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).

- <u>Permit #1-1409 Champlain Valley Exposition Historical Drainage:</u>

  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 BMPDSS 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.

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.

Figure 4: Outfall 31

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.

9 Appendices