction target is negative (-), indicating there needs to be a reduction in high glow from the baseline condition*

[2] *The low flow target is positive (+), indicating there needs to be an increase in low flow from the baseline condition; the low flow target is not actionable under the TMDL, but is included because improving base flow in the watershed is also a water quality goal*

The Credit Scenario represents current conditions and includes changes in the watershed that have occurred since the time of the Base Scenario's creation. The suite of BMPs installed as part of the Highland Industrial Park Stormwater Mitigation Project (6727-INDS.A1) were incorporated into VTBMPDSS, replacing the pre-2002 controls at this site considered under the Base Scenario. The North Street rain gardens constructed by the City Department of Public Works, as well as the Malletts Bay Ave. stormwater diversion (see Section 1), were also added to the Credit Scenario. Figure 3 shows the drainage areas associated with the FRP Credit scenario, and with BMPs included in the various Flow Restoration model scenarios (Section 3).

The Flow Restoration Scenario represents the retrofits needed to sufficiently manage high flows in order to achieve the flow restoration target in the TMDL. In addition, as discussed in Section 1.2, the future growth allocation was revisited and an updated assumption about potential growth in non-jurisdictional impervious surfaces was incorporated into the Flow Restoration Scenario. The Flow Restoration Scenario is discussed in more detail in Section 3.

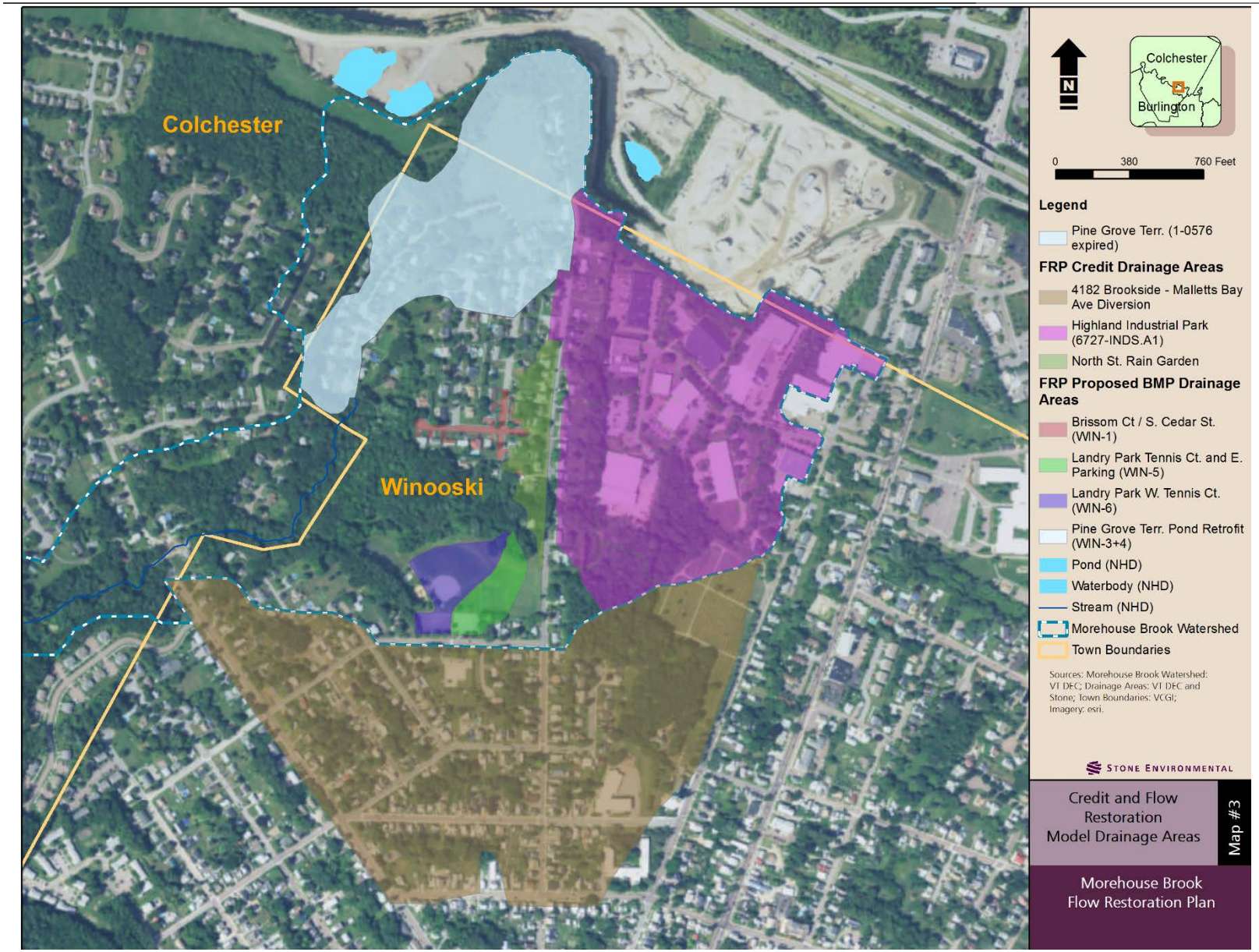


Figure 3. Drainage areas for FRP Credit scenario and for BMPs proposed for the Flow Restoration scenarios.

3. IDENTIFICATION OF REQUIRED CONTROLS

In 2015, field studies were performed throughout the Morehouse Brook watershed to identify and evaluate existing BMPs that were candidates for retrofits, as well as potential locations for new BMPs. Each site was reviewed to determine its ability to meet the CP_v criteria of the 2002 Vermont Stormwater Management Manual. This criterion was utilized as part of the FRP evaluation since the 1-year, 24-hour storm event is a close approximation to the storm event associated with the $Q_{0.3\%}$ flow. The CP_v criterion requires 12-hours of detention for cold water fish habitats, such as Morehouse Brook.

Table 5, below, lists the candidate BMP sites, provides general information about each BMP, and highlights practices that were modeled as part of the FRP. Additional information for each BMP considered in the initial evaluation is provided in Appendix A. While some field work was performed as part of identifying these candidate sites, no detailed hydrologic analysis, property research, engineering, or other studies were performed, and thus unidentified constraints may exist that prevent certain sites from being utilized in the FRP.

Table 5: Summary of BMPs Considered in Developing the Morehouse Brook FRP.

BMP ID	Permit Number, if applicable	Site Name	BMP Type	Included in FRP?	BMPDSS Model Run	Notes
WIN-4	1-0576	Pinegrove Development Associates	Wet pond	Y	Base	Permittee is Pinegrove Development Associates and has not been maintained for some time; some areas of public ROW drain to this facility which will need to be considered as part of future management scenarios
WIN-7 (base)	2-0628	Highland Industrial Park, pre-2002 condition	Wet pond	Y	Base	Entries in this table based on HydroCAD existing condition models for BMPDSS input
Flow_Splitter	4182-9015	Brookside (Malletts Bay Ave.) Flow Splitter	Infiltration	Y	Credit	Diversion structure was desiged/constructed in 2004-2006 in large-diameter storm sewer at intersection of Malletts Bay Avenue and Morehouse Drive. Structure utiilizes excess capacity as temporary in-pipe storage and attenuates peak storm flows in Morehouse Brook by shunting storm flows up to the 2-year, 24-hour event (2.2 inches of rain in 24 hours) to the Winooski River.
North_St_RG		North Street Rain Gardens	Infiltration	Y	Credit	Rain gardens constructed by Winooski DPW
WIN-7	2-0628, 6727-INDS	Highland Industrial Park, present condition with 2013 updates	Wet pond, infiltration	Y	Credit	Significant improvements were made to the Industrial Park's stormwater management facilities in 2013; these improvements are reflected in the existing condition (post-2002) model; no additional measures are included as part of the FRP

BMP ID	Permit Number, if applicable	Site Name	BMP Type	Included in FRP?	BMPDSS Model Run	Notes
WIN-3+4		Pinegrove Development Pond Upgrade	Wet pond	Y	FR	Impervious cover as digitized in 2017
WIN-5		Landry Park, east	Infiltration	Y	FR_4-11-16	Treating runoff from eastern parking lot and tennis courts
WIN-6		Landry Park, west	Infiltration	Y	FR_4-11-16	Treating runoff from western parking lot
WIN-1		North St, Brisson Ct, Cedar St, Dufrense Dr.	Infiltration	Y	FR_7-1-16	Treatment of Brisson Ct and southern Cedar St included as part of the FRP; other areas are believed to drain to WIN-4 and therefore determined to be lower priority
COL-1		Young St	Infiltration	N		Fire service turnaround requirements and steep slopes make retrofits challenging
COL-2		Malletts Bay Ave	Infiltration	N		Very limited space available for practice
WIN-2		Pine Grove Terr, north	Infiltration	N		Area drains to WIN-4 and therefore determined to be lower priority
WIN-3		Pine Grove Terr, south	Infiltration	N		Area drains to WIN-4 and therefore determined to be lower priority

Based an initial evaluation of the BMP opportunities, and discussions with the City of Winooski and Town of Colchester on BMP implementation feasibility, a preferred Flow Restoration Scenario was selected that meets the revised TMDL high flow reduction target (Table 6). The restoration scenario includes GSI retrofits in the municipal right-of-way along Brisson Ct. and southern Cedar St., two infiltration areas to manage runoff from the parking lots at Landry Park, and upgrade/expansion of the existing pond at WIN-4, which will extend into the footprint of WIN-3. Concept designs for each of the BMPs included in the Flow Restoration Scenario are included in Appendix B, and were used in developing the initial cost estimates discussed further in Section 5. Basic soil testing (e.g., hand-augered test pits) was also conducted for the Landry Park sites and is included as Appendix C.

Table 6: VTBMPDSS Model Runs Summary for Proposed FRP Scenario.

VTBMPDSS Run	Scenario Description	Area (sq. mi)	Flow (cfs)		% change vs base	
			High (Q0.3%)	Low (Q95%)	High Flow (Q0.3%)	Low Flow (Q95%)
Original (TMDL) models	Attainment flow		3.179	0.092		
	DEC Base (2002)	0.4094	6.910	0.080		
Updated Models	Attainment flow		3.068	0.092		
	FRP Base	0.3662	6.670	0.070		
	FRP Credit	0.2581	3.310	0.080	-50.4%	14.3%
	WIN-5/6	0.2581	3.130	0.080	-53.1%	14.3%
	WIN-5/6 + WIN-1	0.2581	3.080	0.080	-53.8%	14.3%
	WIN-5/6 + WIN-1 +WIN-3+4	0.2581	2.970	0.080	-55.4%	14.3%

If, as discussed in Section 1.2, it becomes necessary to implement additional BMPs in order to meet the high flow target to account for non-jurisdictional future growth in excess of the currently projected one acre growth allocation, one or more of the BMPs listed in Table 5 that were identified but not included in the initial Flow Restoration Plan will be developed further and included in the design and construction schedule (also see Appendix A). The following order of priority is proposed for inclusion of additional BMPs:

1. WIN-1 and WIN-2: Additional GSI retrofits in the municipal right-of-way along Dufresne Drive, Cedar Street, and/or North Street
2. COL-2: “Green gutter” in the municipal right-of-way along Malletts Bay Avenue
3. COL-1: Infiltration practice and/or cul-de-sac reconfiguration at the end of Young Street
4. WIN-2: GSI retrofits in the right-of-way along Pine Grove Terrace.

4. DESIGN AND CONSTRUCTION SCHEDULE

The 2012 MS4 permit requires that this FRP include a design and construction schedule for the stormwater BMPs that have “been identified by the permittee[s] as necessary to achieve the flow restoration targets.” The schedule must provide for implementation of the BMPs as soon as possible, but no later than 20 years from the effective date of MS4 permit, which is December 5, 2012--meaning that the BMPs must be implemented by the end of 2032. The BMPs included in this FRP will require permitting and design work prior to construction, and will have varying costs. Given the limited nature of the BMPs identified as necessary to achieve the high flow target, and barring any unforeseen complications, it is anticipated the implementation of the BMPs will be completed within ten years from receipt of approval of this FRP from VT DEC, in accordance with the following schedule. A ten year planning horizon was selected in order to provide an opportunity for the City of Winooski and the Town of Colchester to account for these projects in their respective long-range (e.g., 5-year) capital budgets. The order of the projects listed below could be adjusted based on their flow restoration benefits, availability of funding, regulatory approvals and easement requirements.

		Task	
Schedule	Proposed BMP	Design	Construction
FY '19	Pine Grove Terrace Pond	X	
FY '20			X
FY '21	Landry Park, west and east	X	
FY '22			X
FY '23	Brisson Ct; southern Cedar Street	X	
FY '24			X
FY '25			
FY '26			
FY '27			

5. FINANCIAL PLAN

The 2012 MS4 permit also requires that this FRP include a financing plan that estimates the costs for implementing the FRP and describes a strategy for financing the FRP. Costs for implementing the BMPs have been calculated based on the memorandum from Tetra Tech, Inc. dated October 30, 2007. These rates use a 2000 base year and have been updated to account for inflation to the year 2022, using a 2.5% inflation rate. The 2022 year was chosen, assuming that the VT DEC would approve this FRP in early 2017. The costs were not further adjusted in calendar 2017; it was assumed that up to one year of delay in approval would not substantially affect inflation rates or other base cost assumptions. The costs are calculated based on the following equation:

total cost = installation cost (I) + land cost (L) + fixed cost (F)

Where:

I = $6/cf of infiltration, inflated at 2.5% to year 2022 = $10.40/cf; $5/cf of detention, inflated at 2.5% to year 2022 = $8.60/cf

L = $0 as it is not anticipated that property will be required to be purchased

F = project-specific estimate of design/permitting costs

The anticipated costs associated with implementing each BMP identified in Section 4 are presented below in Table 7.

Table 7: Proposed BMP Cost Estimates.

BMP ID	Site Name	BMP Type	Infiltration or Detention Volume (cf)	I ($)	F ($)	Total Cost ($)
WIN-1	Brisson Ct; southern Cedar St	Infiltration	5,449	$56,650	$11,500	$68,150
WIN-5 [1]	Landry Park, east	Infiltration	3,479	$36,200	$5,450	$41,650
WIN-6 [1]	Landry Park, west	Infiltration	2,378	$24,750	$3,700	$28,450
WIN-3+4	Pine Grove Terrace pond	Detention	17,398	$138,250	$30,500	$168,700
TOTAL						**$306,950**

[1] *Does not include any costs associated with parking lot reconstruction which may be needed to promote drainage to BMPs*

Both the City of Winooski and Town of Colchester anticipate that approximately 50% of the cost of these projects will be funded by the State through the Clean Water Block Grants, CWSRF revolving loan program or other State grant funds. Remaining local share costs will be funded by Winooski and Colchester proportional to the share of impervious cover in the watershed. Since Winooski has the largest portion of the impervious area at 90.7%, their share of these local costs will be funded through the Winooski stormwater department Capital Improvements (CIP) budget.

6. REGULATORY ANALYSIS

As part of this FRP, a retrofit is being proposed for the site with an expired State operational stormwater permit (WIN-4, Pinegrove Development Associates).. The City of Winooski will ultimately need to determine if the Pinegrove Development pond is eligible for a Residual Designation Authority permit from the State or whether the facility will need to be adopted by the City under its MS4.

Once improvements are completed by the Pine Grove homeowners' association to bring the pond associated with the expired Pine Grove permit 1-0576 into compliance with current standards, or once upgrades are completed to address deferred maintenance and maximize storage consistent with this FRP, the City of Winooski anticipates taking over this permit. The City is currently in discussion with the homeowners' association regarding this matter.

APPENDICES

APPENDIX A: CONSIDERED FLOW REDUCTION BMPS

Appendix A, Table 1
Details for BMPs Considered

BMP ID	Permit Number, if applicable	Site Name	BMP Type	Included in FRP?	BMPDSS Model Run	New or Existing	MS4s with Impervious Areas	BMP Drainage Area (acres)	Impervious Area Managed (acres)	CPv Managed (ac-ft)	Volume Infiltrated (ac-ft)	WQv Controlled (%)	Notes
WIN-4	1-0576	Pinegrove Development Associates	Wet pond	Y	Base	Existing	Winooski	28.86	5.66	0.19	0		Permittee is Pinegrove Development Associates and has not been maintained for some time; some areas of public ROW drain to this facility which will need to be considered as part of future management scenarios
WIN-7 (base)	2-0628	Highland Industrial Park, pre-2002 condition	Wet pond	Y	Base	Existing	Winooski	34.7		1.17			Entries in this table based on HydroCAD existing condition models for BMPDSS input
Flow_Splitter	4182-9015	Brookside (Malletts Bay Ave.) Flow Splitter	Infiltration	Y	Credit	Existing	Winooski	68.1	26.6	7.90	0		Diversion structure was desiged/constructed in 2004-2006 in large-diameter storm sewer at intersection of Malletts Bay Avenue and Morehouse Drive. Structure utiilizes excess capacity as temporary in-pipe storage and attenuates peak storm flows in Morehouse Brook by shunting storm flows up to the 2-year, 24-hour event (2.2 inches of rain in 24 hours) to the Winooski River.
North_St_RG		North Street Rain Gardens	Infiltration	Y	Credit	Existing	Winooski	3.95	1.22	0.054	0.049	58%	Rain gardens constructed by Winooski DPW
WIN-7	2-0628, 6727-INDS	Highland Industrial Park, present condition with 2013 updates	Wet pond, infiltration	Y	Credit	Existing	Winooski	35.08 (46.7 including off-site contributing drainages)	18.06	1.62	0.085	108	Significant improvements were made to the Industrial Park's stormwater management facilities in 2013; these improvements are reflected in the existing condition (post-2002) model; no additional measures are included as part of the FRP
WIN-3+4		Pinegrove Development Pond Upgrade	Wet pond	Y	FR	New	Winooski	27.93	5.2	0.39	0	77%	Impervious cover as digitized in 2017
WIN-5		Landry Park, east	Infiltration	Y	FR_4-11-16	New	Winooski	2.2	0.62	0.163	0.163	290%	Treating runoff from eastern parking lot and tennis courts
WIN-6		Landry Park, west	Infiltration	Y	FR_4-11-16	New	Winooski	3.1	0.50	0.17	0.17	339%	Treating runoff from western parking lot
WIN-1		North St, Brisson Ct, Cedar St, Dufrense Dr.	Infiltration	Y	FR_7-1-16	New	Winooski	2.0	0.98	0.076	0.076	100%	Treatment of Brisson Ct and southern Cedar St included as part of the FRP; other areas are believed to drain to WIN-4 and therefore determined to be lower priority
COL-1		Young St	Infiltration	N		New	Colchester	1.0	0.50				Fire service turnaround requirements and steep slopes make retrofits challenging
COL-2		Malletts Bay Ave	Infiltration	N		New	Colchester	0.25	0.25				Very limited space available for practice
WIN-2		Pine Grove Terr, north	Infiltration	N		New	Winooski	8.2	2.5				Area drains to WIN-4 and therefore determined to be lower priority
WIN-3		Pine Grove Terr, south	Infiltration	N		New	Winooski	1.0	0.50				Area drains to WIN-4 and therefore determined to be lower priority

ID#: WIN-1

Name: North Street, Brisson and Pine Grove

Concept Description:
Wide, flat street w/ room for on-street parking. A number of roof leaders discharge onto driveways. Opportunities for traffic-calming bump-outs to manage road runoff. Some yards appear amenable to residential-scale rain gardens.

Notes/Feasibility:
Willingness of landowners to install rain gardens is unknown; there may be some resistance to repurposing of on-street parking for stormwater treatment

GENERAL SITE INFORMATION

Site Contact Info:	City of Winooski
Ownership:	Public/private
Land Use Type:	Road/SFRs
Existing BMP on Site?	No
Is site a hotspot?	No
Sources/pollutants:	Road runoff
Soils:	HSG A

SIZING INFORMATION

Drainage Area (ac):	Roughly 2.0 for Brisson Ct. and S. Cedar St.
Impervious Area (ac):	0.98 for Brisson Ct., S. Cedar St.
Practice Area Available (ft^2):	5,449
Existing Head Available?	Yes

RETROFIT DETAILS

Project Candidate:	Yes
Retrofit of new or existing BMP:	New
Proposed Retrofit Practice 1:	Traffic-calming bump-out
Proposed Retrofit Practice 2:	
Non-Structural Controls:	Downspout disconnection
Maintenance Burden:	low

Benefits:		Conflicts:	
Storage	No	Soils	No
Water quality	Yes	Access	Maybe
Recharge	Yes	Land Use	Maybe
Demonstration	Yes	Utilities	Maybe
Repair	No	Wetlands	No

Date: 07/14/15, rev. 3/7/16

Assessed by: JSM/CG

ID#: WIN-2

Name: Pine Grove Terr, west of Cedar St

Concept Description:
Wide, flat street w/ room for on-street parking. A number of roof leaders discharge onto driveways. Opportunities for traffic-calming bump-outs to manage road runoff. In addition, existing green space between sidewalk and road could be repurposed as a "green gutter".

Notes/Feasibility:
Utilities in this neighborhood are buried and may limit some options in the ROW

GENERAL SITE INFORMATION

Site Contact Info:	City of Winooski
Ownership:	Public/private
Land Use Type:	Road/SFRs
Existing BMP on Site?	No
Is site a hotspot?	No
Sources/pollutants:	Road runoff
Soils:	HSG A

SIZING INFORMATION

Drainage Area (ac):	~8.2, only for Pine Grove Terr. (see also WIN-4)
Impervious Area (ac):	~2.5
Practice Area Available (ft^2):	~10,000
Existing Head Available?	Yes

RETROFIT DETAILS

Project Candidate:	Yes
Retrofit of new or existing BMP:	New
Proposed Retrofit Practice 1:	Green street/green gutter
Proposed Retrofit Practice 2:	
Non-Structural Controls:	Downspout disconnection
Maintenance Burden:	Medium

Benefits:		Conflicts:	
Storage	No	Soils	No
Water quality	Yes	Access	No
Recharge	Yes	Land Use	Maybe
Demonstration	Yes	Utilities	Maybe
Repair	No	Wetlands	No

Date: 07/14/15, rev. 3/7/17

Assessed by: JSM/CG

ID#: WIN-3

Name: End of Pine Grove Terrace

Concept Description:
End of Pine Grove Terrace has odd-shaped "cul-de-sac"; existing storm pond is beyond berm on right-side pf photo. Significant erosion was evident below the storm drain outfall that drains cul-de-sac. The cul-de-sac could be reconfigured to reduce the impervious area and create space for storage.

Notes/Feasibility:
Any space that could be created here might may be more efficient to use for pond expansion (see WIN-4, which receives runoff from ~30 acres).

GENERAL SITE INFORMATION

Site Contact Info:	City of Winooski
Ownership:	Public/private
Land Use Type:	Road/SFRs
Existing BMP on Site?	No
Is site a hotspot?	No
Sources/pollutants:	Road runoff/yard waste
Soils:	HSG A

SIZING INFORMATION (measured from GIS)

Drainage Area (ac):	~1 ac to outfall
Impervious Area (%):	50%
Practice Area Available (ft²):	1500 sf
Existing Head Available?	Yes

RETROFIT DETAILS

Project Candidate:	Maybe
Retrofit of new or existing BMP:	New
Proposed Retrofit Practice 1:	Infiltration area
Proposed Retrofit Practice 2:	
Non-Structural Controls:	Impervious cover removal
Maintenance Burden:	Medium

Benefits:		Conflicts:	
Storage	No	Soils	No
Water quality	Yes	Access	No
Recharge	Yes	Land Use	Maybe
Demonstration	Yes	Utilities	Maybe
Repair	No	Wetlands	No

Date: 07/14/15 Assessed by: JSM/CG

ID#: WIN-4

Name: Pine Grove Pond

Concept Description:
Retrofit existing, pre-2002 pond to increase detention time and better manage peak flows. Pond appears to have received limited maintenance; outlet was not viewed during initial site visit.

Notes/Feasibility:
As noted on WIN-3, due to space constraints expansion of pond could preclude construction of infiltration practice at the end of Pine Grove Terr

GENERAL SITE INFORMATION

Site Contact Info:	City of Winooski
Ownership:	Public/private
Land Use Type:	Road/SFRs
Existing BMP on Site?	Yes
Is site a hotspot?	No
Sources/pollutants:	Road runoff/yard waste
Soils:	HSG A

SIZING INFORMATION (measured from GIS)

Drainage Area (ac):	~30 ac
Impervious Area (%):	30%
Practice Area Available (ft²):	6000 sf, incl. existing pond
Existing Head Available?	Yes

RETROFIT DETAILS

Project Candidate:	Yes
Retrofit of new or existing BMP:	Existing
Proposed Retrofit Practice 1:	Pond improvements
Proposed Retrofit Practice 2:	
Non-Structural Controls:	Downspout disconnection
Maintenance Burden:	Low

Benefits:		Conflicts:	
Storage	Yes	Soils	No
Water quality	Yes	Access	No
Recharge	No	Land Use	Maybe
Demonstration	No	Utilities	Maybe
Repair	Yes	Wetlands	Maybe

Date: 07/14/15 Assessed by: JSM/CG

ID#: WIN-5

Name: Landry Park Tennis Court and East Parking Lot

Concept Description:

There is considerable rill erosion on the slope to the south of the tennis courts, which appears to be attributable to runoff from the courts. In addition, a portion of the parking lot drains to the north and east. A bioswale could be constructed at the toe of the court-side slope to convey runoff to the corner of the parking lot, where an infiltration basin could be constructed in place of several existing parking spots.

Notes/Feasibility:

Existing dumpster should be relocated. Parking could be reconfigured and/or a paved swale added to encourage additional area to drain to the north and east.

GENERAL SITE INFORMATION

Site Contact Info:	City of Winooski
Ownership:	Public
Land Use Type:	Parking lot/Landry Park
Existing BMP on Site?	No
Is site a hotspot?	No
Sources/pollutants:	Athletic fields
Soils:	HSG A

SIZING INFORMATION (measured from GIS)

Drainage Area (ac):	2.23 ac
Impervious Area (%):	28%
Practice Area Available (ft^2):	3,479
Existing Head Available?	Some

RETROFIT DETAILS

Project Candidate:	Maybe
Retrofit of new or existing BMP:	New
Proposed Retrofit Practice 1:	Infiltration area
Proposed Retrofit Practice 2:	Bioswale
Non-Structural Controls:	Impervious cover removal
Maintenance Burden:	Medium

Benefits:		Conflicts:	
Storage	No	Soils	No
Water quality	Yes	Access	No
Recharge	Yes	Land Use	Yes
Demonstration	Yes	Utilities	Maybe
Repair	No	Wetlands	No

Date: 07/14/15, rev. 3/7/17

Assessed by: JSM/CG

ID#: WIN-6

Name: Landry Park West Parking Lot

Concept Description:
Western half of the parking lot at Landry Park drains to DI that is currently failed (e.g., collapsed). Soils surrounding the parking lot are HSG A; if parking lot is to be redone, consideration should be given to grading the lot to shed water toward adjacent green space and disconnect it from the storm drain system. There is also space off the northwest corner of the lot where an infiltration area could be established. Some potential for larger practice to north/west of lot near skate park; will required detailed review of existing infrastructure mapping.

Notes/Feasibility:
Although it is clear the City needs to take action to address the failed DI, it is not clear how extensive the renovation may be. Storm sewer maps indicate that Industrial Park pond drains to sewer line that passes thru/under park.

GENERAL SITE INFORMATION

Site Contact Info:	City of Winooski
Ownership:	Public
Land Use Type:	Parking lot/Landry Park
Existing BMP on Site?	No
Is site a hotspot?	No
Sources/pollutants:	Athletic fields
Soils:	HSG A

SIZING INFORMATION (measured from GIS)

Drainage Area (ac):	3.10
Impervious Area (%):	16
Practice Area Available (ft^2):	2,378
Existing Head Available?	Some

RETROFIT DETAILS

Project Candidate:	Maybe
Retrofit of new or existing BMP:	New
Proposed Retrofit Practice 1:	Infiltration area
Proposed Retrofit Practice 2:	
Non-Structural Controls:	
Maintenance Burden:	Medium

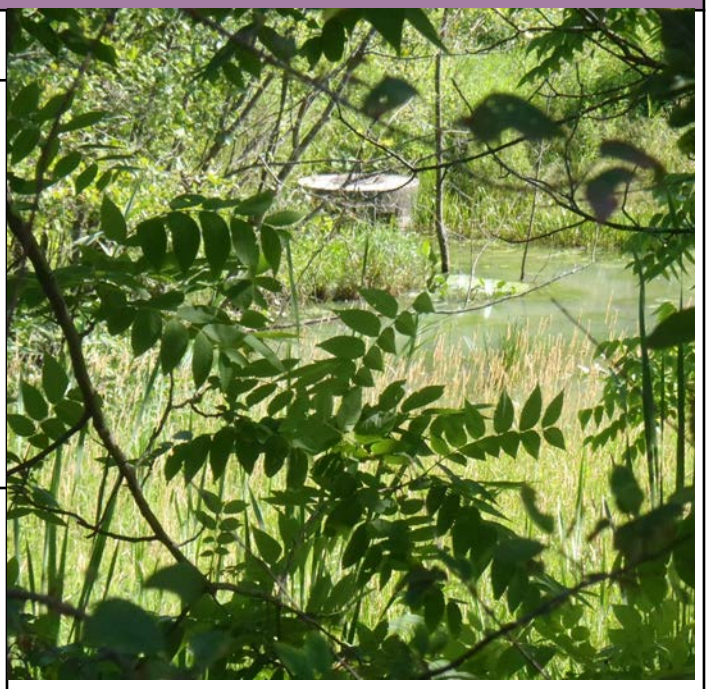
Benefits:		Conflicts:	
Storage	No	Soils	No
Water quality	Yes	Access	No
Recharge	Yes	Land Use	Yes
Demonstration	No	Utilities	Maybe
Repair	Yes	Wetlands	No

Date: 07/14/15, rev. 03/07/17

Assessed by: JSM/CG

ID#: WIN-7

Name: Highland Industrial Park Pond



Concept Description:
Retrofit existing pond to increase detention time and better manage peak flows. Pond appears to have received limited maintenance; outlet was not viewed during initial site visit.

Notes/Feasibility:
Numerous upgrades have been implemented within the industrial park. It will be important o understand the detention time and the impact that the overall system currently has on flows at the watershed outlet

GENERAL SITE INFORMATION

Site Contact Info:	Highland Industrial Park
Ownership:	Private
Land Use Type:	Commercial/industrial
Existing BMP on Site?	Yes
Is site a hotspot?	No
Sources/pollutants:	Road runoff
Soils:	HSG A

SIZING INFORMATION (measured from GIS)

Drainage Area (ac):	25 ac
Impervious Area (%):	75%
Practice Area Available (ft²):	??
Existing Head Available?	Yes

RETROFIT DETAILS

Project Candidate:	Maybe
Retrofit of new or existing BMP:	Existing
Proposed Retrofit Practice 1:	Pond improvements
Proposed Retrofit Practice 2:	
Non-Structural Controls:	
Maintenance Burden:	Low

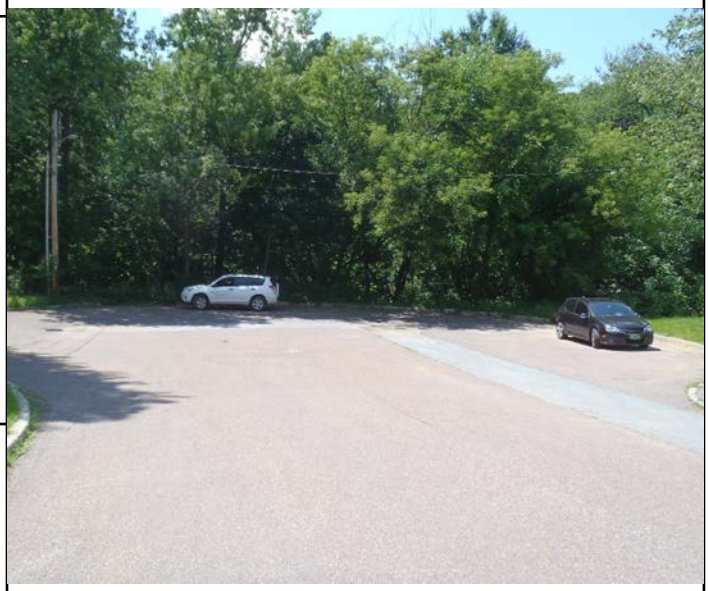
Benefits:		Conflicts:	
Storage	Yes	Soils	No
Water quality	Yes	Access	No
Recharge	No	Land Use	No
Demonstration	No	Utilities	No
Repair	??	Wetlands	??

Date: 07/14/15 Assessed by: JSM/CG

ID#: COL-1

Name: Young Street

Concept Description:
Cul-de-sac at the south west end of Young St has two DIs. Significant erosion was evident below the storm drain outfall connected to these structures. The cul-de-sac could be reconfigured to reduce the impervious area and create space for storage/infiltration. This area is mapped as having highly infiltrative soils.



Notes/Feasibility:
Need to understand Colchester requirements for cul-de-sac layout to determine area eligible for practice; may be able to cover next set of Dis to the north on Young St to increase drainage area

GENERAL SITE INFORMATION

Site Contact Info:	Town of Colchester
Ownership:	Public/private
Land Use Type:	Road/SFRs
Existing BMP on Site?	No
Is site a hotspot?	No
Sources/pollutants:	Road runoff, yard waste
Soils:	HSG A

SIZING INFORMATION

Drainage Area (ac):	~1 ac
Impervious Area (ac):	50%
Practice Area Available (ft^2):	~2000 sf
Existing Head Available?	Yes

RETROFIT DETAILS

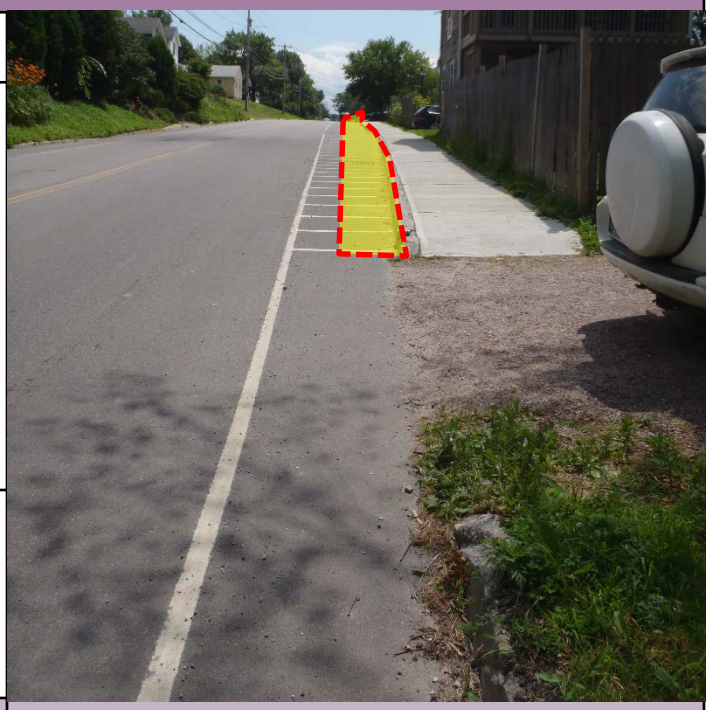
Project Candidate:	Yes
Retrofit of new or existing BMP:	New
Proposed Retrofit Practice 1:	Infiltration area
Proposed Retrofit Practice 2:	
Non-Structural Controls:	Impervious cover removal
Maintenance Burden:	Medium

Benefits:		Conflicts:	
Storage	Yes	Soils	No
Water quality	Yes	Access	No
Recharge	Yes	Land Use	Maybe
Demonstration	Yes	Utilities	Maybe
Repair	Yes	Wetlands	No

Date: 07/14/15 Assessed by: JSM/CG

ID#: COL-2

Name: Malletts Bay Ave



Concept Description:
Near where Malletts Bay Ave crosses over Morehouse Brook, there is a swath of unused pavement that is neither available for parking or as part of the travel lane. This area could be depaved and a green gutter installed.

Notes/Feasibility:
There is considerable bike traffic along Malletts Bay Ave and care would need to be taken to ensure that enough room remains for both bikes and cars to travel safely.

GENERAL SITE INFORMATION

Site Contact Info:	Town of Colchester
Ownership:	Public
Land Use Type:	Road
Existing BMP on Site?	No
Is site a hotspot?	No
Sources/pollutants:	Road runoff, yard waste
Soils:	HSG A

SIZING INFORMATION

Drainage Area (ac):	~0.25 ac
Impervious Area (ac):	100%
Practice Area Available (ft^2):	~300 sf
Existing Head Available?	Yes

RETROFIT DETAILS

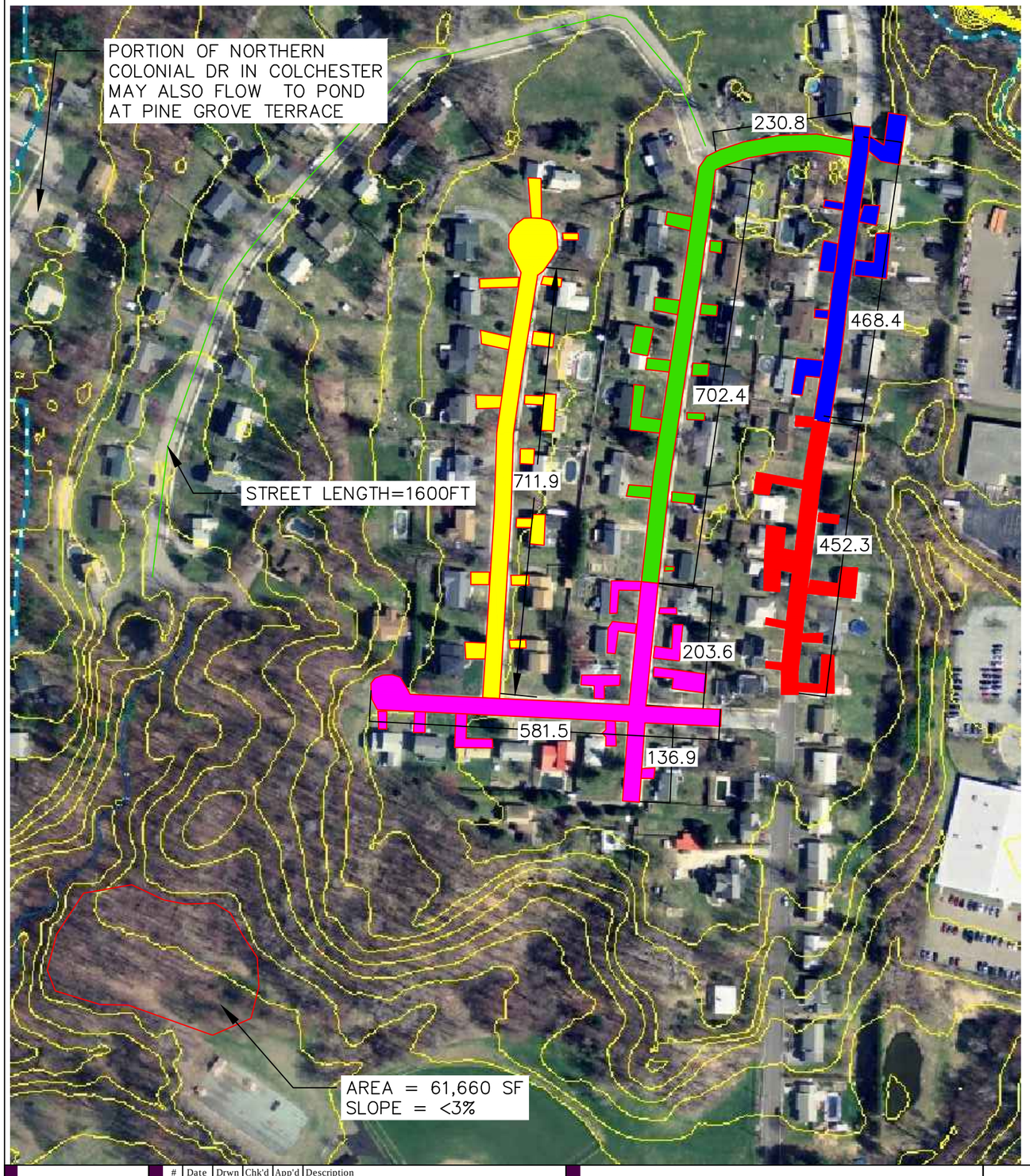
Project Candidate:	Yes
Retrofit of new or existing BMP:	New
Proposed Retrofit Practice 1:	Green street/gutter
Proposed Retrofit Practice 2:	
Non-Structural Controls:	Impervious cover removal
Maintenance Burden:	Medium

Benefits:		Conflicts:	
Storage	No	Soils	No
Water quality	Yes	Access	No
Recharge	Yes	Land Use	Maybe
Demonstration	Yes	Utilities	Maybe
Repair	No	Wetlands	No

Date: 07/14/15

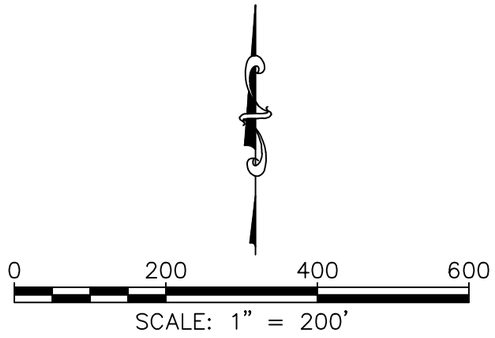
Assessed by: JSM/CG

APPENDIX B: FLOW RESTORATION SCENARIO BMP CONCEPT DESIGNS



DRAINAGE	IMPERVIOUS AREA (SF) [1]	DESTINATION	TOTAL BMP FOOTPRINT (SF)	TOTAL LENGTH OF BUMPOUT [2]	GREEN GUTTER POTENTAL (SF) [3]
YELLOW (DUFRESNE DR)	41,600	POND AT PINE GROVE TERRACE	5,283	881	1,422
PINK (BRISSON CT & SOUTHERN CEDAR ST)	42,903	WEST TO MOREHOUSE BROOK DIRECT	5,449	908	1,566
GREEN (CEDAR ST)	39,288	POND AT PINE GROVE TERRACE	4,990	832	1,404
BLUE (UPPER NORTH ST)	24,231	EAST TO INDUSTRIAL PARK SYSTEM	3,077	513	NONE
RED (NORTH ST)	24,615	EAST TO INDUSTRIAL PARK SYSTEM	3,126	521	NONE

[1] INCLUDES: STREET, ROOFS, DRIVES, SIDEWALKS [2] 6' WIDTH [3] 2' WIDTH



WIN-1 & WIN-2
NORTH , BRISSON, PINE GROVE, CEDAR, DUFRENSE STREETS

DRAWING CREDITS
Drawn On: 12/28/2015
Drawn By: CAG
Checked On:
Checked By:
Project No.: 13-239

REVISIONS

#	Date	Drwn	Chk'd	App'd	Description

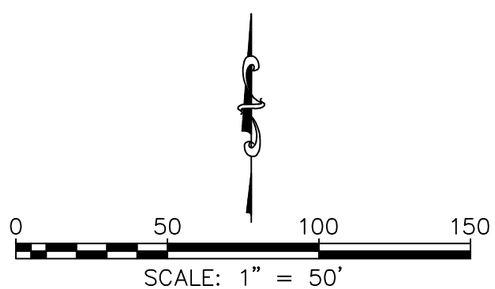
DRAWING SCALE
File:

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

MOREHOUSE BRROK
FLOW REDUCTION ALTERNATIVES
WIN-1 AND WIN-2
WINOOSKI VT

FIGURE NO. 1

DRAINAGE	IMPERVIOUS AREA (SF)	DESTINATION	TOTAL BMP FOOTPRINT (SF)
TENNIS COURT & EAST PARKING LOT	27,392	CATCH BASINS	3,479
WEST PARKLING LOT	18,727	CATCH BASINS	2,378



DRAWING CREDITS
Drawn On: 12/28/2015
Drawn By: CAG
Checked On:
Checked By:
Project No.: 13-239

REVISIONS

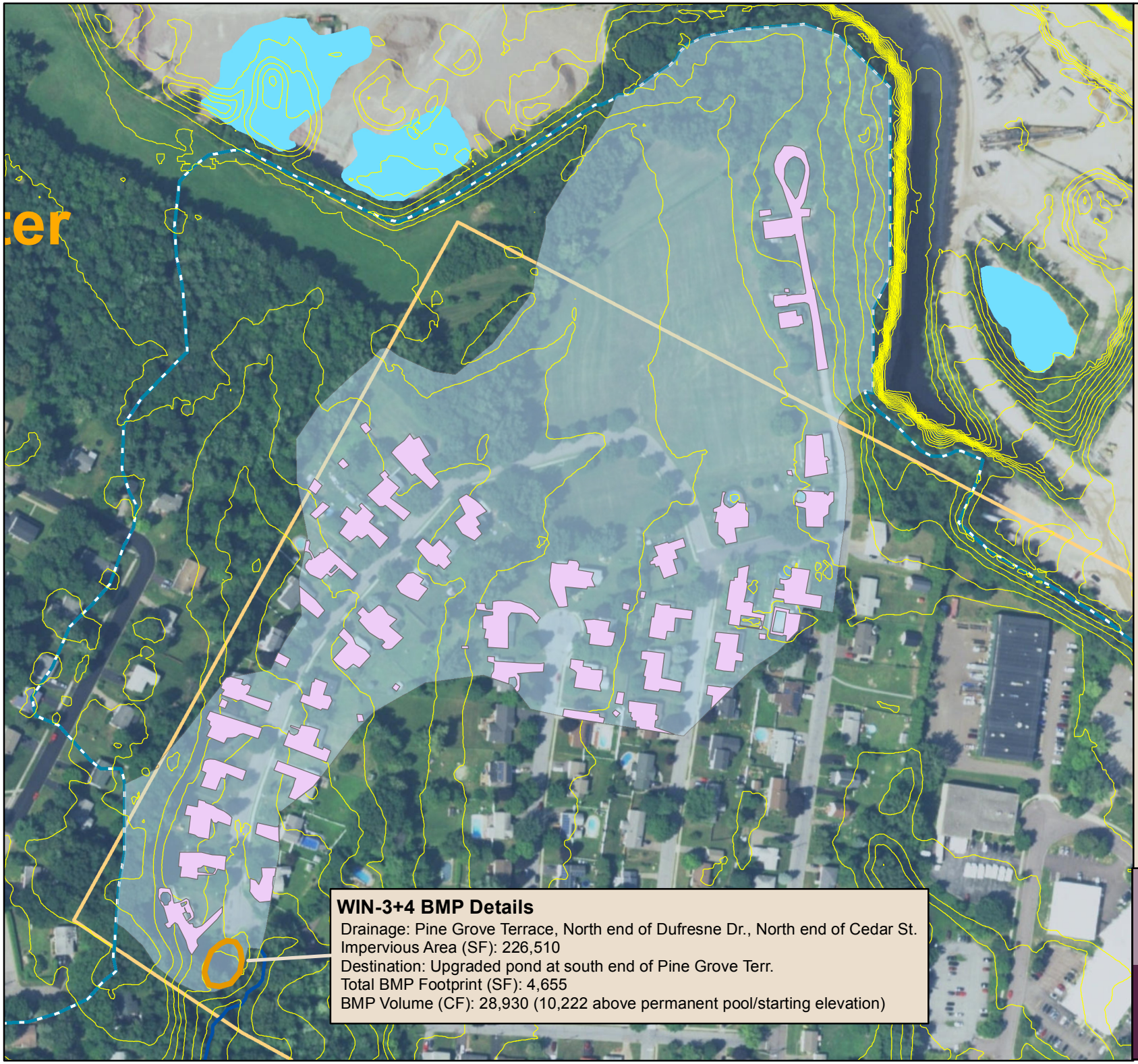
#	Date	Drwn	Chk'd	App'd	Description

DRAWING SCALE
File:

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

MOREHOUSE BRROK
FLOW REDUCTION ALTERNATIVES
WIN-5 AND WIN-6
WINOOSKI VT

FIGURE NO.
2



STONE ENVIRONMENTAL

Pine Grove Terrace Pond Upgrade
WIN-3+4 Concept Plan

Map #3

Morehouse Brook
Flow Restoration Plan

APPENDIX C: LANDRY PARK SOIL TEST RESULTS

Morehouse Brook Watershed Flow Restoration Plan Development, Winooski, Vermont – Hand Auger Soil Test Logs

Soils investigation in Landry Park conducted by Amy Macrellis of Stone Environmental, Inc. on April 28, 2016. No others were present during the investigation. The area of primary focus was the area of soils located north of the tennis court and in the outfield of the baseball diamond, where the Chittenden County Soil Survey shows the soils mapped as "fill material". Overall, the structure and redoximorphic features in the soil profiles evaluated were not indicative of recent fill. It appears that material was generally removed, rather than filled in, during construction of the park.

Auger Test Hole AH-1 (northeast of tennis court)

0" – 8"	Very dark brown (7.5YR 2.5/2) fine sandy loam, weak granular structure, friable consistence, moist. Topsoil with robust grass cover.
8" – 14"	Olive brown (2.5Y 4/3) loamy very fine sand, weak subangular blocky structure, friable consistence, moist.
14" – 30"	Light olive brown (2.5Y 5/3) silt loam, moderate platy structure, firm consistence, moist. Few medium distinct mottles at 24", wet at 30".

No bedrock to depth. Seasonal high groundwater indicators at 24". Structure and redoximorphic features in this soil profile are not indicative of recent fill.

Auger Test Hole AH-2 (just outside NW corner of ball field)

0" – 5"	Dark brown (7.5YR 3/2) very fine sandy loam, weak granular structure, loose consistence, moist. Topsoil.
5" – 9"	Dark grayish brown (2.5Y 4/2) very fine sandy loam, weak subangular blocky structure, friable consistence, moist.
9" – 14"	Olive brown (2.5Y 4/4) very fine sandy loam, weak subangular blocky structure, friable consistence, moist.
14" – 26"	Dark grayish brown (2.5Y 4/2) silt loam, moderate platy, firm consistence, dry. Very hard digging at 20". Few medium faint mottles at 22".

No bedrock to depth. Seasonal high groundwater indicators at 22". Structure and redoximorphic features in this soil profile are not indicative of recent fill.

Auger Test Hole AH-3 (middle of center field in the ballfield)

0" – 6"	Brown (7.5YR 5/2) loamy very fine sand, no discernable structure, friable consistence, moist. No topsoil at this location.
6" – 11"	Brown (7.5YR 4/2) loamy very fine sand, no discernable structure, friable consistence, moist.
11" – 30"	Yellowish brown (10YR 5/4) loamy very fine sand, fining downward to very fine sandy loam at 30", weak subangular blocky structure, friable consistence, moist. Many medium prominent mottles at 18" but easy digging to bottom of horizon.
30" – 36"	Yellowish brown (10YR 5/4) very fine sandy loam, moderate platy structure, firm consistence, moist. Many medium prominent mottles throughout.

No bedrock to depth. Seasonal high groundwater indicators at 18". Structure and redoximorphic features in this soil profile are not indicative of recent fill.

Auger Test Hole AH-4 (20 feet north of parking lot, between east crabapple tree and tennis court)

0" – 6"	Brown (7.5YR 5/2) loamy gravelly sand, no discernable structure, friable consistence, moist. No topsoil at this location.
6" – 18"	Yellowish brown (10YR 5/4) gravelly sand, no discernable structure, friable consistence, moist.
18" – 24"	Light olive brown (2.5Y 5/3) loamy gravelly fine sand, friable consistence, moist. Likely fill material – fragments of plastic bags and jumbled pieces of wood and roots. Some redoximorphic features in this horizon but it's not clear if these are any indication of seasonal high groundwater.
24" – 36"	Light olive brown (2.5Y 5/3) loamy very fine sand, friable consistence, moist. May be fill; still a few organic fragments to 36".
36" – 52"	Light olive brown (2.5Y 5/3) loamy very fine sand, friable consistence, moist. Firm consistence from 36-42"; many medium distinct mottles at 36". Soil texture does not change, but sand is wet and mottles are prominent at 52".

No bedrock to depth. Seasonal high groundwater indicators at 36".

Stream Monitoring Agreement

MEMORANDUM OF AGREEMENT BETWEEN THE VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION AND THE LISTED MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) COMMUNITIES

This Memorandum of Agreement sets forth the agreement between the parties, Vermont Department of Environmental Conservation (DEC) and the following Municipal Separate Storm Sewer System (MS4) Permittees: Burlington International Airport (BTV), City of Burlington (Burlington), Town of Colchester (Colchester), Village of Essex Junction (Essex Junction), Town of Essex (Essex), Town of Shelburne (Shelburne), City of South Burlington (South Burlington), City of Saint Albans (St. Albans City), Town of Saint Albans (St. Albans Town), University of Vermont (UVM), Vermont Agency of Transportation (VTrans), Town of Williston (Williston), and City of Winooski (Winooski) (collectively referred to as "the Parties"), for the purpose of participating in the Ecosystem Restoration and Water Quality Improvement Special Fund to perform the monitoring and other data collection required under the MS4 permitting program.

I. PROJECT PURPOSE:

The purpose of this Agreement, per Act 171 (H.650), Titled: Conservation and land development; stormwater; municipal separate storm sewer systems, is to aid participating MS4 Permittees in obtaining compliance with the flow monitoring requirements of their MS4 permits.

II. SCOPE OF WORK:

The parties agree to the following:

DEC will develop and manage a contract with a third party to carry out flow monitoring requirements as outlined in the existing MS4 permits. Upon signature of this Agreement, DEC will work with the undersigned MS4 Permittees and the contractor to ensure the flow monitoring requirements are met. As long as the MS4 Permittee contributes to the Water Quality Improvement Special Fund as outlined in Section V, they will be considered in compliance with the flow monitoring requirement of the MS4 permit. All management of the Contractor and non-compliance due to the Contractor will be the responsibility of DEC and will not result in any violations under the MS4 permit for any MS4 Permittee signed onto this MOU. DEC will provide the deliverables as outlined in section VIII.

The Parties will provide data on existing flow monitoring gauge sites, precipitation gauge sites, and other information considered to be necessary for the Contractor to complete the work. The Parties will provide funds, as agreed to in Section V, in order to initiate the flow monitoring. Failure to provide the funds as specified will be considered as non-compliance

with this Agreement and the Party will be responsible for maintaining compliance with the MS4 flow monitoring requirements through other means.

III. PROJECT BENEFITS

This project will help to assess the effectiveness of flow restoration plans for up to eleven stormwater impaired streams. Vermont's stormwater Total Maximum Daily Loads (TMDL) utilize flow targets to represent a range of stressors to water quality, from pollutant loads, land based and instream erosion, to increased flooding. Implementation of the flow restoration may take over fifteen years in some watersheds. Flow monitoring will be used by DEC and the Parties to ensure that the management practices implemented under the flow restoration plans are making progress towards the TMDL targets, and redirect efforts if needed.

IV. ENTITY ELIGIBILITY

The entities eligible to participate under the memorandum of understanding include any entity that is subject to the Vermont Municipal Separate Storm Sewer System (MS4) General Permit, signed on December 12, 2012. This includes the following MS4 Permittees: Burlington, Colchester, Essex, Essex Junction, Milton, Rutland Town, Rutland City, St. Albans City, St. Albans Town, Shelburne, South Burlington, Williston, Winooski, UVM, BTV, and VTrans.

V. FINANCIAL CONTRIBUTIONS

As developed by the eligible entities, all participating MS4 communities will divide the costs of the contracted work and pay DEC according to the table below.

		Costs by State Fiscal Years (July 1 – June 30)				
MS4 Permittee	**% of Total Cost**	**2017**	**2018**	**2019**	**2020**	**2021**
BTV	2.1%	$3,623	$2,805	$2,796	$2,087	$2,140
Burlington	7.4%	$12,782	$9,898	$9,866	$7,364	$7,549
Colchester	5.3%	$9,232	$7,149	$7,126	$5,319	$5,452
Essex Junction	6.1%	$10,625	$8,228	$8,201	$6,122	$6,275
Essex	6.0%	$10,473	$8,111	$8,084	$6,034	$6,185
Shelburne	7.0%	$12,185	$9,436	$9,405	$7,021	$7,196
South Burlington	17.4%	$30,170	$23,363	$23,287	$17,383	$17,818
St. Albans City	6.6%	$11,418	$8,842	$8,813	$6,579	$6,743
St. Albans Town	7.1%	$12,287	$9,515	$9,483	$7,079	$7,256
UVM	5.5%	$9,564	$7,407	$7,382	$5,510	$5,648
VTrans	16.6%	$28,794	$22,298	$22,225	$16,590	$17,005
Williston	6.2%	$10,668	$8,261	$8,234	$6,146	$6,300
Winooski	6.6%	$11,363	$8,799	$8,770	$6,547	$6,711

		Costs by State Fiscal Years (July 1 – June 30)				
MS4 Permittee	**% of Total Cost**	**2017**	**2018**	**2019**	**2020**	**2021**
Total	**100.0%**	**$173,184**	**$134,112**	**$133,672**	**$99,781**	**$102,278**

Each participating MS4 Permittee to this agreement is required to submit the payment listed above on or before May 1 each year in order to be considered in compliance with the terms of the agreement for that year. Payments shall be made directly to DEC. If payment is not received in time, monitoring services as provided by the Contractor to the State will be discontinued.

Actual costs are dependent on the finalization of the Contract with the selected Contractor. Fiscal year 2020 and 2021 are anticipated costs based on renewal of the Contract for monitoring services with the selected Contractor.

VI. PROJECT CONTACTS

Parties Contacts
See Attachment A

DEC Contact
David Pasco
Admin. and Innovation Division
802-490-6112
david.pasco@vermont.gov

VII. EFFECTIVE DATE; MODIFICATION

This Memorandum of Agreement shall be effective from the date of execution and shall terminate on June 30, 2021. This Memorandum of Agreement may be amended or modified at any time by mutual written agreement of all Parties.

This agreement will provide monitoring services for the participating MS4 Permittees from State Fiscal Year 2017 (July 1, 2016) through State Fiscal Year 2021 (June 30, 2021).

VIII. DELIVERABLES

Each of the Parties will provide the following deliverables to DEC:

1. Data on existing flow monitoring gauge sites, precipitation gauge sites, and other information considered to be necessary for the Contractor to complete the work, as requested.

2. Notification of any changes in the MS4 Communities' participation in this agreement as early as practicable.

3. Payment of funds as outlined in Section V.

DEC will provide the following deliverables to all participating entities:

1. A comprehensive report outlining Quality Assurance/Quality Control protocols, shall be submitted to all participating entities prior to the initiation of monitoring.

2. Mean daily discharge in cubic feet per second at each site for each day of the monitoring period calculated from measurements taken at five minute intervals.

3. A platform for continuous remote access to streamflow gaging station data (i.e., satellite, radio, or cellular telemetry) complete with real-time data loss notification systems.

4. Mean daily depth of precipitation in inches (to the nearest 0.01 inch) at each site for each day of the monitoring period, calculated from measurements taken at five minute intervals and form of precipitation identified (rain vs. snow).

5. An annual report on each impaired stream with the flow duration curve and calculated flow metrics, and a brief narrative describing the preceding field season, gage configuration, and how data was collected and compiled.

6. On an annual basis, compiled sub-daily data, with field notes available upon request.

WE, THE UNDERSIGNED PARTIES, AGREE TO BE BOUND BY THIS AGREEMENT.

STATE OF VERMONT

Dept of Environmental Conservation

By:

_____

Commissioner

Dept of Environmental Conservation

Date: _____

THE PARTICIPATING PARTIES:

BURLINGTON INTERNATIONAL AIRPORT

By:

_____

Title:_____

Burlington International Airport

Date: _____

WE, THE UNDERSIGNED PARTIES, AGREE TO BE BOUND BY THIS AGREEMENT.

STATE OF VERMONT

Dept of Environmental Conservation

By:

_____

Commissioner

Dept of Environmental Conservation

Date: _____

THE PARTICIPATING PARTIES:

CITY OF BURLINGTON

By:

_____

Title: _____

City of Burlington

Date: _____

WE, THE UNDERSIGNED PARTIES, AGREE TO BE BOUND BY THIS AGREEMENT.

STATE OF VERMONT

Dept of Environmental Conservation

By:

_____

Commissioner

Dept of Environmental Conservation

Date: _____

THE PARTICIPATING PARTIES:

TOWN OF COLCHESTER

By: Bryan K. Osborne

Title: Director of Public Works

Town of Colchester

Date: 3/21/16