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

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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.

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.

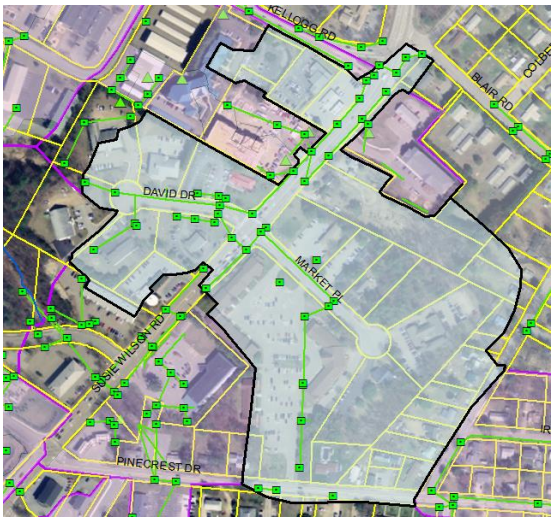
Outfall 199- Morse Dr.

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.

9 Appendices

Table A-2-1 Expired Permit List

BMPDSS Model Scenario[1]	Permit #	Project Name	Ownership	RDA/Renewed	Permit Notes/ System Description
Town of Colchester					
Not in model	1-0052	Eagle Park/Colonial Development Corp	Public	see 4333-INDO.R	catch basins
Not in model	1-0609	Westbury Park- Mobile Home Park (MHP)	Private	RDA proposed	catch basins to grass swales
Not in model	2-1165	Hidden Oaks - Phase 1	Shared		30 lot subdivision. Catch basins and pvc to energy dissipater then to grass swales
Not in model	2-0843	Pheasant Woods Condominium Assoc.	Private	RDA proposed for S/N 1	Overland flow to swale
pre 2002	1-0674	Wall St. Shepard/Gardener Subdivision	Public		Catch basins to 18" perforated PVC, with stone drain to 10' stone drainage ditch and grass swale
pre 2002	1-0959	Hidden Oaks Phase 2	Shared		All catch basins except 7, 8 drain to dry wells.
pre 2002	2-0762	Westbrook Condominiums	Public		Catch Basins to Retention Basin
Town of Essex					
Not in model	1-0250	Pinecrest Glen- Kimberly Drive	Private		direct discharge through headwall
Not in model	1-0518	Ewing Office Park Lot 3	Private		overland to swale
Not in model	1-0552	Shopping Center-Bartlett-Weaver Associates	Private		swale to perforated pipe in a stone infiltration trench
Not in model	1-0619	Subdivision Lot 2 in Ewing Place	Private		stone lined drainage swales
Not in model	1-0694	Ewing Office Lot 1- Ewing Place	Private		catch basins and drain pipe to swale under #2-0634 permit
Not in model	1-0761	Ed-U-Care Children's Center- Ewing Lot 4, 5	Private		grass swale to roadside ditch
Not in model	1-0896	David Dr. Business Park, 7 lots-Carolyn Petit	Private		catch basins to stone lined ditch then overland flow
Not in model	1-0965	Ewing Lot 5 - James Ewing Property	Private		series of dry well catch basins via overland flow
Not in model	1-1463	VT Systems Inc. - 12 market Pl. - Willey	Private		no permit file available
Not in model	2-0633	Shillingford Crossing- Town of Essex	Public		catch basins and pipes to grasses and/or vegetated swales
Not in model	2-0634	Commercial park access road -Ewing Place	Private		catch basins, drop inlets, and grassed swales
Not in model	2-0925	Shopping Center- Bartlett-Weaver Associates	Private		18" pipe to rip-rap lined drainage ditch beside Susie Wilson Rd
Not in model	2-1045	Pearl Street Park-- Owned by Town of Essex	Public		overland flow to grassed swale
pre 2002	1-1469	Mainstay Suites- Handy	Private		permit not on file
pre 2002	1-1143	Racquet's Edge drywell 2	Private	5022-9010 now routes runoff to Indian Brook	infiltration system
pre 2002	1-1143	Racquet's Edge drywell 1	Private	5022-9010 now routes runoff to Indian Brook	infiltration system
Village of Essex Junction					
Not in model	2-0863	Commercial lot- 167 Pearl Street- James Ewing Property Management	Private		overland flow to grassed swale
Not in model	2-0920	Maples Community Townhouses	Private		Maples Townhouse- 209 Pearl Street
pre 2002	1-1527	Highland Village, 65-69 Pearl St.	Private		no permit file available

1- 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

Table A-2-2 Existing BMP List in BMPDSS Model

Model	MS4	DATABASE INFORMATION			
		Permit #	Project/BMP Name	BMP Type	Permit Note
pre 2002	Town of Colchester	1-0959	Hidden Oaks Phase 2	Dry Well	
pre 2002	Town of Colchester	2-0762	Westbrook Condominiums	Retention Basin	
pre 2002	Town of Colchester	1-0674	Wall St. Shepard/Gardener Subdivision	Catch basins to 18" perforated PVC, with stone drain to 10' stone drainage ditch and grass swale	
pre 2002	Town of Essex	1-1469	Mainstay Suites- Handy	Detetention Basin	
pre 2002	Town of Essex	1-1143	Racquet's Edge drywell 2	Dry Well	5022-9010- runoff to Indian Brook
pre 2002	Town of Essex	1-1143	Racquet's Edge drywell 1	Dry Well	5022-9010 -runoff to Indian Brook
pre 2002	Village of Essex	1-1527	Highland Village, 65-69 Pearl St.	Infiltration	
post 2002	Town of Colchester	3945-INDS	Woods Edge HOA/ Town of Colchester	Detention Basin	renewed 3949-INDS.R
post 2002	Town of Colchester	6585-INDS	Area 1A - Wells Meadow, 929 Severance Rd.	Dry Well with Exfiltration (12.5 in/hr)	
post 2002	Town of Colchester	6585-INDS	Area 1B - Wells Meadow, 929 Severance Rd.	Dry Well with Exfiltration (12.5 in/hr)	
post 2002	Town of Colchester	6585-INDS	Area 2 - Wells Meadow, 929 Severance Rd.	Dry Well with Exfiltration (12.5 in/hr)	
post 2002	Town of Colchester	6585-INDS	Area 3 - Wells Meadow, 929 Severance Rd.	Dry Well with Exfiltration (12.5 in/hr)	
post 2002	Town of Essex	17 Morse Storage	Peter Morse Storage	Infiltration	no permit
post 2002	Town of Essex	6993-INDS	6A Susie Wilson Rd	Underground Storage with Exfiltration	
post 2002	Town of Essex	4118-INDSb	S/N 2 - Bobcat Division at 27 Kellogg Rd.	Infiltration	
post 2002	Town of Essex	4118-INDSa	S/N 1 - Bobcat Division at 27 Kellogg Rd.	Infiltration	
post 2002	Town of Essex	4118-INDSc	S/N 3 - Bobcat Division at 27 Kellogg Rd.	Infiltration	
post 2002	Town of Essex	3911-INDSa	S/N 1A (includes drainage areas 1A and 1B)- Cornerstone Condos	Basin with Exfiltration (12.5 in/hr)	supercedes 1-1383
post 2002	Town of Essex	3911-INDSb	S/N 1B (drainage area 1C) - Cornerstone Condo	Basin with Exfiltration (12.5 in/hr)	supercedes 1-1383
post 2002	Town of Essex	3911-INDSc	S/N 2- Cornerstone Condo	Basin with Exfiltration (12.5in/hr)	supercedes 1-1383
post 2002	Town of Essex	3911-INDSd	S/N 3 - Cornerstone Condo	Basin with Exfiltration (12.5in/hr)	supercedes 1-1383
post 2002	Town of Essex	5088-INDS	Lowe's Sub 4A	Infiltration Basin with Exfiltration (8.8 in/hr)	
post 2002	Town of Essex	5088-INDS	Lowe's Sub 4B	Infiltration Basin with Exfiltration (8.8 in/hr)	
post 2002	Town of Essex	5088-INDS	Lowe's Sub 2	Infiltration Basin with Exfiltration (6.3 in/hr)	
post 2002	Town of Essex	5088-INDS	Lowe's Sub 1B	Bioretention Area	
post 2002	Town of Essex	5088-INDS	Lowe's Sub 1A/3	Underground Storage with Exfiltration (5.4 in/hr)	
post 2002	Town of Essex	5088-INDS	Lowe's Sub 1B	Underground Storage with Exfiltration (5.4 in/hr)	
post 2002	Town of Essex	5173-9020	30 Unit Condominium- 47 Susie Wilson Rd.	no HC model	
post 2002	Town of Essex	6056-INDS	Lot 6 Ewing Place	Infiltration Area with Exfiltration (12.5 in/hr)	
post 2002	Town of Essex	5944-INDO	Kellogg Rd Stormwater Pond	Extended Detetention Basin	
post 2002	Town of Essex	4212-INDS	POI 3 -Pinecrest Congregate Housing	Infiltration Area with Exfiltration (12.5 in/hr)	
post 2002	Town of Essex	4212-INDS	POI 4 - Pinecrest Congregate Housing	Infiltration Area with Exfiltration (12.5 in/hr)	
post 2002	Town of Essex	4212-INDS	POI 1 -Pinecrest Congregate Housing	Infiltration Area with Exfiltration (12.5 in/hr)	
post 2002	Town of Essex	4212-INDS	POI 2 -Pinecrest Congregate Housing	Infiltration Area with Exfiltration (12.5 in/hr)	
post 2002	Town of Essex	6548-INDS	Area 1A - Essex Mini Storage	Infiltration Area with Exfiltration (12.5 in/hr)	
post 2002	Town of Essex	6548-INDS	Area 1B- Essex Mini Storage	Infiltration Area with Exfiltration (12.5 in/hr)	
post 2002	Town of Essex	Private	Gary Morse Property	Dry Well with Exfiltration (12.5 in/hr)	
post 2002	Village of Essex	4140-INDS	235 Pearl Street	Stormtech Chambers, Detention	supercedes 2-0872
post 2002	Village Essex	Private	Essex Shopping Center Upgrades	Dry Well with Exfiltration (12.5 in/hr)	
post 2002	VTRANS/Town of Colchester	5598-INDO	Fort Ethan Allen	Extended Detention pond	

Sunderland Brook Flow Restoration Plan
3/23/2015

Table A-3-1 BMP List by BMPDSS Model Scenario

Proposed BMP ID	MS4 owner of impervious draining to practice	Ownership of Land where BMP is located	BMP Type (Key*)	New or Existing Site?	Permit # (if applicable)	Address	Drainage Area, DA (acres)	Impervious Acres Managed (ac)	Channel Protection Volume Managed		Retrofit Description
									CF	Ac-ft	
Added to Credit 1 Scenario											
Existing Post2002 BMPs	Varies	Varies	Varies	Varies	---	---	---	74.53	213792	4.908	Varies
Tracy Rd. -Fort Ethan Allen-	Vtrans/Colchester	VTRANS	IB		6363-INDS	Tracy Rd./ Barnes	4.97	3.94	18513	0.425	Long Infiltration Trench/Bioretention
Outfall 126: Fort Ethan Allen	Town Essex/UVM	Public (Town and UVM)	UIB		NP	Ryan St.	20.42	9.84	25134	0.577	Excessively eroded outfall and channel. Constrained by UVM property. Proposed infiltration basin with perforated pipe within existing terraced area just upslope of the channel.
Outfall 31- Morse Dr.	Town Essex	Private	UIB		NP	Morse Dr.	4.98	3.56	12937	0.297	Infiltration stone gallery at end of pipe.
Outfall 199-Morse Dr.	Town Essex	Private	UIB		NP	Morse Dr.	8.18	5.18	5924	0.136	Retrofit roundabout upslope from outfall with infiltration practice in ROW. Wetlands near outfall.
Route 15/Pearl St.	Village Essex	Private	UIB		2-0920	213 Pearl St.	4.25	2.32	3877	0.089	Redirect Route 15 Stormline to underground infiltration chambers.
Forman Dr. Roundabout	Colchester	ROW	IB		NP	Forman Dr./Severance Dr.	3.14	1.34	2047	0.047	Retrofit grassed circular median with bioretention practice.
Kimberly Drive (O3, O4)	Town Essex	Private	UIB		1-0250	Parizo Dr. /Kimberly Dr.	33.06	7.90	9997	0.230	StormTech infiltration chamber system at end of Parizo Dr.
Added to Credit 2 Scenario											
David Dr. Outfall	Town Essex	ROW	UIB		1-0896, 1-0552, 1-1463	David Dr.	32.21	15.96	61028	1.40	StormTech infiltration Chamber system at end of David Dr.
								50.04	353250	**8.11**	

Key: * NP = No permit
BMP Type: DB: Detention Basin, USC: Underground/Covered Storage Chamber, UIB= Underground Infiltration Basin, IB= Vegetated Infiltration Basin
GSI = Smaller-scale GSI practice DW= Dry Wells *WQ = Addresses WQ issue (i.e. excessive erosion but not flow targets)

Sunderland Brook Flow Restoration Plan
Table A-3-2: MS4 Target Allocation and FRP Progress
6/8/2015

Table 1: Model Scenario Results Summary

Model Scenario	BMPDSS Model Run Date	High Flow Target, Q 0.3 (± %)	Low Flow Target, Q 95 (± %)
TMDL Targets for Sunderland Brook	---	-3.7%	3.6%
Existing Condition Post2002 Scenario	11/12/2014	-7.91%	2.08%
Proposed BMP Scenario "Credit2"	1/16/2015	-17.85%	8.33%

Table 2: TMDL Flow Target Allocation

MS4 Impervious Owner	Total Area w/in Watershed (acres)	Impervious Cover (acres)	% of Watershed Impervious Cover	Target High Flow **Reduction** (%)	Target Low Flow **Increase** (%)
University of Vermont	---	---	---	---	---
Town of Essex	318.32	123.14	37.6%	-1.32%	1.29%
Village of Essex Junction	173.58	86.5	26.4%	-0.93%	0.90%
Town of Colchester	867.07	107.18	32.8%	-1.34%	1.30%
VTrans	17.83	10.42	3.2%	-0.11%	0.11%
Watershed Total	**1376.80**	**327.24**		**-3.7%**	**3.6%**

* 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.

*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.

*Watershed delineation from file: "Sunderland_subwat_Post2002_101714"

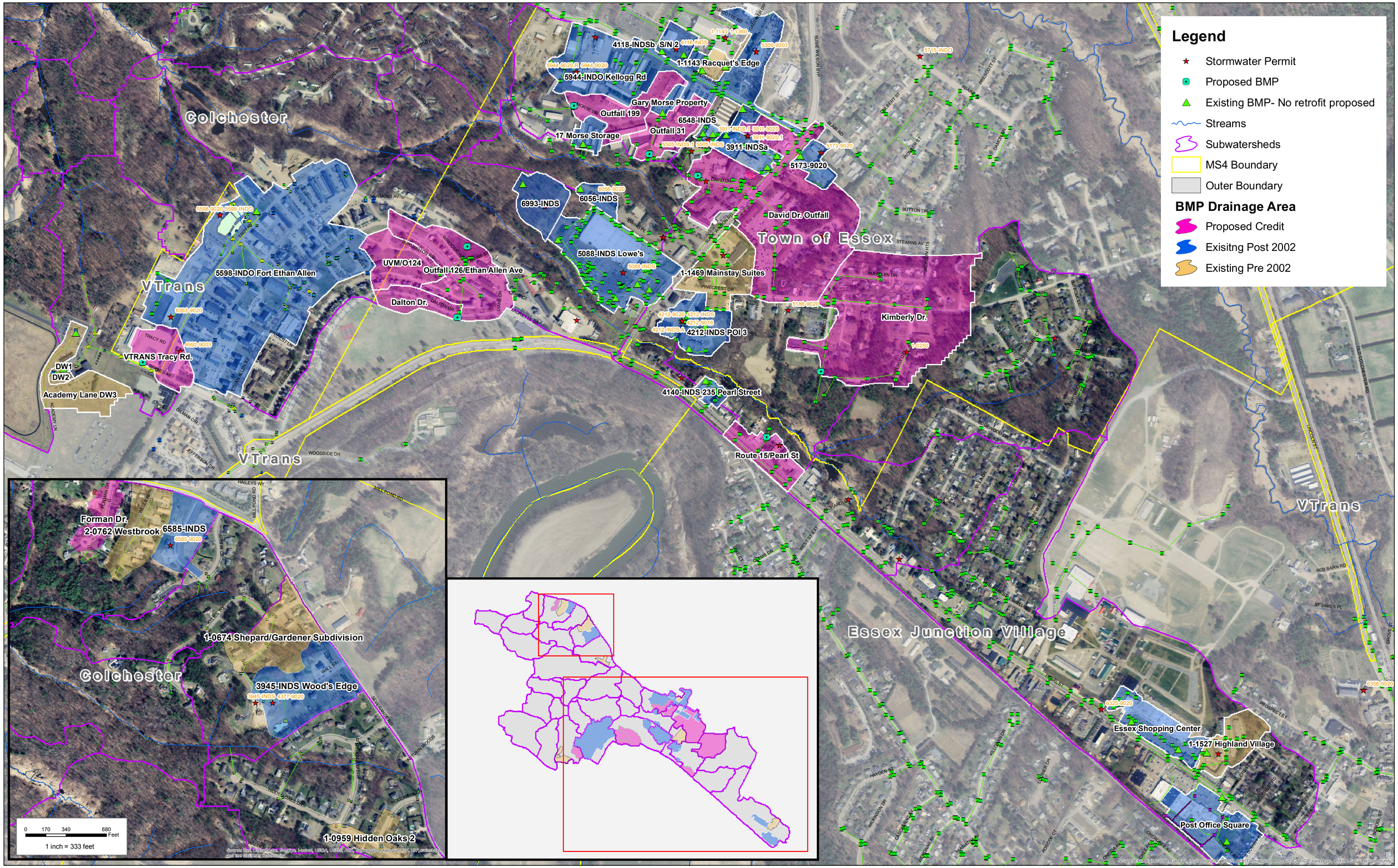
Table 3: Progress toward flow targets by model scenario

MS4 Impervious Owner	**Existing Condition "Post 2002"**						**Proposed BMP Scenario "Credit2"**					
	Managed Impervious Acres by DET or INF[1]	Target High Flow Q 0.3 (± %) Reduction Left [2]	**Percent of High-flow Target addressed, %**	Managed Impervious Acres INF	Target Low Flow Q 95 (± %) Increase Left[3]	Percent of Low flow Target addressed, %	Managed Impervious Acres by DET or INF	Target High Flow Q 0.3 (± %) Reduction Left	**Percent of High flow Target addressed, %**	Managed Impervious Acres INF	Target Low Flow Q 95 (± %) Increase Left	Percent of Low-flow Target addressed, %
Town of Essex	39.0	0%	286.2%	25.5	0%	133.9%	75.3	0%	748.5%	60.8	0%	484.8%
Village of Essex Junction	1.0	-0.88%	10.5%	1.0	0.88%	7.6%	10.6	0%	149.9%	9.6	0%	108.6%
Town of Colchester	33.0	0%	278.3%	2.7	0.99%	16.4%	36.3	0%	414.7%	4.4	0.7%	40.3%
VTrans	4.4	0%	381.7%	0.0	0.11%	0.0%	6.8	0%	796.1%	2.4	0%	221.3%
		4.21%	**213.8%**			**57.8%**			**482.4%**			**231.4%**
	TARGET MET						TARGET MET					

1- DET= Detention BMP providing CPv storage, INF= Infiltration BMP infiltrating the CPv volume

2-When the target was met, the" Q0.3 and Q95 LEFT to the managed" was changed to 0% in the table. There are still MS4's with a portion of the target left, even with the overall Watershed Target MET, because the allocation is relative to the MS4's original target allocation.

3-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.



WATERSHED CONSULTING ASSOCIATES, LLC

Existing and Proposed Stormwater BMPs
Sunderland Brook Flow Restoration Plan
Essex and Colchester, Vermont
as of 2-6-2015

N

0 335 670 1,340 Feet

1 inch = 355 feet

Table A-5-1 BMP Ranking Criteria Key

Category	ID	Criteria	Technical Description	Description
Cost/Operations	A	Project Cost	The project costs were grouped into categories from >$50,000 to >$400,000 based on the range of projects proposed. Cost estimates were developed using the latest unit costs from VTrans as well as local experience. More expensive projects are ranked lower.	Project Costs include additional engineering, permitting, and construction. Transportation and utility conflicts, as well as overall constructability is also reflected in the cost.
	B	Ease of O/M	This criteria is based on experience with the general ease of operation and maintenance for specific categories of practices.	This criteria is based on general knowledge of the ease of operation and maintenance for specific categories of practices. Most stormwater facilities require some amount of annual maintenance, with some BMP's requiring significantly more operational resources than others.
Project Design Metrics	C	Impervious Acres Managed (ac)	Natural groupings within the range of impervious managed for the proposed projects were identified. More impervious managed receives a higher score.	The more impervious managed by a project, the higher the potential pollutant reduction. Additionally, the goal of the FRP is to manage existing impervious surfaces.
	D	Channel Protection Volume (CPv) Mitigated, (i.e.. 1-year Storm)	Groupings within the range of CPv volume storage were identified. The largest grouping receives the highest score. The CPv was estimated in HydroCAD, using local rainfall data.	The Channel Protection Volume (CPv) is the volume of stormwater runoff generated from the 1-year design storm (1.96" in Essex). A BMP which provides CPv storage was determined to reduce the High-flow (Q0.3%), which is the flow rate exceeded 0.3% of the time (output from the State's BMPDSS model). Mitigating the CPv reduces channel erosion and excessive pollutant loading from streams.
	E	Volume Infiltrated (ac-ft)	Natural groupings within the range of volumes infiltrated for the BMPs were identified to which relative points were be assigned. The largest volume infiltrated was assigned the highest score. Volumes were calculated in HydroCAD.	The Volume Infiltrated indicates the amount of stormwater runoff that is infiltrated into the groundwater, and provides baseflow for the stream. The TMDL flow targets include a low-flow target, which is addressed by an infiltration-based BMP.
	F	Water Quality (WQ) Volume Mitigated	The WQ volume mitigated is defined as the runoff volume generated from the 0.9" rainfall that is stored in the BMP's permanent pool. Three categories were identified for the WQ volume 1) 100% WQ volume control which is the best-case standard for the EFA procedure. 2) >= 20% WQ volume as required for redevelopment projects, and 3) less than 20% WQ volume.	The WQ volume mitigated is an indicator of the reduction in pollutant runoff from 90% of annual storm events, approximated to be an 80% removal of the Total Suspended Solids (TSS) and 40% total phosphorus (TP) load.
	G	Primary or Secondary BMP	Primary BMP is the main control practice, whereas a secondary BMP drains to a primary BMP. Primary BMPs have a higher weighting.	A primary BMP is the main control practice, like a large end-of-pipe detention pond. A secondary BMP is located within the drainage area of a primary BMP, providing additional flow control and treatment. Secondary BMPs are weighted less than primary BMPs in terms of reducing stormwater runoff.
Project Implementation	H	Permitabilty	Permitabilty is simplified into two categories to reflect the common scenarios in permitting, as 1) minimal permitting 2) Complex permitting issues.	Permitabilty is a measure of the expected level of effort to permit the project, based on knowledge that each type of permit takes varying amounts of time. Some common permits include Stormwater Construction, Local Zoning, Act 250 amendments, VTRANS ROW, etc.
	I	Land Availability	Public land is preferred, followed by regulated private land, and private land where the owners are known to be open to participate. Private land, in which participation of the owner is unknown is lower priority.	Land availability is critical for BMPs requiring open space for detention and access for the Municipality involved. Properties owned by the Municipality (Public) are ranked the highest, followed by privately owned land with an expired permit, which provides leverage to retrofit the BMP. The next priority is private land with a land owner who is known to be cooperative. If a land owner is known to not be cooperative, points were subtracted from the ranking.

Category	ID	Criteria	Technical Description	Description
Other Project Benefits/Constraints	J	Flood Mitigation	Flood mitigation is categorized by the scale of the impact. A neighborhood flooding issue is weighed more heavily than a localized drainage issue.	Flood mitigation is categorized by the scale of the impact. A neighborhood flooding issue is weighed more heavily than a localized drainage issue.
	K	TMDL Flow Target Addressed (Q03, Q95)	More weight is on BMPs that address both TMDL targets- the high-flow (Q0.3%) and low-flow targets (Q95%). The high-flow target is addressed by detention BMPs which provide storage of the CP volume (1-year storm). The low-flow target is addressed by BMPs which infiltrate the 1-year storm volume.	The goal of the FRP is to implement projects which address the TMDL flow targets. The high-flow target is measured as a **reduction** in the stream flow rate exceeded 0.3% of the time, while the low-flow target is an **increase** in the stream flow rate exceeded 95% of the time (baseflow). Projects which address both targets through storage or infiltration of the 1-year design storm are weighted the highest, followed by projects which address just the high-flow. Projects which do not address the full 1-year storm volume are weighted the lowest.
	L	Lake Champlain Phosphorus TMDL	Yes or no whether the proposed practice will provide benefit toward the Lake Champlain Phosphorus TMDL. This will be determined once the TMDL compliance metrics are released.	The Lake Champlain Phosphorus TMDL has been developed in the effort to reduce nutrient loading and consequential toxic algal blooms in Lake Champlain. The TMDL will require stormwater BMPs to meet a certain level of Total Phosphorus reduction. Each BMP will be evaluated against the TMDL compliance metrics, and scored yes or no if the project meets the TMDL standards.
	M	Other Project Benefits/Constraints	This criteria is to account for indirect project benefits (+) like infrastructure improvements (e.g. aging infrastructure replacement, wetlands enhancement, and if it addresses an expired permit). This criteria also accounts for specific project constraints (-) due to potential erodible soils and bank destabilization.	This criteria is to account for indirect project benefits like infrastructure improvements, community benefits, habitat creation, etc., as well as additional project constraints like potential erodible soils causing bank destabilization concerns.
	N	Annual Total Suspended Solids (TSS) Yield Mitigated (lbs.) *WinSLAMM Model result	The annual TSS Yield mitigated by the proposed BMP was estimated with the Source Loading and Management Model (WinSLAMM), a continuous simulation urban runoff and water quality model. This criteria provides a metric for the WQ benefit of the project.	The annual TSS Yield mitigated by the proposed BMP was estimated with the Source Loading and Management Model (WinSLAMM), a continuous simulation urban runoff and water quality model. This criteria provides a metric for the WQ benefit of the project.
	O	Annual Total Phosphorus (TP) Yield Mitigated (lbs.) *WinSLAMM Model result	The annual TP Yield mitigated by the proposed BMP was estimated with the Source Loading and Management Model (WinSLAMM), a continuous simulation urban runoff and water quality model. This criteria provides a metric for the WQ benefit of the project.	The annual TP Yield mitigated by the proposed BMP was estimated with the Source Loading and Management Model (WinSLAMM), a continuous simulation urban runoff and water quality model. This criteria provides a metric for the WQ benefit of the project.

Table A-5-2 BMP Ranking Scoring Key

Category	ID	Criteria	Quality	Score
Cost/Operations	A	Relative Project Cost	Under $50,000	4
			$50,000-100,000	3
			$100,000-400,000	2
			Over $400,000	1
	B	Ease of O/M	Underground Storage/ Swirl Separator	2
			Bioretention/Rain Gardens/Tree Box Filters	1
			Ponds/Constructed Wetlands	0
Project Design Metrics	C	Impervious Acres Managed (ac)	> 5 acres	5
			4-5 acres	4
			2-4 acres	3
			1-2 acres	2
			< 1 acre	1
	D	Channel Protection Volume (CPv) Mitigated, (ie. 1-year Storm)	0.6-1.0 ac-ft	5
			0.4-0.6 ac-ft	4
			0.2-0.4 ac-ft	3
			0.05-0.2 ac-ft	2
			>0-0.05 ac-ft	1
	E	Volume Infiltrated (ac-ft)	>1 ac-ft	4
			0.5-1 ac-ft	3
			0.1- 0.5 ac-ft	2
			0.01-0.1 ac-ft	1
			no infiltration	0
	F	Water Quality (WQ) Volume Control	>= 100% WQ volume controlled in permanent pool	2
			>= 20 % WQ volume controlled in permanent pool	1
			Under 20% WQ volume controlled in permanent pool	0
	G	Primary or Secondary BMP	Primary	2
			Secondary (Routed to Primary Control)	0
Project Implementation	H	Permitabilty	Minimal Issues/Concerns or no permits	2
			Complex issues/Potential permit denial	0
	I	Land Availability	MS4 owned	4
			Public	3
			Non MS4 owned regulated (expired permit)	3
			Non MS4 owned/Participatory Owner	2
			Unknown	0
			Not MS4 owned/Non participatory owner	-2
Other Project Benefits/Constraints	J	Flood Mitigation (Is existing flooding issue mitigated by project?)	Neighborhood Wide Flooding Issue	3
			Infrastructure damage (e.g. Wet Basement)/Single Property	2
			Nuisance Issue (ie. ponding, puddles, etc).	1
			None	0
	K	TMDL Flow Target Addressed (Q03, Q95)	High and Low Flow Targets	3
			High Flow Target	2
			No target addressed in BMPDSS (just WQ treatment)	1
	L	Lake Champlain Phosphorus TMDL*	Addressed TMDL	1
			Does not address TMDL	0
	M	Other Project Benefits (+) / Constraints (-)	Infrastructure Improvement (e.g. Culvert Replacement) (+)	1
			Educational/Functional Benefit (+)	1
			Recreational Benefit (+)	1
			Expired permit on site (+)	1
			Outfall Erosion Control (+)	1
			Potential Erodible soils/Bank Destabilization issues (-)	-1
			Access Issues (-)	-1
			Uncertainty in groundwater table/feasibility for infiltration (-)	-3
			Loss of Habitat (-)	-1
	N	Annual Total Suspended Solids (TSS) Yield Mitigated (lbs.) *WinSLAMM Model result	>10,000	5
			3000-10,000	4
			1500-3000	3
			1000-1500	2
			50-1000	1
			<50	0
	O	Annual Total Phosphorus (TP) Yeild Mitigated (lbs.) *WinSLAMM Model result	<5	6
			4-5	5
			3-4	4
			2-3	3
			1-2	2
			<1	1
	*Lake Champlain Phosphorus TMDL compliance metrics TBD. All projects which address > 20%of the WQ volume are considered meeting this standard.			

Table A-5-1 BMP Ranking Criteria Key

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Cost/Operations	A	Project Cost	The project costs were grouped into categories from >$50,000 to >$400,000 based on the range of projects proposed. Cost estimates were developed using the latest unit costs from VTrans as well as local experience. More expensive projects are ranked lower.	Project Costs include additional engineering, permitting, and construction. Transportation and utility conflicts, as well as overall constructability is also reflected in the cost.
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	L	Lake Champlain Phosphorus TMDL	Yes or no whether the proposed practice will provide benefit toward the Lake Champlain Phosphorus TMDL. This will be determined once the TMDL compliance metrics are released.	The Lake Champlain Phosphorus TMDL has been developed in the effort to reduce nutrient loading and consequential toxic algal blooms in Lake Champlain. The TMDL will require stormwater BMPs to meet a certain level of Total Phosphorus reduction. Each BMP will be evaluated against the TMDL compliance metrics, and scored yes or no if the project meets the TMDL standards.
	M	Other Project Benefits/Constraints	This criteria is to account for indirect project benefits (+) like infrastructure improvements (e.g. aging infrastructure replacement, wetlands enhancement, and if it addresses an expired permit). This criteria also accounts for specific project constraints (-) due to potential erodible soils and bank destabilization.	This criteria is to account for indirect project benefits like infrastructure improvements, community benefits, habitat creation, etc., as well as additional project constraints like potential erodible soils causing bank destabilization concerns.
	N	Annual Total Suspended Solids (TSS) Yield Mitigated (lbs.) *WinSLAMM Model result	The annual TSS Yield mitigated by the proposed BMP was estimated with the Source Loading and Management Model (WinSLAMM), a continuous simulation urban runoff and water quality model. This criteria provides a metric for the WQ benefit of the project.	The annual TSS Yield mitigated by the proposed BMP was estimated with the Source Loading and Management Model (WinSLAMM), a continuous simulation urban runoff and water quality model. This criteria provides a metric for the WQ benefit of the project.
	O	Annual Total Phosphorus (TP) Yield Mitigated (lbs.) *WinSLAMM Model result	The annual TP Yield mitigated by the proposed BMP was estimated with the Source Loading and Management Model (WinSLAMM), a continuous simulation urban runoff and water quality model. This criteria provides a metric for the WQ benefit of the project.	The annual TP Yield mitigated by the proposed BMP was estimated with the Source Loading and Management Model (WinSLAMM), a continuous simulation urban runoff and water quality model. This criteria provides a metric for the WQ benefit of the project.

Table A-5-2 BMP Ranking Scoring Key

Category	ID	Criteria	Quality	Score
Cost/Operations	A	Relative Project Cost	Under $50,000	4
			$50,000-100,000	3
			$100,000-400,000	2
			Over $400,000	1
	B	Ease of O/M	Underground Storage/ Swirl Separator	2
			Bioretention/Rain Gardens/Tree Box Filters	1
			Ponds/Constructed Wetlands	0
Project Design Metrics	C	Impervious Acres Managed (ac)	> 5 acres	5
			4-5 acres	4
			2-4 acres	3
			1-2 acres	2
			< 1 acre	1
	D	Channel Protection Volume (CPv) Mitigated, (ie. 1-year Storm)	0.6-1.0 ac-ft	5
			0.4-0.6 ac-ft	4
			0.2-0.4 ac-ft	3
			0.05-0.2 ac-ft	2
			>0-0.05 ac-ft	1
	E	Volume Infiltrated (ac-ft)	>1 ac-ft	4
			0.5-1 ac-ft	3
			0.1- 0.5 ac-ft	2
			0.01-0.1 ac-ft	1
			no infiltration	0
	F	Water Quality (WQ) Volume Control	>= 100% WQ volume controlled in permanent pool	2
			>= 20 % WQ volume controlled in permanent pool	1
			Under 20% WQ volume controlled in permanent pool	0
	G	Primary or Secondary BMP	Primary	2
			Secondary (Routed to Primary Control)	0
Project Implementation	H	Permitabilty	Minimal Issues/Concerns or no permits	2
			Complex issues/Potential permit denial	0
	I	Land Availability	MS4 owned	4
			Public	3
			Non MS4 owned regulated (expired permit)	3
			Non MS4 owned/Participatory Owner	2
			Unknown	0
			Not MS4 owned/Non participatory owner	-2
Other Project Benefits/Constraints	J	Flood Mitigation (Is existing flooding issue mitigated by project?)	Neighborhood Wide Flooding Issue	3
			Infrastructure damage (e.g. Wet Basement)/Single Property	2
			Nuisance Issue (ie. ponding, puddles, etc).	1
			None	0
	K	TMDL Flow Target Addressed (Q03, Q95)	High and Low Flow Targets	3
			High Flow Target	2
			No target addressed in BMPDSS (just WQ treatment)	1
	L	Lake Champlain Phosphorus TMDL*	Addressed TMDL	1
			Does not address TMDL	0
	M	Other Project Benefits (+) / Constraints (-)	Infrastructure Improvement (e.g. Culvert Replacement) (+)	1
			Educational/Functional Benefit (+)	1
			Recreational Benefit (+)	1
			Expired permit on site (+)	1
			Outfall Erosion Control (+)	1
			Potential Erodible soils/Bank Destabilization issues (-)	-1
			Access Issues (-)	-1
			Uncertainty in groundwater table/feasibility for infiltration (-)	-3
			Loss of Habitat (-)	-1
	N	Annual Total Suspended Solids (TSS) Yield Mitigated (lbs.) *WinSLAMM Model result	>10,000	5
			3000-10,000	4
			1500-3000	3
			1000-1500	2
			50-1000	1
			<50	0
	O	Annual Total Phosphorus (TP) Yeild Mitigated (lbs.) *WinSLAMM Model result	<5	6
			4-5	5
			3-4	4
			2-3	3
			1-2	2
			<1	1
	*Lake Champlain Phosphorus TMDL compliance metrics TBD. All projects which address > 20%of the WQ volume are considered meeting this standard.			

Sunderland Brook Flow Restoration Plan (FRP)
BMP Ranking Matrix
10/5/2016

Site ID	BMP Type	Retrofit Description	Cost/Operations				Project Design Metrics														Other Project Benefits/Constraints												Total Score
			A		B		C		D		E		F		G		H		I		J		K		L		M		N		O		
			Project Cost		Ease of O/M		Impervious Acres Managed (ac)		Channel Protection Volume (CPv)		Volume Infiltrated (ac-ft)		WQ Volume controlled (%)		Primary or Secondary BMP		Permitting Restrictions		Land Availabilty where BMP is located		Flood Mitigation		TMDL Flow Target Addressed (Q03, Q95)		Lake Champlain P TMDL addressed?		Other Benefits/Constraints		Annual Total Suspended Solids (TSS) Yield Mitigated (lbs.)		Annual Total Phosphorus (TP) Yeild Mitigated (lbs.)		
			Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score		Value	Score	Value	Score	Value	Score	Value	Score	Value	
Tracy Rd. -Fort Ethan Allen	IB	Long Infiltration Tren	$134,750	2	Undergrou	2	3.94	4	0.43	3	0.43	2	>= 100% W	2	Primary	2	Minimal Issu	2	MS4 owned	4			High/Low	3	Addressed	1			370	1.1	1.71	2.1	30
Outfall 126: Fort Ethan Allen	UIB	Excessively eroded o	$201,266	2	Undergrou	2	9.84	5	0.58	3	0.58	3	>= 100% W	2	Primary	2	Minimal Issu	2	MS4 owned	4			High/Low	3	Addressed	1	Erosion mit	1	2517	3	3.87	4	37
Outfall 31- Morse Dr.	UIB	Infiltration stone gall	$130,000	2	Undergrou	2	3.56	4	0.30	3	0.30	2	>= 100% W	2	Primary	2	Minimal Issu	2	Non MS4 owne	2			High/Low	3	Addressed	1			7390	4	3.92	4	33
Outfall 199-Morse Dr.	UIB	Retrofit roundabout	$36,173	4	Undergrou	2	5.18	5	0.14	2	0.14	2	>= 100% W	2	Primary	2	Minimal Issu	2	Unknown Parti	0			High/Low	3	Addressed	1			1013	2	1.45	2	29
Route 15/Pearl St.	UIB	Redirect Route 15 Str	$55,469	3	Undergrou	2	2.32	3	0.09	2	0.09	1	>= 100% W	2	Primary	2	Minimal Issu	2	Unknown Priva	0			High/Low	3	Addressed	1	Provides tre	1	1164	2	1.29	2	26
Forman Dr. Roundabout	IB	Retrofit grassed circu	$71,860	3	Bioretentio	1	1.34	2	0.05	1	0.05	1	>= 100% W	2	Primary	2	Minimal Issu	2	MS4 owned	4			High/Low	3	Addressed	1			310	1	1.03	2	25
Kimberly Drive (O3, O4)	UIB	StormTech infiltration	$467,794	1	Undergrou	2	7.90	5	0.23	2	0.23	2	>= 100% W	2	Primary	2	Minimal Issu	2	Unknown Priva	0			High/Low	3	Addressed	1	Provides tre	1	1498	2	5.2	5	30

Ascending		
ID #	**Site ID**	**BMP Type**
8	David Dr. Outfall	UIB
2	Outfall 126: Fort Ethan Allen	UIB
3	Outfall 31- Morse Dr.	UIB
1	Tracy Rd. -Fort Ethan Allen	IB
7	Kimberly Drive (O3, O4)	UIB
4	Outfall 199-Morse Dr.	UIB
5	Route 15/Pearl St.	UIB
6	Forman Dr. Roundabout	IB

	Decending
Retrofit Description	**Total Score**
StormTech infiltration Chamber system at end of David Dr.	39
Excessively eroded outfall and channel. Constrained by UVM property. Proposed infiltration basin with perforated pipe within existing terraced area just	37
Infiltration stone gallery at end of pipe.	33
Long Infiltration Trench/Bioretention	30
StormTech infiltration chamber system at end of Parizo Dr.	30
Retrofit roundabout upslope from outfall with infiltration practice in ROW. Wetlands near outfall.	29
Redirect Route 15 Stormline to underground infiltration chambers.	26
Retrofit grassed circular median with bioretention practice.	25

Sunderland Brook Flow Restoration Plan(FRP) Project
Task 4: Ranked BMPs Table
BMPs Ranked watershed-wide based on matrix of criteria

ID #	Site ID	BMP Type	Retrofit Description	Total Score
8	David Dr. Outfall	UIB	StormTech infiltration Chamber system at end of David Dr.	39
2	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
3	Outfall 31- Morse Dr.	UIB	Infiltration stone gallery at end of pipe.	33
1	Tracy Rd. -Fort Ethan Allen	IB	Long Infiltration Trench/Bioretention	30
7	Kimberly Drive (O3, O4)	UIB	StormTech infiltration chamber system at end of Parizo Dr.	30
4	Outfall 199-Morse Dr.	UIB	Retrofit roundabout upslope from outfall with infiltration practice in ROW. Wetlands near outfall.	29
5	Route 15/Pearl St.	UIB	Redirect Route 15 Stormline to underground infiltration chambers.	26

Sunderland Brook Flow Restoration Plan
4/23/2015

Table A-5-4: Total Phosphorus and TSS Reduction Benefits from Proposed BMPs

Site Name	MS4 owner of impervious draining to practice	Ownership of Land where BMP is located	BMP Type (Key*)	Permit # (if applicable)	Runoff Area, DA (acres)	Impervious Acres Managed (ac)	Channel Protection Volume Managed		WQ Results				Retrofit Description
							CF	Ac-ft	Annual TSS Yield Mitigated w/control (lbs)	% TSS reduction	Annual Total Phosphorus (TP) Yield Mitigated w/ control (lbs)	% TP Reduction	
Tracy Rd. -Fort Ethan Allen-	Vtrans/Colchester	VTRANS	IB	6363-INDS	4.97	3.94	18513	0.43	370.00	100.00%	1.71	100.00%	Long Infiltration Trench/Bioretention
Outfall 126: Fort Ethan Allen	Town Essex/UVM	Public (Town and UVM)	UIB	NP	20.42	9.84	25134	0.58	2530.00	100.00%	3.91	100.00%	Excessively eroded outfall. Constrained by UVM property. Proposed energy dissipater and large detention chamber.
Outfall 31- Morse Dr.	Town Essex	Private	UIB	NP	4.98	3.56	12937	0.30	7390.03	99.20%	3.92	98.20%	Replace pipe with perforated 24" and stone bed.
Outfall 199-Morse Dr.	Town Essex	Private	UIB	NP	8.18	5.18	5924	0.14	1013.16	98.17%	1.45	97.24%	Retrofit roundabout upslope from outfall with infiltration practice. Wetlands near
Route 15/Pearl St.	Village Essex	Private	UIB	2-0920	4.25	2.32	3877	0.09	1163.54	96.61%	1.29	94.48%	Redirect Route 15 Stormline to Underground Infiltration Chambers.
Forman Dr. Roundabout	Colchester	ROW	IB	NP	3.14	1.34	2047	0.05	309.60	97.21%	1.03	96.92%	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	10019	0.23	1498.00	100.00%	5.20	100.00%	Infiltration basin at outfall.
David Dr. Outfall	Town Essex	ROW	UIB	1-0896, 1-0552, 1-1463	32.21	15.96	61028	1.40	27957.00	99.04%	15.34	98.58%	StormTech infiltration Chamber system at end of David Dr.
						50.04	139479	**3.20**					

Key: * NP = No permit
BMP Type: DB: Detention Basin, USC: Underground/Covered Storage Chamber, UIB= Underground Infiltration Basin, IB= Vegetated Infiltration Basin
GSI = Smaller-scale GSI practice DW= Dry Wells *WQ = Addresses WQ issue (i.e. excessive erosion but not flow targets)

TOWN OF ESSEX
SUNDERLAND BROOK FRP

Tracy Lane 30% Opinion of Probable Cost
As of January 20, 2015

Item #		Vtrans Item	RS Means Item	Description	Estimated Quantity	Unit	Material	Labor	Equipment	Unit Cost	Total Cost (ENR 9900)[1]	Total Cost (ENR 10000)[2]
I. CONSTRUCTION COST												
1		203.15		Excavation (Open Basin)	420	CY	$ -	$ 5.00	$ 7.00	$ 12.00	$ 5,040.00	$ 5,090.91
2		204.20		Trench Excavation of Earth	400	CY	$ -	$ 5.00	$ 7.00	$ 12.00	$ 4,800.00	$ 4,848.48
3				Retrofit Existing Catch Basin	1	EA	$ 250.00	$ 15.00		$ 265.00	$ 265.00	$ 267.68
4		613.10		Stone Fill, Type I (for Infiltration Trench)	370	CY				$ 44.47	$ 16,470.37	$ 16,636.74
5		620.50		Removing and Resetting Fence	310	LF	$ -	$ 5.92	$ 1.64	$ 7.55	$ 2,341.00	$ 2,364.64
6		635.11		Mobilization/Demobilization	1	LS	$ 7,500.00			$ 7,500.00	$ 7,500.00	$ 7,575.76
7		651.15		Seed	12	LB	$ 5.00	$ 5.00		$ 10.00	$ 120.00	$ 121.21
8		651.20		Agricultural Limestone	0.5	Ton				$ 486.92	$ 243.46	$ 245.92
9		651.25		Hay Mulch	1	Ton				$ 599.88	$ 599.88	$ 605.94
10		651.35		Topsoil	160	CY	$ 25.00	$ 10.00	5	$ 40.00	$ 6,400.00	$ 6,464.65
11		652.10		Erosion Prevention Sediment Control Plan	1	LS	$ 1,000.00			$ 1,000.00	$ 1,000.00	$ 1,010.10
12		652.20		Monitoring Erosion Prevention Sediment Control Plan	5	HR		$ 60.00		$ 60.00	$ 300.00	$ 303.03
13		652.30		Maintenance of EPSCP	1	LS	$ 1,000.00			$ 1,000.00	$ 1,000.00	$ 1,010.10
14		653.20		Temporary Erosion Matting	1,430	SY	$ 5.00	$ 2.50		$ 7.50	$ 10,725.00	$ 10,833.33
15				Bonds (2.0%)	1	LS				$ 1,035.29	$ 1,035.29	$ 1,045.75
											SUBTOTAL CONSTRUCTION:	$ 53,333.33
											USE:	$ 60,000.00
II. CONSTRUCTION CONTINGENCY												
1				Construction Contingency (15%)	1					$ 9,000.00		$ 9,000.00
											SUBTOTAL CONSTRUCTION CONTINGENCY:	$ 9,000.00
III. FINAL DESIGN ENGINEERING[3]												
1				Final Design and Permitting (excluding geotechnical)	1					$ 6,090.00		$ 6,090.00
2				Geotechnical	1					$ 600.00		$ 600.00
											SUBTOTAL FINAL DESIGN ENGINEERING:	$ 6,690.00
IV. CONSTRUCTION PHASE ENGINEERING[3]												
1				Construction Phase Engineering	1					$ 11,165.00		$ 11,165.00
											SUBTOTAL CONSTRUCTION PHASE ENGINEERING:	$ 11,165.00
V. OTHER COSTS												
1				Administrative	1					$ 300.00		$ 300.00
2				Easement Assistance	1					$ 900.00		$ 900.00
4				Legal	1					$ 900.00		$ 900.00
5				Bond Vote Assistance	1					$ 300.000		$ 300.00
6				Short Term Interest	1					$ 1,500.000		$ 1,500.00
											SUBTOTAL OTHER COSTS:	$ 3,900.00
											TOTAL PROJECT COST:	**$ 90,755.00**
											USE:	**$ 100,000.00**

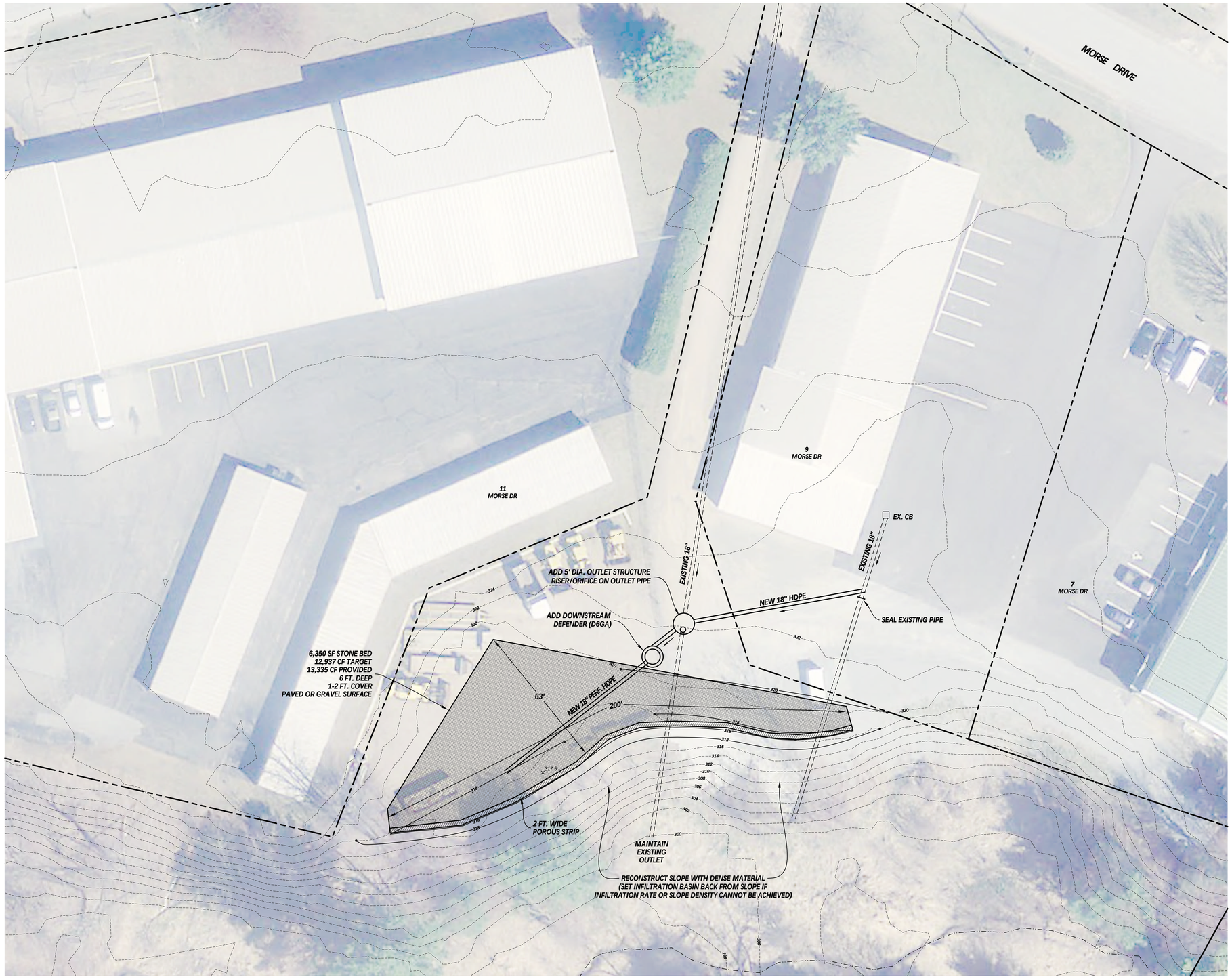
Notes:
1. ENR 9900 = November 2014
2. ENR 10,000 = June 2015
3. Engineering costs for Final Design and Construction are based on the VT DEC Facilities Engineering Fee Curve Allowance

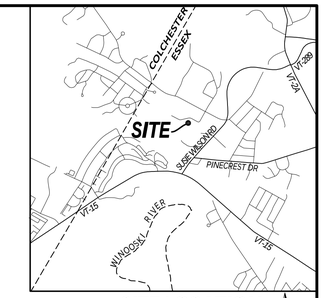
TOWN OF ESSEX
SUNDERLAND BROOK FRP

UVM/Fort Outfall 126 30% Opinion of Probable Cost
As of January 30, 2015

Item #		Vtrans Item	RS Means Item	Description	Estimated Quantity	Unit	Material	Labor	Equipment	Unit Cost	Total Cost (ENR 9900)[1]	Total Cost (ENR 10000)[2]
I. CONSTRUCTION COST												
1		204.20		Trench Excavation of Earth	250	CY	$ -	$ 5.00	$ 7.00	$ 12.00	$ 3,000.00	$ 3,030.30
2		204.22		Trench Excavation of Earth, Exploratory	100	CY	$ 15.00	$ 25.00	$ 25.00	$ 65.00	$ 6,500.00	$ 6,565.66
3		204.25		Structure Excavation	50	CY	$ -	$ 5.00	$ 15.00	$ 20.00	$ 1,000.00	$ 1,010.10
4		204.30		Granular Backfill for Structures	40	CY	$ 22.00	$ 5.00	$ 7.00	$ 34.00	$ 1,360.00	$ 1,373.74
5				Bituminous Pavement	160	SY				$ 70.13	$ 11,220.00	$ 11,333.33
6		601.09		CPEP (24")	150	LF	$ 22.00	$ 16.00	$ 14.00	$ 52.00	$ 7,800.00	$ 7,878.79
7				3/4" Crushed Stone for Pipe	80	CY	$ 18.00	$ 5.00	$ 7.00	$ 30.00	$ 2,400.00	$ 2,424.24
8		604.21		Precast Reinforced Concrete Catch Basin with Cast Iron Cover	30	VF	$ 310.00	$ 15.00	$ 25.00	$ 350.00	$ 10,500.00	$ 10,606.06
9		635.11		Mobilization/Demobilization	1	LS	$ 20,000.00			$ 20,000.00	$ 20,000.00	$ 20,202.02
10		649.51		Geotextile for Silt Fence	600	SY	$ 2.50	$ 2.50		$ 5.00	$ 3,000.00	$ 3,030.30
#REF!		652.10		Erosion Prevention Sediment Control Plan	1	LS	$ 2,500.00			$ 2,500.00	$ 2,500.00	$ 2,525.25
#REF!		652.20		Monitoring Erosion Prevention Sediment Control Plan	60	HR		$ 60.00		$ 60.00	$ 3,600.00	$ 3,636.36
#REF!		652.30		Maintenance of EPSCP	1	LS	$ 6,000.00			$ 6,000.00	$ 6,000.00	$ 6,060.61
#REF!		653.35		Vehicle Tracking Pad	20	CY	$ 30.00	$ 5.00	7	$ 42.00	$ 840.00	$ 848.48
17				Pre-treatment Downstream Defender	1	LS				$ 22,249.84	$ 22,249.84	$ 22,474.59
18				Drywells (All inclusive)	2	EA				$ 11,677.84	$ 23,355.68	$ 23,591.60
19				Infiltration Gallery (All inclusive)	1	LS				$ 131,720.00	$ 131,720.00	$ 133,050.51
20				Bonds (2.0%)	1	LS				$ 5,140.91	$ 5,140.91	$ 5,192.84
											SUBTOTAL CONSTRUCTION:	$ 264,834.78
											USE:	$ 270,000.00
II. CONSTRUCTION CONTINGENCY												
1				Construction Contingency (15%)	1					$ 40,500.00		$ 40,500.00
											SUBTOTAL CONSTRUCTION CONTINGENCY:	$ 40,500.00
III. FINAL DESIGN ENGINEERING[3]												
1				Final Design and Permitting (excluding geotechnical)	1					$ 20,580.00		$ 20,580.00
2				Geotechnical	1					$ 2,700.00		$ 2,700.00
											SUBTOTAL FINAL DESIGN ENGINEERING:	$ 23,280.00
IV. CONSTRUCTION PHASE ENGINEERING[3]												
1				Construction Phase Engineering	1					$ 37,730.00		$ 37,730.00
											SUBTOTAL CONSTRUCTION PHASE ENGINEERING:	$ 37,730.00
V. OTHER COSTS												
1				Administrative	1					$ 1,350.00		$ 1,350.00
2				Easement Assistance	1					$ 4,050.00		$ 4,050.00
3				Land Acquisition	0	Acre				$ 120,000.00		$ -
4				Legal	1					$ 4,050.00		$ 4,050.00
5				Bond Vote Assistance	1					$ 1,350.000		$ 1,350.00
6				Short Term Interest	1					$ 6,750.000		$ 6,750.00
											SUBTOTAL OTHER COSTS:	$ 17,550.00
											TOTAL PROJECT COST:	**$ 389,060.00**
											USE:	**$ 390,000.00**

Notes:
1. ENR 9900 = November 2014
2. ENR 10,000 = June 2015
3. Engineering costs for Final Design and Construction are based on the VT DEC Facilities Engineering Fee Curve Allowance





SITE LOCATION
NTS

LEGEND

- PROPERTY LINE
- EXISTING CONTOUR
- PROPOSED CONTOUR
- EXISTING STORM LINE
- PROPOSED STORM LINE
- DRAINAGE COURSE

NOTES

1. THIS IS NOT A BOUNDARY SURVEY. BOUNDARY INFORMATION IS FROM TOWN TAX MAPS.
2. EXISTING TOPOGRAPHY WAS CREATED FROM CHITTENDEN COUNTY LiDAR (2004).

20 0 10 20 40 80
(IN FEET)
1 inch = 20 ft.

CONCEPT

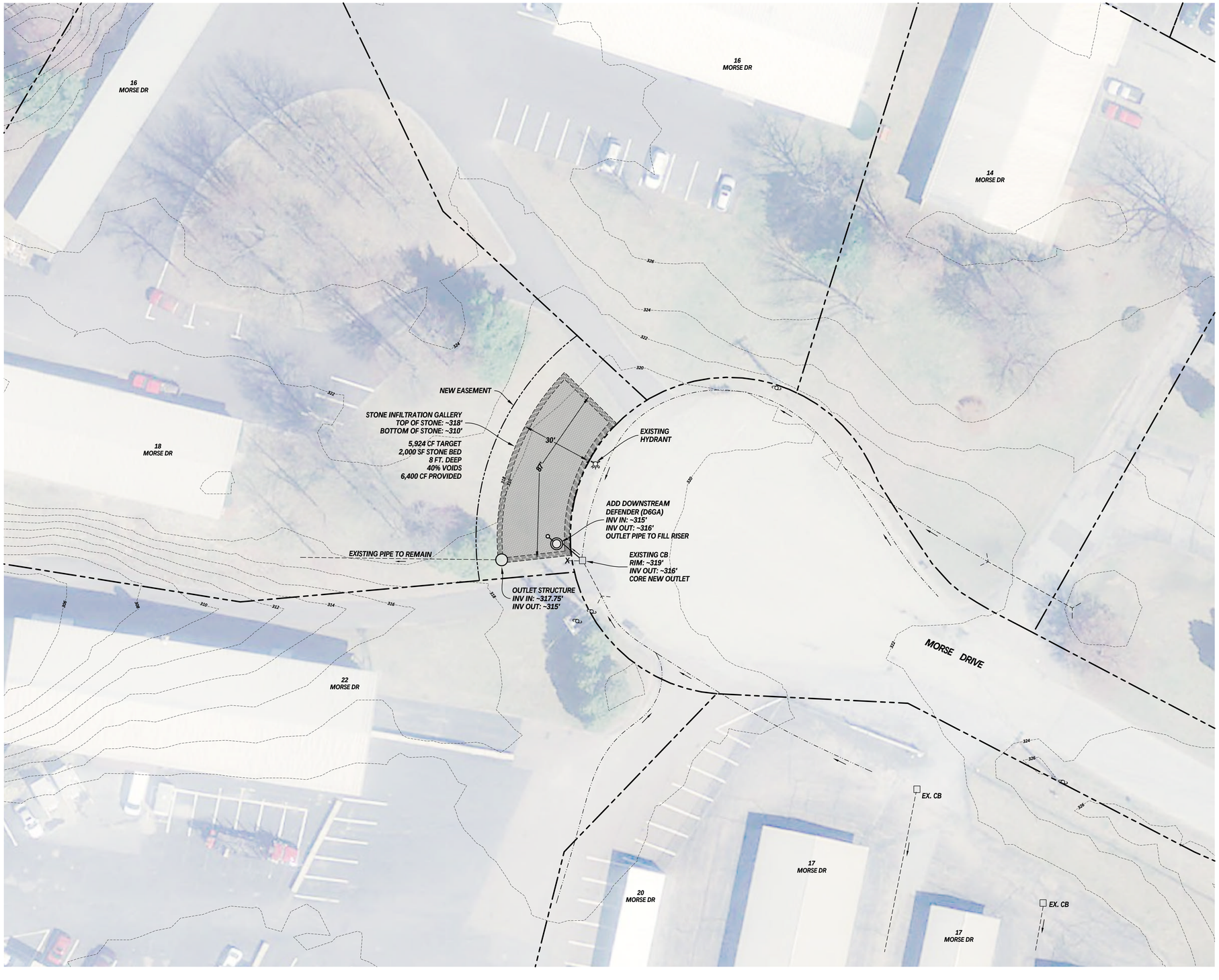
SUNDERLAND BROOK FLOW RESTORATION PLAN

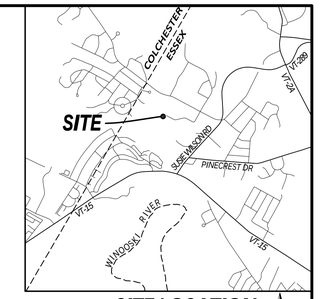
ESSEX/COLCHESTER, VERMONT

MORSE DRIVE OUFALL 31 STORMWATER IMPROVEMENT PLAN

WATERSHED CONSULTING ASSOCIATES, LLC
Stormwater Management | Water Quality | Erosion Control
430 Shelburne Road P.O. Box 4413
Burlington, VT 05406
Mobile: 802.922.4871 | Main: 802.497.2367
www.watershedca.com

APPROVED BY:	AT	DRAWN BY:	SMS/ATS	SCALE:	NOTED
DATE:	2-19-15	CHECKED BY:	AT	SHEET:	1 OF 1





SITE LOCATION
NTS

LEGEND

- PROPERTY LINE
- EXISTING CONTOUR
- EXISTING STORM LINE
- PROPOSED STORM LINE
- DRAINAGE FLOW PATH
- HYDRANT
- UTILITY POLE

NOTES

1. THIS IS NOT A BOUNDARY SURVEY. BOUNDARY INFORMATION IS FROM TOWN TAX MAPS.
2. EXISTING TOPOGRAPHY WAS CREATED FROM CHITTENDEN COUNTY LiDAR (2004).

20 0 10 20 40 80
(IN FEET)
1 inch = 20 ft.

CONCEPT

SUNDERLAND BROOK FLOW RESTORATION PLAN

ESSEX/COLCHESTER, VERMONT

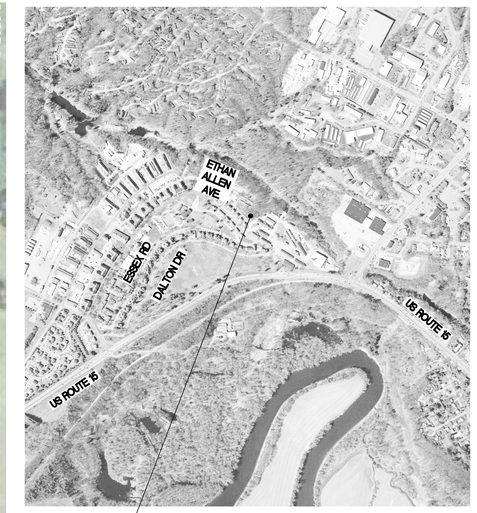
MORSE DRIVE OUFALL 199 STORMWATER IMPROVEMENT PLAN

WATERSHED CONSULTING ASSOCIATES, LLC
Stormwater Management | Water Quality | Erosion Control
430 Shelburne Road P.O. Box 4413
Burlington, VT 05406
Mobile: 802.922.4871 | Main: 802.497.2367
www.watershedca.com

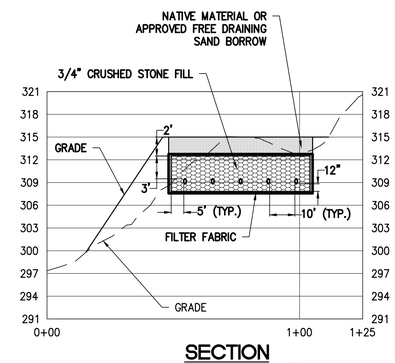
APPROVED BY:	AT	DRAWN BY:	SMS/ATS	SCALE:	NOTED
DATE:	2-19-15	CHECKED BY:	AT	SHEET:	1 OF 1

PLAN
SCALE: 1"=30'

GRAPHIC SCALE
0 30 45 60
(IN FEET)



LOCATION MAP
SCALE: 1"=1000'



SECTION
SCALE: HORIZ. 1"=30'
VERT. 1"=3'

Aldrich + Elliott
WATER RESOURCE ENGINEERS
6 Market Place, Suite 2
Essex Jct., VT 05452
P: 802.879.7733
AEengineers.com

WATERSHED CONSULTING ASSOCIATES, LLC

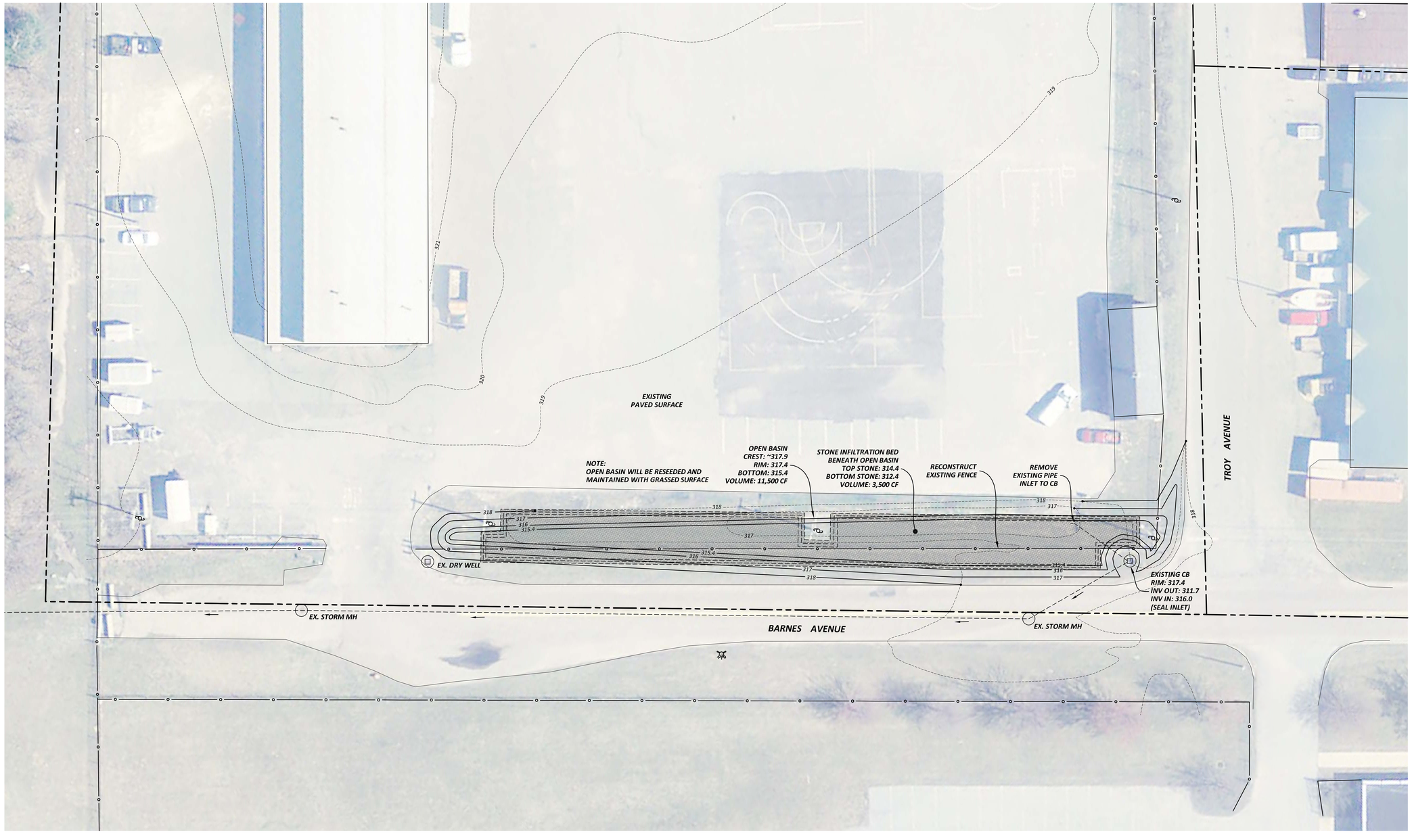
No.	DATE	DESCRIPTION	CHECKED

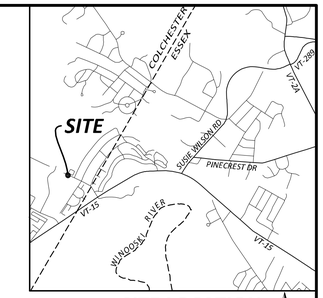
TOWN OF ESSEX, VERMONT

SUNDERLAND BROOK FRP

DESIGNED JAB	PROJECT NO. 14037
DRAWN JEN	DRAWING 1
CHECKED WAE	
DATE FEB. 2015	

Y:\14037-ESSEX\14037-SUNDERLAND BROOK-SITE.dwg, 2/20/2015 2:09:06 PM





SITE LOCATION
NTS

N

LEGEND

- PROPERTY LINE
- EXISTING CONTOUR
- PROPOSED CONTOUR
- EXISTING STORM LINE
- CHAIN LINK FENCE
- HYDRANT
- UTILITY POLE

20 0 10 20 40 80
(IN FEET)
1 inch = 20 ft.

NOTES

1. THIS IS NOT A BOUNDARY SURVEY. BOUNDARY INFORMATION IS FROM TOWN TAX MAPS.
2. EXISTING TOPOGRAPHY WAS CREATED FROM CHITTENDEN COUNTY LIDAR (2004).

CONCEPT

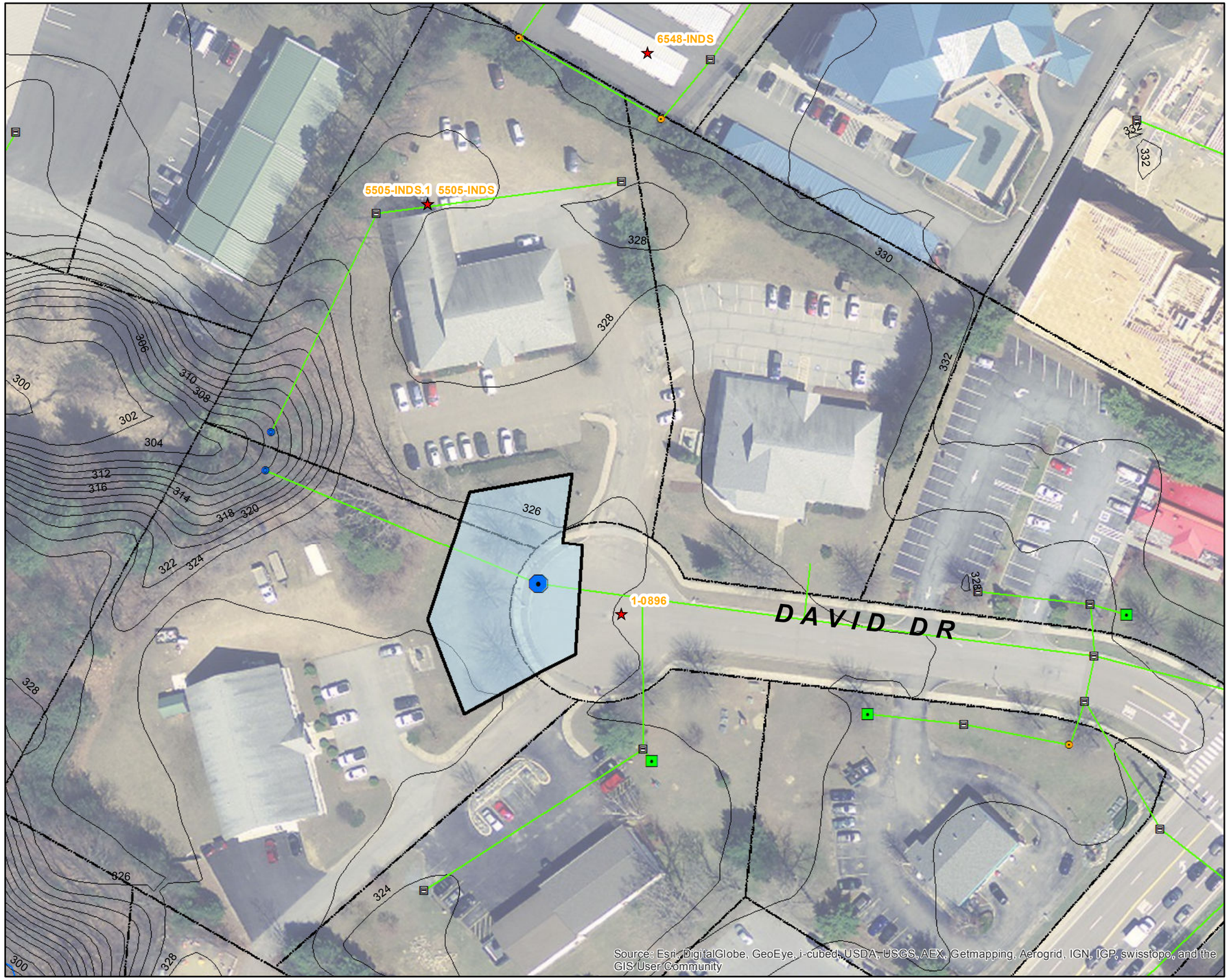
SUNDERLAND BROOK FLOW RESTORATION PLAN

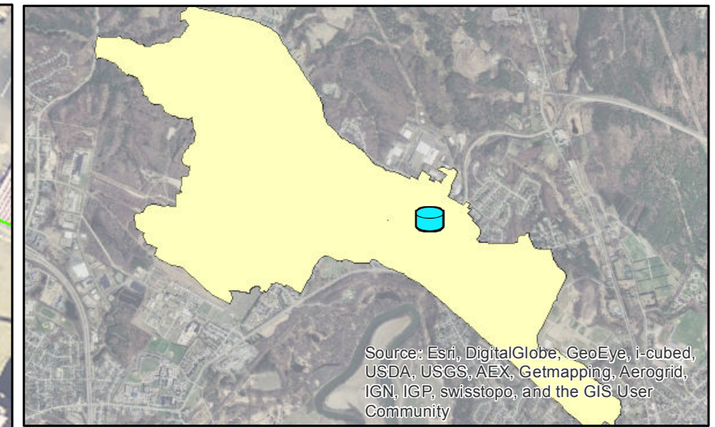
ESSEX/COLCHESTER, VERMONT

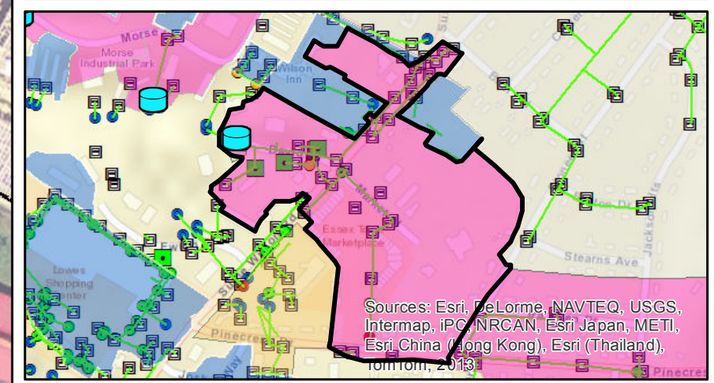
TRACY ROAD OUFALL STORMWATER IMPROVEMENT PLAN

WATERSHED CONSULTING ASSOCIATES, LLC
Stormwater Management | Water Quality | Erosion Control
430 Shelburne Road P.O. Box 4413
Burlington, VT 05406
Mobile: 802.922.4871 | Main: 802.497.2367
www.watershedca.com

APPROVED BY:	AT	DRAWN BY:	SMS/ATS	SCALE:	NOTED
DATE:	2-20-15	CHECKED BY:	AT	SHEET:	1 OF 1







LEGEND

- Permit
- PROPOSED STORM STRUCTURE
- Proposed Underground Chamber System
- PROPERTY LINE
- EXISTING 2' CONTOUR
- Sunderland Brook

BMP Drainage Area

- Existing Post 2002
- Existing Pre 2002
- Proposed
- Outer Boundary

NOTES:

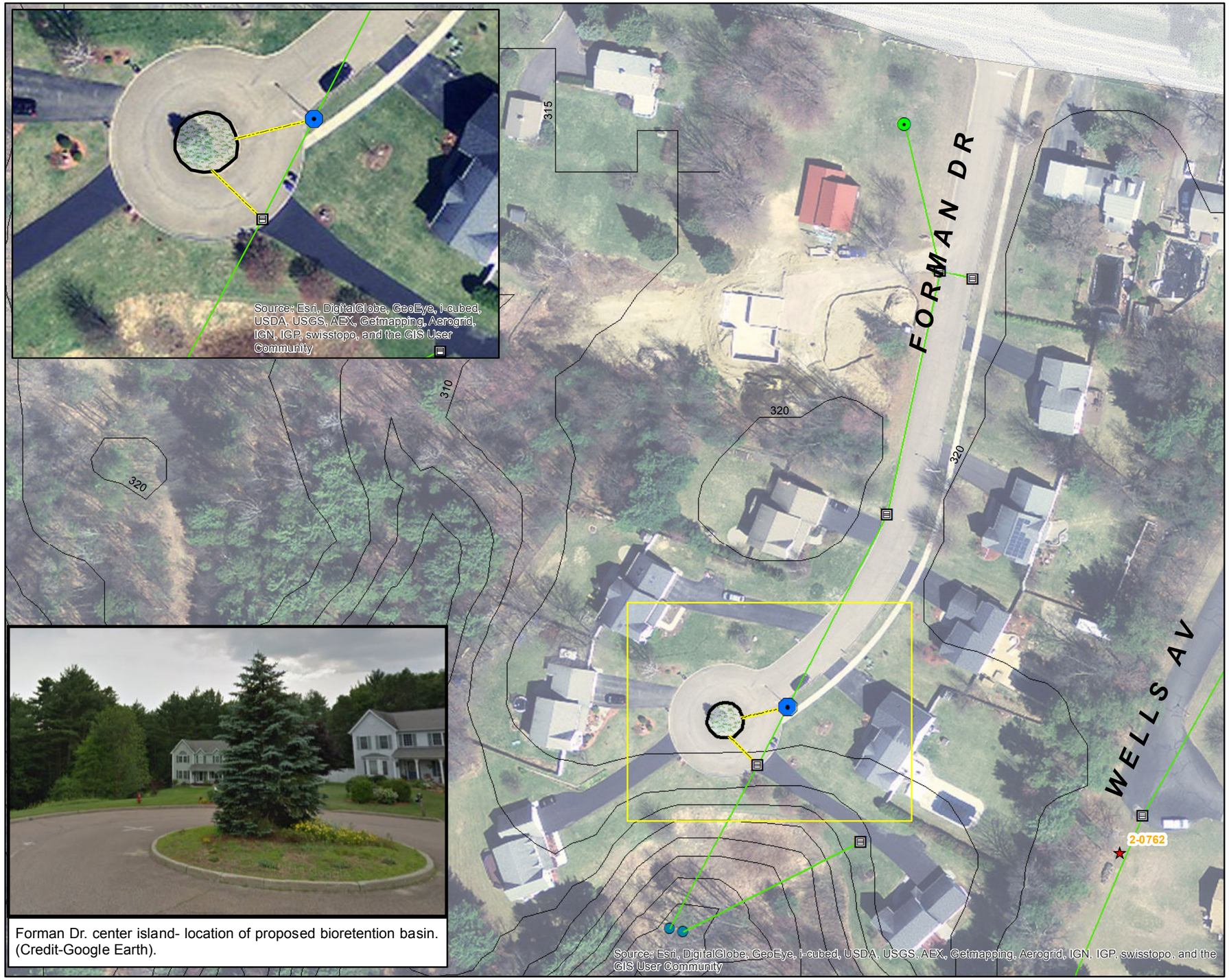
The proposed retrofit involves installation of an underground chamber system at the end of David Dr, using StormTech MC-3500 chambers. A flow splitter will route the 1-year storm to the chamber system, with high-flow bypass via the existing outfall. The existing bank will also be stabilized as a part of the project.

WATERSHED CONSULTING ASSOCIATES, LLC

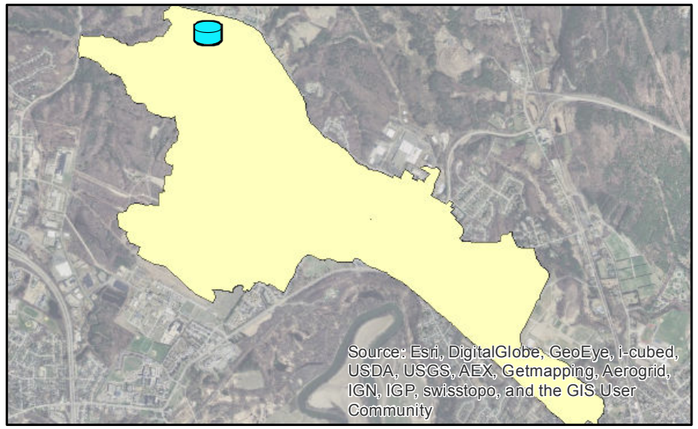
0 40 80 160 240 Feet

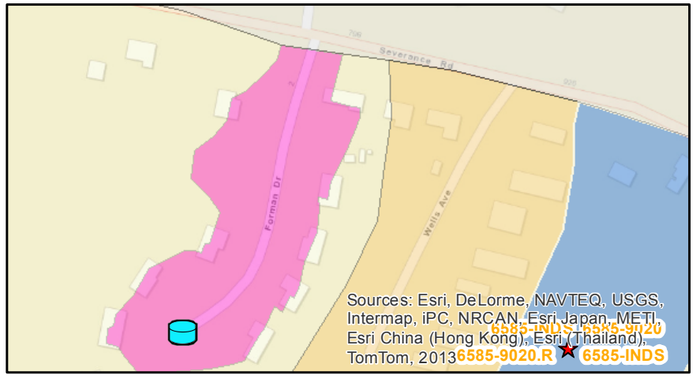
N S

SUNDERLAND BROOK FLOW RESTORATION STUDY ESSEX, VERMONT		
David Dr. Underground Chamber System		
DATE: 2-6-15	DRAWN BY:JS	SCALE:NOTED



Forman Dr. center island- location of proposed bioretention basin. (Credit-Google Earth).





LEGEND

- Permit
- PROPOSED STORM STRUCTURE
- PROPOSED STORM PIPE
- Proposed Bioretention Basin
- EXISTING 5' CONTOUR
- Outer Boundary

BMP Drainage Area

- Existing Post 2002
- Existing Pre 2002
- Proposed

NOTES:

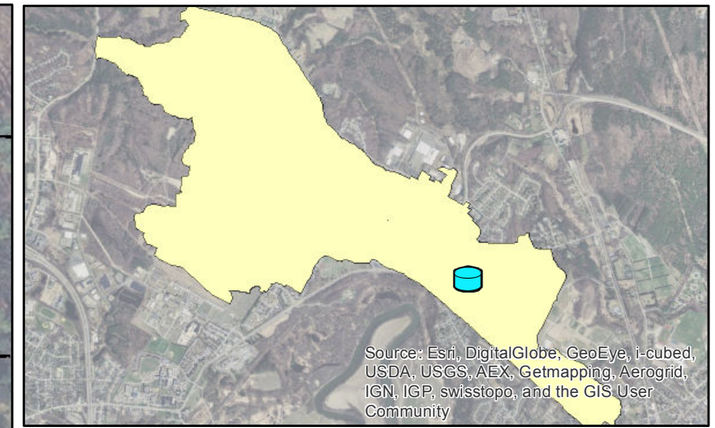
The Forman Dr. project involves a retrofit of the center island to a bioretention basin, with a stone infiltration gallery below for additional storage. The basin will manage surface runoff from Forman Dr. as well the 1-year storm flow from the existing collection system. High-flows will bypass the system and drain via the existing outfall.

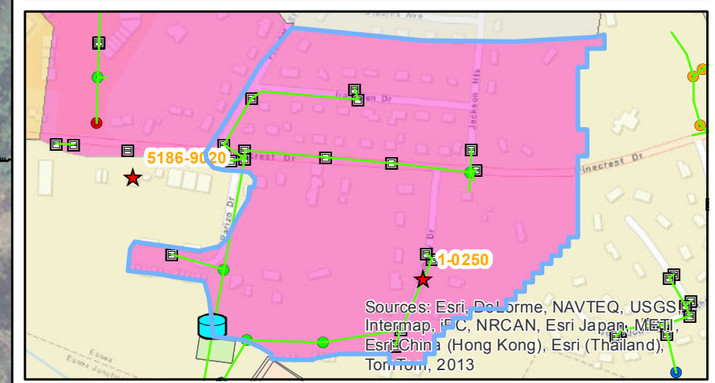
WATERSHED CONSULTING ASSOCIATES, LLC

0 40 80 160 240 320 Feet

N S

SUNDERLAND BROOK FLOW RESTORATION STUDY COLCHESTER, VERMONT		
Forman Dr. Bioretention Retrofit		
DATE: 2-6-15	DRAWN BY:JS	SCALE:NOTED





LEGEND

- PROPOSED STORM STRUCTURE
- PROPOSED STORM PIPE
- Proposed Underground Infiltration Basin
- PROPERTY LINE
- EXISTING 2' CONTOUR
- Permit
- Outer Boundary

BMP Drainage Area

- Existing Post 2002
- Existing Pre 2002
- Proposed

NOTES:

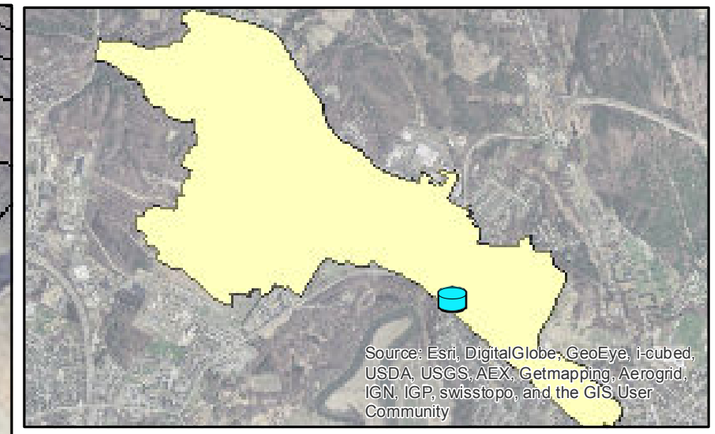
The proposed retrofit involves installation of an underground infiltration basin at the end of Parizo Dr. A new flow splitter will route the 1-year storm flow from the Kimberly Dr. outfall to the basin, with high-flow bypass via the existing outfall.

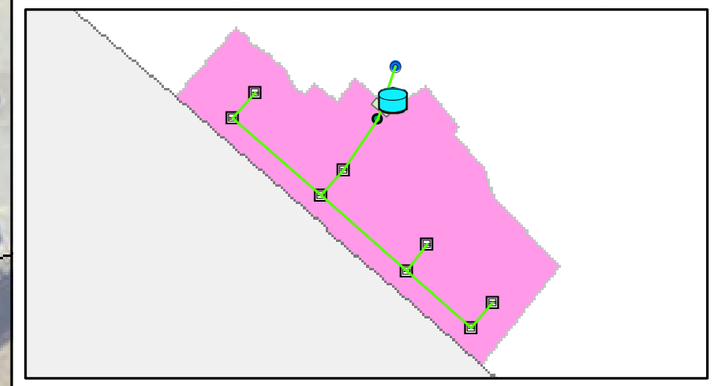
WATERSHED CONSULTING ASSOCIATES, LLC

0 40 80 160 240 Feet

N S

SUNDERLAND BROOK FLOW RESTORATION STUDY ESSEX, VERMONT		
Kimberly Dr. Underground Infiltration Basin		
DATE: 2-6-15	DRAWN BY:JS	SCALE:NOTED





LEGEND

- Proposed Retrofit
- PROPOSED STORM STRUCTURE
- PROPOSED STORM PIPE
- Proposed Underground Chamber System
- PROPERTY LINE
- EXISTING 2' CONTOUR
- Outer Boundary

BMP Drainage Area

- Existing Post 2002
- Existing Pre 2002
- Proposed

NOTES:

The proposed retrofit for the Route 15 outfall, located at 213 Pearl St, is to install an infiltration system with StormTech SC-740 chambers under the back parking lot of the Contois School of Music property. The chamber system would mitigate the 1-year storm volume, with high-flow bypass via the existing outfall.

WATERSHED CONSULTING ASSOCIATES, LLC

0 40 80 Feet

N S

SUNDERLAND BROOK FLOW RESTORATION STUDY ESSEX, VERMONT		
Route 15/Pearl St Underground Infiltration Chamber System		
DATE: 2-6-15	DRAWN BY:JS	SCALE:NOTED