Rugg Brook Flow Restoration Plan

MS4 GENERAL PERMIT REQUIREMENT (IV.C.1)

September 29, 2016

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I. Disclaimer

The intent of this plan is to present the data collected, evaluations, analyses, designs, and cost estimates for the Rugg Brook Flow Restoration Plan (FRP) Project, completed under a contract between Northwest Regional Planning Commission and the hired consultant team, Watershed Consulting Associates, LLC and Aldrich & Elliott. The Rugg Brook FRP was prepared to meet the compliance requirement for the National Pollutant Discharge Elimination System General Permit 3-9014 (Vermont Department of Environmental Conservation 2012) for stormwater discharges to impaired waters for Rugg Brook impervious surface owners: the City of St. Albans and the Town of St. Albans.

II. Executive Summary

This Flow Restoration Plan (FRP) for the Rugg Brook watershed was developed in accordance with requirements for Municipal Separate Storm Sewer System (MS4) entities. Once approved by the Vermont Department of Environmental Conservation (VT DEC) this FRP will become part of the Rugg Brook Stormwater Management Plan (SWMP) prepared by the Town of St. Albans and the City of St. Albans, two of the three MS4 permittees. Although three MS4 entities own impervious cover within the Rugg Brook watershed, the Vermont Department of Transportation (VTrans) has elected to prepare its own FRP document. However, all proposed projects including the VTrans projects are included in this document to provide a watershed-wide plan. The MS4 permitees in this watershed are the Town of St. Albans, the City of St. Albans, and VTrans. The plan was developed in accordance with the Municipal Separate Storm Sewer System (MS4) General Permit #3-9014 Subpart IV.C.1 as a part of the participating MS4s Stormwater Management Program (SWMP). This FRP will serve as a long term planning tool for the MS4s to implement stormwater best management practices (BMPs) throughout the watershed in the effort to return Rugg 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, equivalent to greater than the 1-year design storm) from the Pre-2002 condition, as required by the Rugg 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 BMP scenarios, was used for the assessment. The BMPDSS estimated 16% of the high flow target was met with existing BMPs, designed to meet the 2002 Vermont Stormwater Management Manual (VTSWMM) design standards, when compared to the Pre-2002 condition. Therefore, additional BMPs are required to meet 100% of the actionable flow target.

In addition to the identification of stormwater controls, the TMDL flow targets and future growth assumption developed by the VT DEC was reviewed in the context of the FRP development. Specifically, the expected non-jurisdictional impervious area growth in the watershed over the next 20 years was determined using a GIS analysis. An assumed 15 acres of non-jurisdictional impervious growth was used to develop the original TMDL requirements. A revised estimate of 4.54 acres was calculated based on the actual non-jurisdictional growth rate from 2003 to 2014. The revised future growth reduced the high flow target ($Q_{0.3\%}$) from 16.0% to 15.3%[1]. The modified flow target was incorporated into the FRP planning process and assessment of the proposed BMP implementation scenario.

Development of the FRP involved field inspection of all existing BMPs with an expired stormwater permit followed by review and revision of the previously run BMPDSS model scenarios. Several revisions to existing BMP drainage areas and BMP design configurations were

[1] See Tables 1 and 2: The modified target was calculated as: -(15.0%) + (-1.0%)*(4.54 ac/15 ac) = -15.3%

identified during field inspection and accounted for in the revised models. After the existing model scenarios were reviewed, new BMPs were identified, inspected, and assessed in the BMPDSS.

The final evaluated BMP list includes 31 projects: nine retrofits to existing ponds with expired permits, five new detention practices in the Town, one new infiltration basin in the Town, four new underground infiltration systems along Route 7 in the City, four new detention practices to mitigate runoff from primarily VTrans-owned impervious, and eight new sand filters in the I-89 median.

The proposed BMPs were assessed with the BMPDSS model, and determined to provide a -17.46% reduction in high flow, which addresses 114% of the TMDL high flow target ($Q_{0.3\%}$) through reduction of runoff from the 1-year design storm. While not an actionable target, the low flow (baseflow) was estimated to increase by 9% over the Post-2002 condition. However, the low flow in the proposed scenario was still below the Pre-2002 condition. The high flow target mitigated by each project (%) and cumulative target addressed (%) was determined for each projects. In order to address 100% of the high flow target, 30 of the 31 proposed BMPs must be constructed. The planning level cost for implementation of the FRP is approximately $2,400,000 (excluding VTrans). Preliminary 30% engineering plans were developed for the new projects with planning level cost estimates.

A comprehensive ranking matrix was developed to prioritize the proposed projects based on criteria including considerations for the cost, design, aesthetics, and other project benefits and constraints. The ranking provides a tool for the MS4s to use as they prioritize projects with available financial resources. The prioritization was also used to develop a long term implementation schedule.

III. Background

Rugg Brook is currently one of the State of Vermont's stormwater impaired waterways, as determined by the US Environmental Protection Agency's (EPA) 303(d) list. In the effort to restore Rugg Brook to its attainment condition and lift its impaired designation, a flow based TMDL was developed for the watershed, outlining required reductions in high flows and an increase in baseflow. The flow targets are the basis for the FRP.

The purpose of the FRP is to outline a plan for the retrofit of existing impervious cover with stormwater management Best Management Practices (BMPs). These practices can include detention basins, bioretention filters, underground storage, and others. The TMDL set forth that watershed hydrology must be controlled in the Rugg 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 include the identification of retrofits to existing BMPs with expired State stormwater permits, new BMP controls, a design and construction (D&C) schedule, a financial plan, and a regulatory analysis.

Each MS4 is required to prepare an FRP for impaired waters. Two of the three MS4s contributing impervious cover runoff to Rugg Brook, the Town of St. Albans and the City of St. Albans, agreed to prepare a joint FRP for the watershed with consideration of the individual MS4's flow target allocation based on impervious ownership. VTrans, the third MS4 permitee, will complete a separate FPR document.

III.1 TMDL Flow Targets

In the effort to restore Rugg Brook to its attainment condition and lift its impaired designation, a flow-based Total Maximum Daily Load (TMDL) was developed for Rugg Brook using flow as a surrogate for pollutant loading. This document outlines required reductions in stream high flows and increase in stream low flows.

The basis for the TMDL required high flow reductions was the comparison of modeled Flow Duration Curves (FDCs) between this impaired watershed and comparable attainment watersheds. A FDC graphs the percentage of time during a period that flow exceeds a certain value, with the low flow represented by the 95th percentile ($Q_{95\%}$) and the high flow represented by the 5th percentile ($Q_{0.3\%}$). 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 to develop FDCs from which an area normalized high flow and low flow were extracted by drainage area. The percent change between impaired and attainment FDCs were used as a basis for the TMDL requirements. The high-flow ($Q_{0.3\%}$) was determined to be relatively equivalent to the 1-year design storm flow. Therefore, all proposed BMPs are designed to the Channel Protection volume (CP_v) storage standard to address the high-flow reduction target.

Included in the 2012 MS4 permit issuance were new requirements for municipalities to develop FRPs to implement the stormwater TMDLs. The FRPs must be developed for each impaired watershed by October 1, 2016, and must include the following elements:

1) An identification of required controls
2) A design and construction schedule
3) A financial plan
4) A regulatory analysis
5) The identification of regulatory assistance
6) Identification of any third party implementation

The schedule shall provide for implementation of the required BMPs as soon as possible, but no later than 20 years from the effective date of the permit, before December 5, 2032.

Table 1: Rugg Brook TMDL flow targets are shown below.

Target High Flow Q 0.3 (± %) Reduction	Target Low Flow Q 95 (± %) Increase
-16.0%	16.8%

III.2 Future Growth Modified Target:

The VT DEC added a future growth factor to the TMDL flow targets to account for future non-jurisdictional impervious growth. Non-jurisdictional growth encompasses impervious area that does not require a stormwater permit and is not managed by a stormwater BMP. Therefore, this type of growth is important to account for within the 20-year stormwater management plan. The VT DEC estimated a future growth of 15 acres based on local development and projected growth. A GIS-based exercise was completed the Chittenden County Regional Planning Commission (CCPRC) to verify the VT DEC's assessment. They found that a more realistic future growth estimate was 4.54 acres based on the actual non-jurisdictional growth rate from 2003 to 2014.

The CCPRC used impervious cover mapping from 2003, developed from Quickbird satellite imagery, and compared this data to imperious cover mapping from 2014. The net change in impervious cover was calculated over the 11-year timeframe. Impervious cover within the drainage area of a Post-2002 Stormwater BMP was cut from the layer. The remaining impervious cover was considered the non-jurisdictional growth over 11 years. A growth rate was then calculated as shown below. The revised non-jurisdictional future growth over the next 20 years was estimated to be 4.54 acres, versus the VTDEC's estimate of 15 acres.

$$\text{Growth Rate} = \left(\left(\frac{Non-Jurisdictional\ Impervious\ ,2014)}{Non-Jurisdictional\ Impervious,2003}\right)^{\left(\frac{1}{years}\right)}\right) - 1\ ) * 100$$

The revised future growth (FG) reduced the high-flow target (Q 0.3%) reduction from 16.0% to 15.3%, which was calculated as shown in the following equation.

$$\text{Modified Flow Target} = (Target\ \%\ with\ no\ FG) + (\ Target\ \%\ from\ FG) * \left(\frac{Revised\ FG\ acres}{Original\ FG\ acres}\right)$$

The modified flow targets for Rugg Brook were used for this FRP and are shown in Table 2.

Table 2 TMDL flow restoration targets

Target High Flow Q 0.3 (± %) Reduction	Target Low Flow Q 95 (± %) Increase
-15.3%	**16.8%**

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

III.3 MS4 Allocation of Flow Targets

Allocation of the flow targets by MS4 was approximated based on relative impervious cover ownership within the watershed. Railroads and agricultural areas were excluded from these calculations.

Approximately 74% of the impervious cover in the Rugg Brook watershed is within the Town of St. Albans, 16% within the City of St. Albans, and 10% is owned by VTrans (Table 3). The TMDL flow targets were then allocated to each MS4 based on their impervious ownership with the modified target with 4.54 acres and adjusted TMDL targets (Table 3).

Table 3 Rugg Brook flow targets allocated by MS4

Owner	Total Watershed Area (acres)	Impervious Cover (acres)	% of Watershed Impervious Cover	Target High Flow Q 0.3 (± %) Reduction [1]	Target Low Flow Q 95 (± %) Increase
St. Albans Town	1556.4	151.4	73.9%	-11.30%	12.41%
VTrans	131.8	32.2	15.7%	-2.40%	2.64%
St. Albans City	70.5	21.4	10.4%	-1.60%	1.75%
Watershed Total	**1758.8**	**204.9**		**-15.30%**	**16.80%**

[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.

IV. BMPDSS Model Assessment

The VTDEC worked with an external consultant (TetraTech) to develop a Vermont-specific hydrologic model, the Vermont BMPDSS, 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 Pre-2002 (baseline), Post-2002 (existing condition), and a Credit (BMP implementation) scenario. All models are compared to the Pre-2002 model on a percent change basis.

IV.1 Existing Condition Review

Both the Pre-2002 and Post-2002 models were reviewed and updated as necessary. Several field visits were conducted from July to September of 2014 of permitted sites within the Rugg Brook watershed (Figure 1). Existing BMPs included in the Pre-2002 and Post-2002 BMPDSS models were assessed and existing VT DEC model inputs were compared with field observations. Updated input files for the Pre-2002 and Post-2002 models were submitted to the VT DEC to run the updated model scenarios.

Figure 1. Staff inspect existing stormwater swales in St. Albans.

IV.2 Permit Review

All expired stormwater permits in the watershed were acquired and reviewed during the BMPDSS model assessments. The expired permits were grouped into those existing stormwater systems with a BMP which provided extended detention of the 1-year design storm (Group 1; Table 4), and those existing stormwater systems without a BMP that provides extended detention (i.e., a system of catchbasins with no outfall management; Group 2).

The Group 1 list was compared to the list of BMPs included in the BMPDSS Pre-2002 and Post-2002 models to check for omissions. Only expired permit systems that include a BMP with CPv storage were included in the BMPDSS model, because only these BMPs can help to meet flow targets. Field assessments were then completed at each Group 1 site to determine if the practice was operating according to the approved expired permit. Each site was also assessed for retrofit opportunities to upgrade the system to the 2002 VTSWMM standards. A full list of expired permits within the watershed and a description of their existing stormwater system and proposed retrofit (if applicable) is included in Appendix 2 (A-2-1).

Table 4 Group 1" Expired permit stormwater BMPs that provide extended detention of the 1-year design storm

Permit #	Permittee	MS4 Draining to Practice	Project Name	Associated Permits	BMP Type in Model
1-1428b	Private	VTrans/ Town	St. Albans Milk and Maple		Detention Pond
1-0908	HOA	VTrans/ Town	Tanglewoods		Detention Pond
1-1563 P1	HOA	VTrans/ Town	Pineview Estates		Detention Pond
1-1563 P2	HOA	Town	Pineview Estates		Detention Pond
1-1563 P3	HOA	Town	Pineview Estates		Detention Pond
1-1563 P4	HOA	VTrans/ Town	Pineview Estates		Detention Pond
1-1563 P5	HOA	VTrans/ Town	Pineview Estates		Detention Pond
2-0291	Town	Town	Collins-Perley Athletic Complex	#5961-9010 upgrades	Detention Pond
1-1428c	Private	VTrans/ Town	St Albans Milk and Maple		Detention Pond
1-1428a	Private	Town	St Albans Milk and Maple		Detention Pond
1-0930	Private	Town	Church of the Rock		Detention Pond
1-1442	HOA	Town	Sunset Terrace Phase 3		Detention Pond
3567-9010	Private	Town	Barry Callebaut Inc	# 2-0142	Detention Pond

*Prepared by Emily Schelley (VTDEC, Jan. 2014). Revised by WCA (2015)

IV.2.1 VTDEC BMPDSS Existing Model Review

Progress towards target high flow reductions were assessed using the BMPDSS model, but in order to assure that these results were accurate, both the Pre-2002 and Post-2002 models were assessed and revised as needed. New BMPs either developed since the model was last updated or unknown at the time of the last model update were added. Additionally, other revisions such as watershed boundary changes were incorporated. Updated input files for the Pre-2002 and Post-2002 models were submitted to VT DEC so that updated model scenarios could be run. Input files included revised HydroCAD® models of each BMP as necessary and GIS data for BMP drainage areas, subwatersheds, and BMP locations. A full list of existing BMPs in the Pre-2002 and Post-2002 model scenarios is included in Appendix 2 (Table A-2-2).

IV.2.1.1 Pre-2002 Model Revisions

Several revisions were made to the Pre-2002 BMPDSS model based on information provided by the MS4 entities and the VT DEC as well as field investigations. The model was revised as follows:

- Subwatershed boundaries around the Superior Ceramics pond, permitted under #3410-9010, and the St. Albans Interstate Access Road (SASH) were adjusted to reflect field observations (Figure 2).

Figure 2. WCA and Town Public Works Director inspect #3410-9010 outlet structure to verify pond routing.

- BMP model entries were adjusted for the following BMPs after comparison between the existing model data and field measurements:
    - #1-1428 Ponds 2 and 3: St. Albans Milk and Maple
    - #1-0908 Tanglewoods Pond
    - #1-1563 Ponds 1, 2, and 3: Pine View Estates
    - #1-0930 Church of the Rock
    - #1-1442 Sunset Terrace
    - #3567-9010 Barry Callebaut
    - #4197-9010 Superior Ceramics Lot

IV.2.1.2 Post-2002 Model Revisions

Several revisions were also necessary for the Post-2002 BMPDSS model. The model was revised as follows

- Two new development projects previously omitted from the model had since begun construction and were thus added, including:
    - #5577-INDS Harborview development on Main Street, permit (conventional catchbasin and pipe conveyance systems routed to stormwater detention pond)
    - #6375-INDS AFB subdivision along Bellevue Carriage Road (conventional catchbasin and pipe conveyance systems routed to stormwater detention pond)

- Subwatershed boundaries around the new Harborview subdivision were adjusted to account for changes in the pond routing to a different tributary compared to the pre-development condition.

The proposed rain garden and gravel swale on the Barry-Callebaut property were not added to the model due to limitations of the BMPDSS model resolution. The scale of the project is too small to be accounted for by the model, and caused an error when included in the model input.

IV.2.1.3 Diversion Structure Considerations

The Stevens-Rugg diversion structure, first built in 1957, is a historic structure designed to address flooding issues in the City of St. Albans by diverting stream flow from Stevens Brook to Rugg Brook. After an extensive study of the structure in the early 2000s, a new water quality and flood equalization system was constructed at the site to minimize increased stormwater flows to Rugg Brook and provide enhanced water quality treatment.

The diversion structure has posed some difficulties for modeling the Rugg Brook watershed in the BMPDSS model. The VTDEC developed an alternative method to simulate the interaction between Stevens Brook and Rugg Brook by use of a regulator device. The regulator design was

calibrated to the BMP design, and effectively splits the flow. Flow from the Stevens Brook watershed model is added to the Rugg Brook watershed by using the time series output file from the Stevens Brook model as an input file for Rugg Brook. The Stevens Brook models used for the Rugg Brook analysis correspond to the scenario modeled. For the Pre-2002 condition, the latest Pre-2002 scenario model is used. For the Rugg Credit scenario model, the proposed FRP Credit scenario model for Stevens Brook (developed under the Stevens Brook FRP Project in 2012) is used to account for future flow reductions. A memo prepared by Emily Schelley (VT DEC) is provided in Appendix 2 which details the procedure utilized for the diversion structure in the BMPDSS.

IV.2.1.4 Post-2002 Model Results

The Post-2002 model was revised with three iterations resulting in an overall slight increase in progress toward the high flow target from the previous model prepared by the VT DEC (Table 5). This is primarily due to changes in the Pre-2002 condition model, improving the modeled condition from the previous model iterations. A full list of the existing BMPs in the Pre-2002 and Post-2002 models is included in Appendix 2 (Table A-2-1). The Post-2002 condition scenario includes 15 individual BMPs, each managing the 1-year design storm, and five of which also provide recharge to groundwater. The most up-to-date Post-2002 condition model scenario (as of January 30th, 2015) was estimated to provide a -2.5% reduction in high flow, calculated as a percent change between the unadjusted flow in the Pre-2002 and Post-2002 scenario, addressing 16% of the TMDL high flow target. The low flow was estimated to decrease by 2.99% from the Pre-2002 scenario, not addressing the non-actionable low flow target. Based on the model results, additional CPv stormwater controls will be required to meet the required TMDL high flow target. Biomonitoring of the streams will ultimately determine if Rugg Brook has reached attainment conditions in compliance with the Vermont Water Quality Standards.

Table 5 Post-2002 BMPDSS model assessment results

Model Run	Description	High Flow Reduction (%)	Low Flow Increase (%) [1]	BMPDSS Model Run Date
TMDL Targets for Rugg Brook with 15 acres Non-Jurisdictional Growth		-16.00%	16.8%	----
Modified TMDL Target for Rugg Brook with 4.54 acres Non-Jurisdictional Future Growth		-15.30%		
VT DEC Post-2002 Model	VT DEC's original Post-2002 model	-2.49%	0.0%	9/18/2013
WCA Revised Existing Condition Model (8/21/2014)	Addition of 5577-INDS and 6375-INDS projects	-2.82%	-1.5%	8/21/2014
WCA Revised Existing Condition Model (10/10/2014)	WCA revised additional subwatersheds and existing BMP designs.	-2.65%	-4.5%	10/10/2014
WCA Revised Existing Condition Model (1/30/2015)	Revised subwatersheds.	-2.50%	-2.99%	1/30/2015
Percent of Target Managed (with Post-2002 Model Run 1/30/2015)		16%	-27%	----
1 - 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.				

V. Required Controls Identification

The process of BMP identification was initiated with a field assessment on August 20th, September 11th, and October 22nd, 2014, of existing BMPs covered by an expired permit to assess the opportunity for upgrade potential to the 2002 VTSWMM standards. Prior to the initial field visit, the team conducted a desktop assessment of the watershed to identify open spaces ideal for BMP implementation, with priority on municipally owned land. The 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 as indicated by mapped Hydrologic Group A or B soils.

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 the HydroCAD® model to meet the CPv storage criteria for cold waters (12-hour detention standard).

Feasibility of BMPs was determined based on available space, Natural Resources Conservation Service mapped soils, existing 1-foot topographic elevation contours derived from LIDAR, and mapped stormwater and wastewater infrastructure provided by the Town and VTrans. Supplemental survey data was collected for the projects as needed. Natural resources were

screened at the sites as well. An in-depth engineering assessment will still be required at each site to confirm the presence or absence of utilities 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. The team prepared 30% preliminary engineering conceptual designs for the new projects provided in Appendix 1.

V.1 BMPDSS Credit Model Results

Selection of the final proposed BMP list was an iterative process. The final proposed BMP list was developed based on an iterative assessment using the BMPDSS model. The first proposed Credit scenario included:

- Nine retrofits to existing ponds with expired permits,
- Five new detention practices in the Town,
- One new infiltration basin in the Town,
- One new underground infiltration system along Route 7 in the City,
- Three new detention practices to mitigate runoff from primarily VTrans owned impervious, and
- Eight new sand filters in the I-89 median.

A separate model run was done only with the nine existing BMP retrofits, Credits_EX. The Credits_EX scenario estimated a decrease in high flow of 6.85%, addressing 45% of the target (Table 6). Another Credit model was then run, Credit 1, which included all proposed retrofits except the SASH BMP. This model estimated a decrease in high flow of 17.97%, addressing 117% of the target (Table 6).

Additional field work was completed at several sites and a few revisions were made to the Credit 1 model run BMPs. A large infiltration basin on the J+L Service lot was removed, and replaced with four new infiltration BMPs in the ROW of South Main Street. In addition, a new gravel wetland was added to mitigate runoff from the SASH. These revisions and additions constitute the second proposed Credit model, Credit 2. The Credit 2 scenario estimated a 17.46% decrease in the high flow from the Pre-2002 condition, addressing 114% of the high flow target. A full modeling summary, including all the model run results completed for Rugg Brook with results compared to the original and modified target, is provided in Appendix 3 (Table A-3-1). There is also a table of BMPs, sorted by the model run to which the BMP was first added (Table A-3-2). BMPs were maintained in each subsequent run. The low flow did not increase in any Credit model scenarios.

Table 6 BMPDSS model runs summary for proposed FRP scenario

Model Run	Description	High Flow Reduction (%)	BMPDSS Model Run Date
Modified TMDL Target for Rugg Brook with 4.54 ac Non-Jurisdictional Future Growth		-15.30%	
VT DEC Post-2002 Condition Model	VT DEC's existing model, includes all Post-2002 BMPs	-2.49%	9/18/2013
WCA Revised Post-2002 Model (1/30/2015)	Revised Subwatersheds.	-2.50%	1/30/2015
Percent of target managed with revised Post-2002 model (1/30/2015)		16%	----
Credit_EX model	Proposed BMP scenario with only retrofits to existing BMPs with expired permits (9 projects).	-6.85%	10/10/2014
Percent of target managed with Credit_EX model run (10/10/14)		45%	----
Credit 1 model	Proposed BMP scenario with all proposed retrofits except SASH BMP.	-17.97%	10/13/2014
Percent of target managed with Credit 1 model run (10/13/14)		117%	----
Credit 2 model	Revised South Main St. practices, Nason St., and Twin Court. Add new SASH BMP.	-17.46%	1/30/2015
Percent of target managed with Credit 2 model run (1/30/2015)		114%	----

These modeled high flow reductions were then allocated to each of the MS4 entities based on impervious cover in the watershed and impervious cover managed by BMPs that provide extended detention. Each of the three MS4s have met >100% of their high flow reduction target, with the Town of St. Albans and the City of St. Albans addressing 110% and 102% respectively (Table 7).

Table 7 BMPDSS model runs summary for proposed FRP scenario

Owner	Target High Flow Q 0.3 (± %) Reduction	High Flow Q 0.3 (± %) Reduction Achieved with Credit Model	High Flow Q 0.3 (± %) Reduction Remaining with Credit Model [1]	High Flow (Q 0.3) Target addressed (%)
St. Albans Town	-11.30%	-12.4%	1.11%	109.8%
VTRANS	-2.40%	-3.42%	1.02%	142.4%
St. Albans City	-1.60%	-1.6%	0.03%	101.9%
Watershed Total	**-15.30%**	**-17.46%**	**2.16%**	**114.1%**

[1] The high flow reduction remaining is positive (+), indicating that modeled results have overachieved the high flow reduction and no reduction remains.

V.2 Proposed FRP Model Scenario

The final recommended BMP list is represented in the Credit 2 model run, which includes 31 proposed BMPs (Table 8). The proposed FRP scenario addresses 114% of the modified high flow target, providing a 14% factor of safety (FOS). The additional FOS is included in the recommended BMP list to provide the MS4s with additional options in the event the list has to be modified, or as 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 8, calculated based on the CPv storage and the BMPDSS model run result (Credit 2 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 the VT DEC that the high flow ($Q_{0.3\%}$) is approximately equivalent to the 1-year storm peak discharge. Essentially, the high flow is directly reduced in the model by mitigating the CPv.

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. 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 MS4's allocated responsibility of the flow targets, summarized in Table A-3-3 (Appendix 3).

VI. Proposed Implementation Plan

The proposed BMPs are summarized in Table 8, including the impervious cover treated, drainage area, and CPv storage estimated by the HydroCAD® 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 8. An additional table is included in Appendix A-3-2, which separates the projects by the model run to which the project was first added.

Table 8 Final proposed BMPs for the Rugg Brook FRP

Site Name	Ownership of Land where BMP is located	BMP Type [2]	Permit #	Drainage Area (acres)	Impervious Acres Managed (acres)	Runoff Channel Protection Volume (CPv) Storage		Percent of High flow Target Managed	*Cumulative* Percent of High flow Target Managed
						cft	ac-ft	%	%
Industrial Park Pond	Town	Detention	3348-9010/ 1-1268	38.64	9.0	49713	1.141	13.4%	29.4%
Tanglewoods	Private	Detention	1-0908	27.69	8.8	28140	0.646	13.2%	42.5%
South Main St. Infiltration	Private/ Cadillac Motel	Infiltration	No Permit	6.55	3.5	15769	0.362	5.2%	47.8%
SASH/Nason St Connector	City/ VTrans/Town	Detention	No Permit	21.12	4.9	15682	0.36	7.3%	55.1%
Twin Court	Private	Detention	1-0658	17.64	5.2	15682	0.36	7.8%	62.8%
Barry Callebaut Inc	Private	Detention	3567-9010	10.37	6.9	8364	0.192	10.3%	73.2%
Nason Street/ Green Mountain Dr.	Private	Detention	1-0577	7.76	1.7	8189	0.188	2.5%	75.7%
Industrial Park Pond	Town	Detention	3348-9010/ 1-1268	38.64	9.0	49713	1.141	13.4%	29.4%

[1] See Table 6. The existing BMPDSS model run estimated 16% of the flow target is addressed with existing BMPs.

Site Name	Ownership of Land where BMP is located	BMP Type [2]	Permit #	Drainage Area (acres)	Impervious Acres Managed (acres)	Runoff Channel Protection Volume (CPv) Storage		Percent of High flow Target Managed	*Cumulative* Percent of High flow Target Managed
						cft	ac-ft	%	%
Clyde Allen Dr.	Private	Detention	2-1168	11	2.5	8015	0.184	3.8%	79.5%
St Albans Milk and Maple (P3)	Private/Public Road	Detention	1-1428c (P3)	3.08	1.3	6447	0.148	1.9%	81.4%
South Main St.-2	City	Infiltration	No Permit	4.13	1.2	4792	0.11	1.8%	83.2%
St Albans Milk and Maple (P2)	Private	Detention	1-1428a (P2)	1.66	1.4	4095	0.094	2.2%	85.4%
Freeborn St.	Private/ Public Road	Underground Infiltration	No Permit	2.94	1.3	3572	0.082	1.9%	87.3%
South Main St.-3	City	Infiltration	No Permit	0.98	0.4	2526	0.058	0.7%	88.0%
Church of the Rock	Private	Detention	1-0930	3.24	1.4	2483	0.057	2.1%	90.0%
Pineview Estates (P2)	Private	Detention	1-1563	5.52	1.9	2047	0.047	2.9%	92.9%
Pineview Estates (P3)	Private	Detention	1-1563	4.9	0.9	1437	0.033	1.3%	94.2%
Sunset Terrace Phase 3	Private	Detention	1-1442	1.75	0.7	958	0.022	1.0%	95.2%
Pineview Estates (P1)	Private	Detention	1-1563	1.02	0.3	697	0.016	0.5%	95.7%
South Main St.-1	City	Infiltration	No Permit	0.9	0.2	1394	0.032	0.4%	96.0%
Exit 19 South_CN	VTrans	Detention	No Permit	62.11	3.8	90169	2.07	5.6%	101.7%
Access Rd. East	VTrans/Private	Detention	No Permit	103.1	2.8	79279	1.82	4.1%	105.8%

Site Name	Ownership of Land where BMP is located	BMP Type [2]	Permit #	Drainage Area (acres)	Impervious Acres Managed (acres)	Runoff Channel Protection Volume (CPv) Storage		Percent of High flow Target Managed	*Cumulative* Percent of High flow Target Managed
						cft	ac-ft	%	%
Access Rd. West	VTrans/Priv	Detention	Portion of 1-1428	13.7	0.6	28401	0.652	0.8%	106.6%
SDC87	VTrans	Median Filter	No Permit	3.8	0.9	5579	0.128	1.4%	108.0%
SDC83b	VTrans	Median Filter	No Permit	1.8	0.4	3339	0.077	0.5%	108.5%
SDC27	VTrans	Median Filter	No Permit	1.61	0.4	2762	0.063	0.6%	109.2%
SDC280	VTrans	Median Filter	No Permit	2.13	0.4	2741	0.063	0.6%	109.7%
SDC347	VTrans	Median Filter	No Permit	1.4	0.3	2608	0.06	0.5%	110.2%
SDC83a	VTrans	Median Filter	No Permit	1.71	0.3	2534	0.058	0.4%	110.6%
SDC342	VTrans	Median Filter	No Permit	1.6	0.3	2358	0.054	0.5%	111.0%
SDC29	VTrans	Median Filter	No Permit	2.25	0.4	2358	0.054	0.6%	111.6%
I-89/Holyoke Farm	Private	Infiltration	No Permit	61.87	1.6	62117	1.426	2.5%	114.1%
				Totals:	99.9		10.66		

[2] BMP Type: Detention = stormwater pond designed to detain the 1-yr design storm (1.94"). Underground infiltration = storage tank under pavement or grass which infiltrates runoff into the subsurface soils.

VI.1 Proposed Retrofits to Existing BMPs

Each existing BMP with an expired stormwater permit providing CPv storage was assessed for retrofit to meet the 2002 VTSWMM standards. Nine of the existing detention ponds were not providing full detention of the CPv for 12 hours. For most of the ponds, either a new low flow or reduced size orifice was proposed to provide full CPv detention. Expansion of several of the ponds was also proposed. Table 9 summarizes the retrofits proposed for the existing BMPs.

Table 9 Proposed retrofits to existing BMPs

Permit #	Project Name	Address	Managed Impervious (acres)	Existing System	Proposed Retrofit
1-0908	Tanglewoods	Tanglewoods Dr.	8.8	Shallow detention pond. Flooding issues in upstream conveyance.	Regrade pond, add outlet structure, add two forebays and improve drainage swales to reduce flooding.
3567-9010	Barry Callebaut Inc	Industrial Park Rd.	6.9	Detention Pond	Reduce 8" low flow orifice to 2.5".
1-1428a	St Albans Milk and Maple/ Mobil (P2)	Fairfax Rd. /SASH	1.4	Detention area in Mobil Station parking lot (North)	Regrade and expand existing detention area.
1-1428c	St Albans Milk and Maple/ Mobil (P3)	Fairfax Rd. /SASH	1.3	Detention Pond in Mobil Station parking lot (West)	Reduce low flow orifice from 4" to 2".
1-0930	Church of the Rock	Fairfax Rd. / Garden Dr.	1.4	Detention Pond in back parking lot.	Remove 4" low flow orifice. Expand Pond.
1-1563	Pineview Estates (P1)	Fairfax Rd. / Allaire Dr.	0.3	1 of 5 ponds built for Pineview Estates Subdivision.	Add 2" low flow orifice at 518.75'.
1-1563	Pineview Estates (P2)	Fairfax Rd. / Allaire Dr.	1.9	1 of 5 ponds built for Pineview Estates Subdivision.	Reduce 3" low flow orifice to 2".
1-1563	Pineview Estates (P3)	Fairfax Rd. / Allaire Dr.	0.9	3 of 5 ponds built for Pineview Estates Subdivision.	Add 2" low flow orifice. Needs Maintenance.
1-1442	Sunset Terrace Phase 3	Sunset Terrace Rd.	0.7	Existing pond, built for portion of Sunset Terrace subdivision.	Reduce 2" low flow to 1.5". Expand and clear overgrowth.

VI.2 Town of St. Albans Proposed New BMPs

Industrial Park Pond (#3348-9010/ #1-1268)

In 2008, Cross Engineering of St. Albans, developed a stormwater enhancement study for the industrial park, under contract with the Franklin County Industrial Development Corp (Appendix 1-Plans). The study was tabled at the time. The focus of the study was an existing stormwater lagoon, that since has been abandoned (Figure 3). In 2012, part of the proposed enhancements were implemented including several engineered check dams within the median strip along Industrial Park Road. The improvements were observed to be functioning as designed on a site visit in September of 2014.

Figure 3. Industrial Park median swales which drain to the area of the proposed new detention pond.

The initial design involved an expanded detention pond extending from the existing stormwater pond at the end of Industrial Park Road, to the south onto Mylan Technologies Property. A new inlet pipe would route runoff from 38.64 acres of the industrial park to the pond. This design would meet the water quality, CPv, overbank flood control, and extreme flood control. Mylan Technologies and the neighboring property owner, Lapierre, were not willing to provide land for the project. Therefore, an alternative smaller pond design was developed in 2009 by Cross Engineering. This alternative design includes a revised detention pond layout within the Town owned parcel at the end of Industrial Park Road, but does not provide full overbank flood protection or extreme flood control. Cross Engineering's design and corresponding report are included in Appendix 1. This was the design used for the BMP in the BMPDSS modeling assessment. A revised cost estimate was developed for the project as well.

Twin Court Pond (#1-0658)

Twin Court has a history of flooding issues along the roadway. Ruggiano Engineering developed plans to increase the size of the stormwater conveyance along Twin Court. In addition, a detention pond is proposed at the end of the conveyance system, located along the stream on the north side of the stream crossing (Figure 4).

Figure 4. Rugg Brook crossing at end of Twin Court.

The Town has discussed accepting ownership of a portion of the roadway, currently owned by the Homeowner's Association (HOA) of the condominiums on the west side of the Rugg Brook crossing. However, there have been easement issues with the HOA, slowing progress on this project. The pond was included in the project list and FRP assessment.

Clyde Allen Drive Gravel Wetland (#2-1168)

Clyde Allen Drive is a neighborhood off Fairfax Street with a system of catchbasins and swales permitted under expired permit #2-1168. The existing drainage system drains directly to the stream. The open grass lawn, just south of the Vermont Housing Authority owned homes, was identified as an ideal location for a detention retrofit due to the open space, proximity to the stream, and ability to help mitigate an existing flooding issue (Figure 5).

Figure 5. Grassed lawn proposed for retrofit with new gravel wetland.

Across the road from the BMP site, there is an area of low ground in the backyard of two homes (Figure 6). The homeowners have brought the issue of standing water to the attention of the Town before, and have reported wet basements.

The proposed retrofit involves installing a new footing drain and stone swale between the two homes' backyards. The footing drain would then connect to a new storm pipe, which would be routed to the proposed gravel wetland. Two new 18 inch culverts would also be needed to provide the necessary drain improvements. A flow splitter will route the 1-year storm to the proposed gravel wetland, while all high flows are routed to existing discharge, with additional buffer improvements. The proposed gravel wetland will be a large open basin, with vegetation on the surface. Beneath the vegetation will be 2 feet of stone, which provides additional storage and filtering of sediment and other pollutants from the stormwater prior to discharge out a low flow orifice.

Figure 6. Low area between homes along Clyde Allen Drive with history of flooding. New footing drain and outlet proposed to drain area.

Freeborn Street Infiltration Basin

An area east of South Main Street, at the intersection of Freeborn Street and Potter Avenue, was identified as a potential site for an infiltration basin. There is a pocket of soils mapped as Hydrologic Group B, which is suitable for infiltration. Upon field inspection, it appeared the existing stormwater outfall, just to the left of the open green space was severely eroded (Figure 7). In addition, an exposed PVC sewer pipe was observed within the existing channel. The sewer pipe was covered with stone shortly after observation in the field (Figure 8). The work revealed there are sandy soils in this area.

Figure 7. Open lawn area on Freeborn Street identified for stormwater retrofit.

This project was installed by the Town of St. Albans during the summer of 2015. The retrofit involved the installation of an underground infiltration basin at the edge of the open grass lawn. The existing stormwater conveyance system was routed to the new basin, with a high flow bypass (>10-year storm) to a new outfall. The infiltration basin consisted of a 15’x 50’

chamber with 6 feet of drainage stone. A Downstream Defender® (D4GA) pretreatment hydrodynamic separator was placed at the inlet for ease of maintenance, and to ensure longevity of the infiltration. The Downstream Defender is vacuumed like a typical catch basin.

Figure 8. New stone cover in existing drainage swale, near location of the new infiltration basin.

Nason Street/Green Mountain Drive (#1-0577) Detention

The neighborhood along Green Mountain Drive is currently covered under an expired stormwater permit (#1-0577). It was determined that the northern portion of the neighborhood, north of Victoria Drive, drains to a collection system on the west side of Green Mountain Drive. The east side of Green Mountain Drive drains to a bowl-shaped area with a 24-inch culvert to the brook (Figure 9).

Figure 9. Nason St. / Green Mt. Dr. Right-of-Way

The bowl-shaped area in the right-of-way was identified as a retrofit site to provide detention

and improved water quality. The project would involve regrading the existing depressed area to a detention basin, with a low flow orifice and high flow bypass to the existing culvert. In addition, the swale on the east side of the roadway would be regraded to create a series of detention areas, with lateral check dams. The bowl would be grassed for ease of maintenance.

VI.3 City of St. Albans Proposed BMPs

South Main Street Infiltration Basins

Along South Main Street and Route 7, between the intersection with the SASH to Freeborn Street, there is an area of Hydrologic Group B soils, which have potential for infiltration. As such, the ROW was inspected for opportunities for green stormwater infrastructure practices, like stormwater planters, curb extensions, underground infiltration basins, dry wells, etc.

South Main Street Infiltration Basin:

A large open grass area in front of the Cadillac Motel was identified as the location for a proposed 840 square foot underground infiltration basin (Figure 10). An underground infiltration chamber system was selected as the best option because this type of practice requires limited maintenance and will not interfere with road maintenance operations. The chamber would be offline, tied into the existing stormwater conveyance system along Route 7, and sized to mitigate the 1-year design storm. Flows above the 1-year storm would bypass the system. Potential water line conflicts are still to be determined. The town would need to acquire an easement for the practice from the motel property owners.

Figure 10. Entrance to Cadillac Motel. Site of proposed underground infiltration basin.

South Main Street M1, M3, M3:

Along Route 7, three stormwater curb extensions with infiltration basins were proposed in the right-of-way, designed as offline practices to detain and infiltrate up to the 1-year design storm volume (Figures 11, 12, and 13). An example of a stormwater curb extension is provided in Figure 14. The practices would be tied into the existing stormwater conveyance system. Curb cuts would be installed to increase catchment of surface runoff from the roadway. The current roadway width is approximately 25 feet, which is wider than the minimum 13 feet for shared use. The proposed practices would extend a maximum of 4 feet into the existing roadway, maintaining the required road width. Practices could be left with a pea gravel surface to reduce maintenance.

Figure 11. Site for "M2" Stormwater Curb Extension along Route 7.

Figure 12. Site for "M3" Stormwater Curb Extension along Route 7.

Figure 13. Site for "M1" Stormwater Curb Extension along Route 7.

Figure 14. Example of a stormwater curb extension for the Route 7 ROW (Credit: VA DRC Stormwater Design Manual 2013).

VI.4 VTrans Proposed BMPs

Exit 19 South Detention Basin

Figure 15. Exit 19 center median. Site of proposed stormwater basin.

The center median between the Exit 19 South on-ramp and the SASH is presently contoured and piped to collect drainage from three segments of I-89, and a large portion of the upper watershed, east of I-89. This makes this site a feasible candidate for stormwater improvements (Figure 15). The land is within the VTrans ROW and would only treat VTrans owned impervious, with the exception of a small amount of private impervious area at the top of the upstream watershed. The proposed BMP is a stormwater detention pond designed to VTrans standards for structures within the ROW, with approximately 2 acre-feet of storage. Water quality components such as a sand or stone bed, forebay, and/or micro pool could be integrated into the design if necessary. The site was screened for natural resources and found to contain dense *Phragmities australis* growth, which will need to be considered in the excavation process. It is recommended that excavated materials are re-used onsite to minimize the spread of invasive species offsite.

Access Road East (SASH/Fairfax Road)

Figure 16. Site of proposed Access Rd. East project.

There is a privately owned open space, located between Rugg Brook, the northwest corner of Fairfax Road, and the SASH, which is a candidate site for implementation of a new stormwater detention basin (Figure 16). A stone bed and micro pool are proposed to improve water quality benefits of the project. The proposed basin would collect and store drainage from a segment of an existing mapped tributary which takes drainage from an expired permit site (#1-1428), a segment of I-89, and a large area of the upper watershed east of I-89.

The location of the proposed BMP is on land that is currently owned by a local farmer, and within the VTrans ROW. The section of land which is proposed for BMP implementation appears to be devoid of farming practices, likely due to the presence of the existing tributary dividing the field. This BMP would be a shared system that would require town management and cost sharing with VTrans as well as private

permittees. This project has the potential to provide very significant benefits toward the flow target in the watershed, therefore it would be worth the effort to approach the landowner.

Access Road (SASH) West Basin

The Access Road (SASH) West Basin would be located along the northern (westbound) side of a section of the SASH. The BMP was designed as a median sand filter which would collect drainage from the roadway and the upslope field, before draining to a culvert under the SASH. The BMP could be designed to provide CPv storage as well as water quality treatment. This project would be located within the VTrans ROW, but has potential for cost-sharing with the Town, as the BMP would treat drainage from privately owned land, and cropland within the Town. Additionally, a portion of the highway which currently drains to the Tanglewood subdivision basin, under expired permit #1-0908, would drain to the proposed BMP.

Figure 17. Site of proposed "Access Rd. East Basin" at intersection of Fairfax Rd. and the SASH.

Median Sites

Eight median sites were identified which would detain and treat runoff from I-89 in the existing highway median. The structures would be considered equivalent to dry swales as defined in the 2002 VTSWMM. The structures would be located in existing vegetated stormwater conveyances in the I-89 median. Key features of the structures include earthen check dams designed to create up to 1.5 feet of ponding depth behind each dam, amended soils consisting of a 50/50 blend of sand and native soil at the surface, and a pure sand filter below (Figure 18). A perforated underdrain wrapped in stone would be located below the sand filter, which would be connected to the outlet structure, or daylighted. A plan for SDC 280 is provided to demonstrate the typical layout of the median sand filter BMP, which would be consistent for the other median sites (Appendix 1). The proposed sand filters are consistent with the three filter systems constructed in the Exit 19 ROW in 2013—existing BMPs VTrans 138, 75c, and 80b (See Map in Appendix A-4).

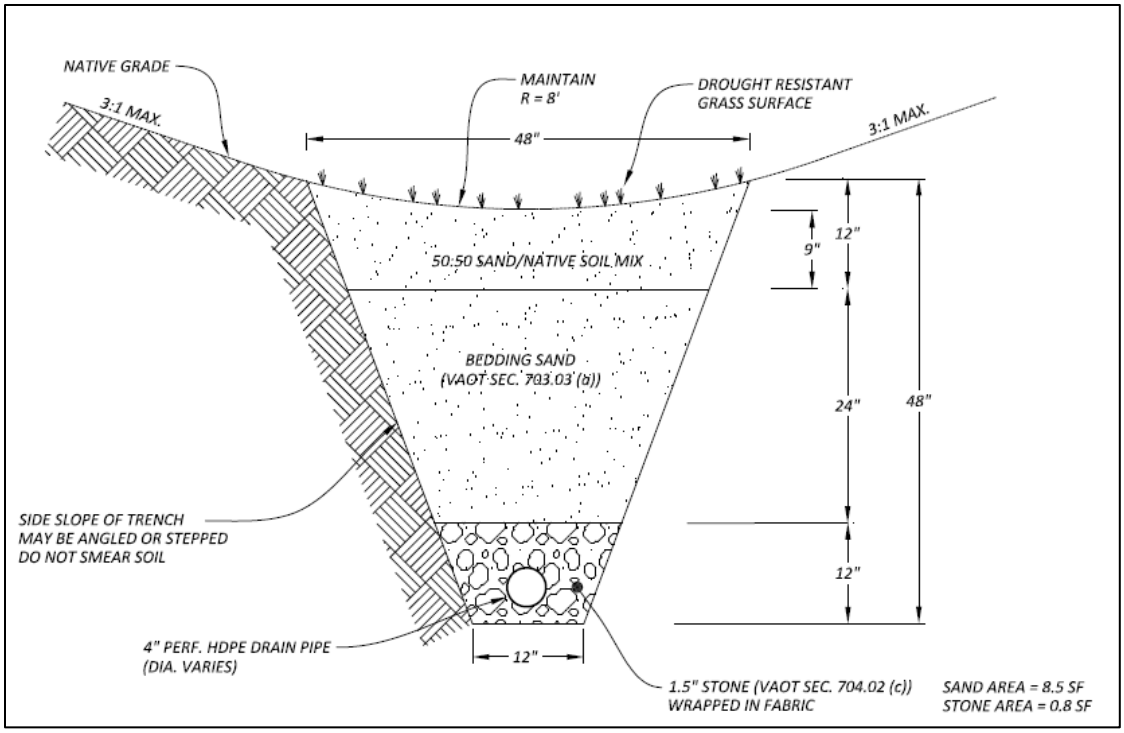


Figure 18. Median filter section view (Credit- WCA)

VI.5 Joint MS4 Proposed BMPs

I-89/ Holyoke Farm Infiltration Basin

On the southern border of the impaired watershed boundary, there is an area with Hydrologic Group A mapped soils, which have potential for infiltration. The area was identified as a potential site for an infiltration BMP to treat runoff from an I-89 culvert. The proposed BMP would be located on land owned by an active farm, adjacent to I-89, located off Holyoke Farm Road. This project is one of five BMPs that have the potential to increase baseflow to the stream, via infiltration, which addresses both the high flow and low flow TMDL targets.

The proposed BMP would be a 15,000 square foot infiltration basin (Figure 19). The surface would be reseeded with grass for ease of maintenance. Below the surface would be 3 feet of drainage stone on top of the native soil. The basin would detain and filter the 1-year design storm CPv to reduced Total Suspended Solids (TSS), and Total Phosphorus (TP). New surface flow paths draining to the proposed BMP would be constructed as well as a new discharge pipe to direct runoff from the southern VTrans culvert to the practice (Figure 19). The proposed placement of the BMP was based on optimizing catchment of runoff from two I-89 culverts and the flat terrain. The existing use of the open space for farm operations would need to be verified to limit disturbance to the owner's ongoing use of the land.

Figure 19. Proposed infiltration basin on farm land, located off Holyoke Farm Rd.

The proposed project is on land owned by an active farm. There is potential the farm may need to implement BMPs for compliance with the Lake Champlain Phosphorus TMDL. This proposed project has potential to also address runoff from the farm to mitigate phosphorus runoff, which could provide VTrans with a joint opportunity to address runoff from a portion of I-89.

SASH/Route 7 Gravel Wetland

The culvert under Route 7 on South Main Street (at the west end of the SASH) was identified as a priority for stormwater drainage management. The existing drainage area for the culvert includes: a majority of impervious cover from the SASH owned by VTrans, the portion of the SASH owned by the City, and a minor portion of the St. Albans Education Center's back parking lot (Figure 20). There is no VTrans owned land available to manage the SASH runoff. A City owned parcel, located across Route 7 from the SASH and set back approximately 500 feet from the culvert outlet, was identified as a potential location for a gravel wetland to provide storage and filtration for the 1-year storm runoff volume.

Nason Street Connector Project: Plans developed by VHB Engineering to add a new road connection from Route 7 to Lemnah Drive were considered when developing the plan for this project. As of now, the project is at the 60% design phase. Based on plans from January 2015, a water quality basin was proposed between the railroad and new road, potentially leaving space for an additional BMP. The Nason Street Project is still in the design phase, and is subject to

change. Therefore, this project may need to be revised and/or could be prohibited due to the lack of available space.

Figure 20. Drainage area for SASH/Route 7 culvert, with MS4 boundaries. The proposed plan as of January 2015 for the Nason St. Connector road was included in this map (NW corner).

VI.6 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. The purpose of the ranking matrix is to provide the MS4s with a tool to prioritize projects on a number of criteria, rather than just on flow benefit. The matrix is set up for use in the future as new information for the proposed BMPS is developed and/or BMPs are added or removed from the list. The criteria and categories are included in Table 10.

Table 10 Criteria used for project ranking

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, (ie. 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
Other Project Benefits	J	Flood Mitigation (Is existing flooding issue mitigated by project?)
	K	TMDL Flow Target Addressed ($Q_{03\%}$, $Q_{95\%}$)
	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 field verified and calibrated model that will accurately predict pollutant loading and BMP effectiveness. WCA modeled the BMPs using WinSLAMM and quantified the annual TSS and TP reductions in loads of pollutant per year. Ranges for the TSS and TP removals were identified, and assigned a score of zero to six points, with six being the greatest benefit. The final ranking of proposed projects is included in Table 11 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 TP and TSS loading reductions for each proposed BMP is provided in Appendix A-5-4.

Table 11 Ranked proposed FRP BMPs based on comprehensive ranking matrix

Rank	Site ID	MS4	Retrofit Description	Total Score
1	Tanglewoods	Town	Expand and retrofit Detention Basin	25.00
2	Industrial Park Pond	Town	Expand abandoned pond and redirect parking lot/road runoff to pond.	25.00
3	Exit 19 South	VTrans	Detention Basin	22.00
4	Barry Callebaut Inc	Town	Reduce 8" low flow orifice to 2.5".	21.00
5	S. Main St. Infiltration	City	Underground Infiltration gallery in open space at Cadillac Motel Entrance	20.50
6	S. Main St.-2	City	Dry well system in ROW	20.25
7	SASH/Federal St Connector	VTrans/City	Incorporate detention of SASH runoff with Federal St. Connector Project	20.00
8	Clyde Allen Dr.	Town	Gravel Wetland	19.00
9	Access Rd. East	VTrans	Gravel Wetland	19.00
10	SDC83b	VTrans	Median Filter	19.00
11	SDC27	VTrans	Median Filter	19.00
12	SDC83a	VTrans	Median Filter	19.00
13	SDC342	VTrans	Median Filter	19.00
14	SDC29	VTrans	Median Filter	19.00
15	S. Main St.-1	City	Dry well system in ROW	18.25
16	S. Main St.-3	City	Dry well system in ROW	18.25
17	Freeborn St.	Town	Dry Well adjacent to parking lot.	18.25
18	SDC87	VTrans	Median Filter	18.00
19	SDC280	VTrans	Median Filter	18.00
20	Nason St./ Green Mountain Dr.	Town	Bioretention with underdrain along roadway.	18.00
21	St. Albans Milk and Maple (P2)	Town	Regrade and expand pond.	18.00
22	St. Albans Milk and Maple (P3)	Town	Reduce low flow orifice.	18.00
23	Church of the Rock	Town	Remove 4" low flow orifice. Expand Pond.	18.00
24	SDC347	VTrans	Median Filter	18.00
25	Pineview Estates (P2)	Town	Reduce 3" low flow orifice to 2".	17.00
26	I-89/Holyoke Farm	Town	Infiltration Basin	16.00
27	Pineview Estates (P1)	Town	Add 2" low flow orifice at 518.75'.	16.00
28	Pineview Estates (P3)	Town	Add 2" low flow orifice.	16.00
29	Sunset Terrace Phase 3	Town	Reduce 2" low flow to 1.5".	16.00
30	Twin Court	Town	Detention Basin.	16.00
31	Access Rd. West	VTrans	Gravel Wetland	13.00

VI.7 Critical Source Area Study for St. Albans

A Critical Source Area (CSA) Study was completed by the NRPC to quantify phosphorus loading in the St. Albans City and Town in order to identify critical areas for phosphorus pollution control. The proposed FRP scenario was overlaid onto the CSA study results to exhibit the proposed BMPS largely focused in areas with higher TP loading (Appendix 8). There are also areas where an existing BMP could potentially decrease the estimated TP loadings for some subwatersheds. As the Lake Champlain Phosphorus TMDL is finalized, it is important to try to address both the stormwater flow TMDL and phosphorus TMDL goals at the same time. In addition to flow control, which is the most effective way to address the stormwater TMDL, considerations for improved water quality benefits by the proposed stormwater control BMPs, were incorporated into the design alternatives. For example, phosphorus loading reductions were improved by choosing a gravel wetland design alternative, versus a detention pond.

VII. Design and Construction Schedule

A D&C schedule is a required element of the final approved FRP, providing an outline for the implementation of the proposed FRP over a 20-year timeframe. A D&C was prepared with the 23 projects that will be implemented by the Town of St. Albans and the City of St. Albans. The projects were spaced out over the timeframe in five separate, three year phases. The timeline considered: effort for design, acquisition of necessary permits and/or regulatory approvals. The estimated total cost by MS4. It should be noted that both the Town of St. Albans and the City of St. Albans have projects proposed projects in multiple watersheds, and as such the schedule presented below may appear not well distributed across the timeframe. This is due to the schedule projects in Stevens Brook watershed. Summed project costs are shown by implementation phase in Table 12. The total costs included in this table take into account the cost sharing described below. They also do not include the Freeborn St. project in St. Albans Town as this project has already been completed. The D&C is included in Appendix A-6. Adjustments to the flow targets may impact the schedule and full implementation of the proposed projects. Additionally, the D&C is a working document and will be revised based on new information about the projects and/or stream conditions.

Table 12 Total cost by implementation phase for both MS4 entities

MS4	Phase 1 (1-4 years)	Phase 2 (4-6 years)	Phase 3 (7-9 years)	Phase 4 (10-13 years)	Phase 5 (14-17 years)
St. Albans Town	$451,500	$145,000	$445,000	$470,000	$467,000
St. Albans City	$34,750	--	$379,000	--	--

Cost-Share Allocation

A cost-share was applied for projects with multiple MS4 jurisdictions based on a percentage factor. This combined the percent runoff contribution and percent impervious surface ownership within the BMP drainage area into an overall percent allocation. The percent runoff contribution was determined using site specific HydroCAD models for each BMP drainage area. The percent impervious was determined through a GIS exercise, using 2011 impervious cover mapping prepared by the Lake Champlain Basin Program. The cost-share allocation applied, provides one example for how the MS4s can share the financial responsibility for projects with contributing areas from multiple jurisdictions. The cost breakdown, percent runoff volume and percent impervious area are summarized in Appendix A-10 for the following projects: I-89 Holyoke Farm infiltration gallery, Access Road East detention basin, Access Road West detention basin, Exit 19 South basin, and the SASH/Nason Street Connector project.

VIII. Financial Plan

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 initial 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, and the plan preparers attempted to identify BMPs with a sole MS4 owner. However, optimal BMP locations did not always follow property boundaries. For joint ownership projects, the funding responsibility will be negotiated between the involved MS4s. The challenges with cost-sharing will be considered in the final FRP proposed financial plan, and may dictate the recommended strategy.

Funding Sources:

The Town of St. Albans does not have a separate funding source for stormwater related costs. The stormwater program may be funded from the general tax, which is pooled for the Town's Public Works Department. The Town is in the process of developing their stormwater program and regulations in the upcoming year, which will determine how they will fund the FRP projects.

The City of St. Albans is willing pursue cost sharing of planning, construction and O&M costs of any BMP based on how much land is treated within the MS4 (City/Town/VTrans). The City commits to assuming at least a 50% match from the State for the funds for final planning for each BMP. The City will likely be able to work on two projects concurrently. The City will spend the next 2-3 years exploring a stormwater utility as a source of local funding for the BMPs, as well as other stormwater items. The City assumes at least a 50% match from the State for the funds associated with construction of any BMP.

VIII.1 BMP Cost Estimates:

Itemized cost estimates were developed for the VTrans, Exit 19 South Basin, as well as the Clyde Allen Drive projects (Appendix 7). For all other projects, a modified spreadsheet method was used as detailed in section 7.1.2.

VIII.1.1 Itemized Cost Estimates:

The itemized cost estimates 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 7. The cost estimates are based on the following criteria:

- **Construction Cost**: The construction costs were developed based on using both VTrans 5-year average costs, VTrans Estimator Program, 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 the VTDEC. 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 the VTDEC. 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%.

VIII.1.2 Cost Estimates Using Spreadsheet Method:

A spreadsheet-based method, originally developed by Horsley-Witten Group, was used to develop planning level costs for all proposed BMPs. The methodology was used in the development of the Centennial Brook FRP and provides consistent cost estimates for each BMP within the watershed. It is expected that these costs will change as further design is completed and site conditions and constraints are better understood. Cost estimates are based on limited site investigation, but are useful for planning purposes. All estimates presented are based on 2014 dollars.

The cost estimation is based on the design control volume as determined by HydroCAD models developed for each site, unit costs that take into account the type of BMP, a site adjustment factor that takes into account the difficulty of construction based on present development at a location, a factor for the design and permitting of the BMP, and a land acquisition cost.

Unit Costs and Site Adjustment Factors: construction costs were estimated using unit costs and a site adjustment factor summarized in Table 13 below. Unit costs were assigned for each BMP type, and a site adjustment multiplier was applied depending on the type of site.

Table 13 Unit costs and adjustment factors for each BMP type

BMP Type	Base Cost ($/ft^3)
Detention Basin	$2
Infiltration Basin	$4
Underground Chamber (infiltration or detention)	$12
Bioretention	$10
Green Infrastructure/ Underground Chamber Combo	$22
Site Type	**Cost Multiplier**
Existing BMP retrofit	0.25
New BMP in undeveloped area	1
New BMP in partially developed area	1.5
New BMP in developed area	2
Adjustment factor for large aboveground basin projects	0.5

Derived from Horsley Witten Memorandum Dated January 9th 2014 (Page 11)

Site Specific Costs: Cost of significant utility or other work related to the construction of the BMP itself. Site specific costs are variable based on past experience.

Base Construction Cost: Calculated as the product of the design control volume, the unit cost, and the site adjustment factor.

Permits and Engineering Costs: Used either 20% (for largest storage volume projects), and 35% for smaller or complex projects.

Land Acquisition Costs *(Modified*): A variation from the HW method was applied. Based on an estimate from the City Assessor, the land acquisition cost was calculated as $120,000 per acre required for the BMP, applied to projects on private land. It should be noted that this value is based on a limited estimate and not necessary an expected cost per acre.

Total Project Cost: Calculated as the sum of the base construction cost, permitting and engineering costs, and land acquisition costs.

Cost per Impervious Acre: Calculated as the construction costs plus the permitting and engineering costs divided by the impervious acres managed by the BMP.

Operation and Maintenance: The annual O&M was calculated as 3% of the base construction costs, with a maximum of $10,000.

Minimum Cost Adjustment: After total project costs were determined for each proposed BMP based on the HW methodology, costs were reviewed and adjusted so that projects involving an outlet retrofit, such as a new outlet structure, were assigned a minimum cost of $10,000, and a project involving an expansion retrofit were assigned a minimum cost of $25,000.

VIII.1.3 BMP Cost Estimates Table

The total cost for implementation of the FRP projects was determined, with assumed cost-sharing for the joint MS4 projects (Table 14). This is an approximate estimate and is subject to change, based on more refined design and cost-sharing agreements. The cost breakdown is relatively consistent with the impervious cover breakdown in the watershed. Tables 15 and 16 show the cost breakdown by BMP for the Town of St. Albans and the City of St. Albans respectively. The Freeborn St. project in St. Albans Town has already been completed. As such, the cost of this project has not been included in the watershed and MS4 totals below.

Table 14 Total project cost estimate for FRP projects by MS4, assuming cost sharing for joint MS4 projects

MS4	Total Project Cost
Town of St. Albans	$1,978,500
City of St. Albans	$413,750
VTrans	See VTrans FRP Document
Total:	**$2,392,250** (excluding VTrans)

Table 15 Proposed BMPs cost estimates for the Town of St. Albans

Project Name	Impervious Cover (Acres)	Design Control Volume (ac-ft)	Base Unit Cost ($/cft)	Site Adjustment Factor	Permits & Engineering Contingency	Land Cost	Minimum Project Cost ($10k for simple retrofits; $25k otherwise)	Final Project Cost	Final Project Cost Rounded to Nearest $1,000	St. Albans Town Cost Allocation (% of total project cost)	St. Albans Town Cost Allocation ($)
Pineview Estates (P1)	0.2	0.02	$2	0.25	$122	$0	$10,000	$10,000	$10,000	100%	$10,000
St Albans Milk and Maple (P3)	1.3	0.15	$2	0.25	$1,128	$0	$10,000	$10,000	$10,000	100%	$10,000
Sunset Terrace Phase 3	0.3	0.02	$2	0.25	$168	$0	$10,000	$10,000	$10,000	100%	$10,000
Pineview Estates (P2)	1.7	0.05	$2	0.25	$358	$0	$10,000	$10,000	$10,000	100%	$10,000
Pineview Estates (P3)	0.5	0.03	$2	0.25	$144	$0	$10,000	$10,000	$10,000	100%	$10,000
Barry Callebaut Inc	7.0	0.19	$2	0.25	$836	$0	$10,000	$10,000	$10,000	100%	$10,000
St Albans Milk and Maple (P2)	1.4	0.09	$2	0.25	$717	$0	$25,000	$25,000	$25,000	100%	$25,000
NWMC-South Pond B	1.0	0.15	$2	0.25	$1,143	$0	$25,000	$25,000	$25,000	100%	$25,000
Church of the Rock	1.4	0.06	$2	0.25	$248	$0	$25,000	$25,000	$25,000	100%	$25,000
Tanglewoods	7.7	0.65	$2	0.5	$9,849	$0	$25,000	$37,989	$38,000	100%	$38,000
SASH/Nason St Connector	4.3	0.39	$2	2	$23,601	$48,000	$25,000	$139,032	$139,000	50%	$69,500
Exit 19 South	6.9	2.07	Itemized Cost Estimate*					$360,000	$360,000	25%	$90,000
Nason St./ Green Mountain Dr.	1.5	0.19	$10	1	$16,379	$0	$25,000	$98,271	$98,000	100%	$98,000
Twin Court	4.2	0.36	$2	2	$21,954	$16,080	$25,000	$100,761	$101,000	100%	$101,000
Freeborn St. [1]	*1.1*	*0.08*	*Itemized Cost Estimate**					*$120,000*	*$120,000*	*100%*	*$120,000*

Access Rd West	0.6	0.65	Itemized Cost Estimate*					$250,000	$250,000	50%	$125,000
I-89/Holyoke Farm	2.7	1.43	$4	1	$49,693	$72,000	$25,000	$370,159	$370,000	50%	$185,000
Industrial Park Pond	18.5	1.14	$2	1.5	$52,187	$31,440	$25,000	$232,733	$233,000	100%	$233,000
Grice Brook Retirement Community	2.8	1.35	$2	1	$23,522	$102,960	$25,000	$244,094	$244,000	100%	$244,000
Clyde Allen Dr.	2.4	0.18	Itemized Cost Estimate*					$250,000	$250,000	100%	$250,000
Access Rd East	10.2	1.82	Itemized Cost Estimate* (Significant land cost included)					$820,000	$820,000	50%	$410,000
								Total	**$3,038,000**[1]	**Total**	**$1,978,500**[1]

* An itemized cost estimate was completed for this project, which was considered to be a more accurate representation of the

[1] The Freeborn St. project has already been completed. As such, totals do not take this project into account.

Table 16 Proposed BMPs cost estimates for the City of St. Albans

Project Name	Impervious Cover (Acres)	Design Control Volume (ac-ft)	Base Unit Cost ($/cft)	Site Adjustment Factor	Permits & Engineering Contingency	Land Cost	Minimum Project Cost ($10k for simple retrofits; $25k otherwise)	Final Project Cost	Final Project Cost Rounded to Nearest $1,000	St. Albans Town Cost Allocation (% of total project cost)	St. Albans Town City Allocation ($)
SASH/Nason St Connector	4.3	0.39	$2	2	$23,601	$48,000	$25,000	$139,032	$139,000	25%	$34,750
South Main St.-1	0.2	0.01	$22	1.5	$5,031	$0	$25,000	$25,000	$25,000	100%	$25,000
South Main St.-2	1.1	0.03	$22	1.5	$15,094	$0	$25,000	$58,218	$58,000	100%	$58,000
South Main St.-3	0.4	0.02	$22	1.5	$10,062	$0	$25,000	$38,812	$39,000	100%	$39,000
S. Main St. Infiltration	3.1	0.28	$12	1	$51,227	$59,760	$25,000	$257,348	$257,000	100%	$257,000
								Total	**$518,000**	**Total**	**$413,750**

** Although this project is a retrofit of an existing BMP, it was determined that due to site specific complexity, costs would be comparable to a new BMP. As such, a site adjustment factor of 2 was used.

IX. Regulatory Analysis

The Town of St. Albans has decided that all expired stormwater permits be incorporated into the Town's MS4 permit. The Town does not request that the State exercise Residual Designation Authority (RDA) on any of the expired permits in Rugg Brook at this time. The Town is working diligently to contact the homeowners responsible for the expired permits to complete the needed maintenance and discuss the Town's intention of taking over the permits. In many cases this is a difficult and time consuming task given no homeowner associations exist. It remains a possibility that the Town may request RDA assistance from the Agency of Natural Resources, if an agreement for the Town to take over an expired permit cannot be reached.

The City of St. Albans has provided to the State a list of expired stormwater permits that will be incorporated into the City's MS4 permit and an additional list of permits of sites proposed for Residual Designation Authority (RDA) permitting through VT ANR. As part of this plan, retrofits are being proposed on sites tied to an expired State operational stormwater permit. If retrofit projects are to be covered under the MS4 permit, the MS4 will elect to take over O&M of the stormwater system and will report on any pertinent O&M activities as part of the MS4 requirements. If the retrofit project is to be covered under an RDA permit, the private landowners holding the permit will retain the responsibility of O&M on the retrofit stormwater system.

A full list of the expired permits with discharges to Rugg Brook indicating the retrofits proposed under this FRP is included in Appendix 2 (Table A-2-1).

X. Glossary of Terms

A glossary of relevant terms is provided below.

Best Management Practice (BMP)- Generally, BMPs are defined as "Schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the State and waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage" (MS4 Permit, 2012). In the context of the FRP, BMPs include prescribed stormwater flow control practices as defined in the computer-based BMPDSS model, in which various BMPs scenarios can be assessed.

Best Management Practice Decision Support System (BMPDSS)- A computer-based hydrologic model used to assess the impact of various stormwater Best Management Practice (BMP) scenarios. This tool was developed by a private consultant for the VTDEC to use as the assessment tool for the compliance of the Stormwater TMDLs.

Channel Protection Volume (CPv)- The stormwater volume generated from the one-year, 24-hour rainfall event (1.9"). The Vermont Stormwater CPv Design Standard requires 12 hours of extended detention storage (ED) of the CPv in warmwater fish habitat (24 hour for coldfish), as a means to reduce channel erosion.

Detention BMP- A BMP (eg. Pond, biofilter) which stores stormwater for a defined length of time before it eventually drains to the receiving water body. Stormwater is not retained in the practice. The objective with e detention BMP is to reduce the peak discharge (Qp) from the Basin, in the effort to reduce channel erosion and settle out pollutants from the stormwater.

Flow Duration Curve (FDC)- 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 ($Q_{0.3\%}$).

Flow Restoration Plan (FRP)- The FRP is a required element of the MS4 General Permit #3-9014, under section IV. C. 1., for stormwater discharges to impaired waters. The FRP is a 20-year implementation plan of stormwater flow control Best Management Practices (BMPs) to meet the TMDL high flow target and return the impaired water to its attainment condition. The FRP is required to include a list of stormwater BMP controls, as well as modeling results from the State's Vermont BMPDSS model demonstrating compliance of the approved TMDL flow-target with the proposed BMP list.

Infiltration BMP- A BMP **(**eg. Storm-tech Chamber, bioretention) which allows for the infiltration of stormwater into the subsurface soil as groundwater, which returns to the stream as baseflow. Mapped soils of Hydrologic group A or B (sandy well drained soils) are an indicator

of infiltration potential. Infiltration reduces the amount of surface storage required. Typical BMP practices include infiltration basins, underground chamber systems, bioretention practices, etc.

Non-Jurisdictional Impervious- Non-jurisdictional growth is by definition impervious area that does not require a stormwater permit and it not managed by a stormwater BMP (impervious growth < 1 acre).

Residual Designation Authority (RDA)- State's authority to issue an RDA permit to discharges not covered by the MS4 Permit. The RDA permit is separate from the MS4 permit, held by the private landowner.

Stormwater Management Plan (SWMP)- A comprehensive program to manage stormwater discharges from the Municipal Separated Storm Sewer System as mandated by the MS4 General Permit #3-9014.

Stormwater TMDL (TMDL)- Vermont developed stormwater TMDL's for impaired watersheds using stormwater flow as a surrogate for pollutants. The basis for the flow-based TMDL is the understanding that stormwater is the source of pollutant loading, therefore minimizing stormwater flows will reduce pollutant loading to the streams and Lake Champlain. The approved TMDL is defined by a reduction in high flows, defined as greater than the 1-year storm event (~1.94" in St. Albans). The TMDL also includes a non-actionable (not enforced) lo-flow target which is an increase in baseflow (groundwater flow to streams).

Total Maximum Daily Load (TMDL)- A TMDL is a calculation of the maximum pollutant loading that a water body can accommodate and still meet Vermont Water Quality Standards. The term TMDL also refers to the regulated management plan, which defines who the water body will be regulated and returned to its acceptable condition, including the maximum loading, sources of pollution, and criteria for determining if the TMDL is met.

TMDL High flow Target - The TMDL target defined as the percent change between the baseline condition (pre 2002) and the existing or proposed condition (Post 2002) high flow. The high flow is the flow rate in the stream that is exceeded only 0.3% of the time (Q0.3%), over a 10 year simulation period. The Q0.3% has been equated to the 1-year design storm runoff.

TMDL Low flow Target - The non-actionable TMDL target defined as the percent change between the baseline condition (pre 2002) and the existing or proposed condition (Post 2002) low flow. The low flow is the flow rate in the stream that is exceeded 95% of the time (Q95%), over a 10 year simulation period. The Q95% is considered "baseflow" which is the flow in a stream fed by groundwater.

XI. Appendices

Rugg Brook BMPDSS Notes

Emily Schelley, Environmental Analyst, VTDEC, July 12, 2013

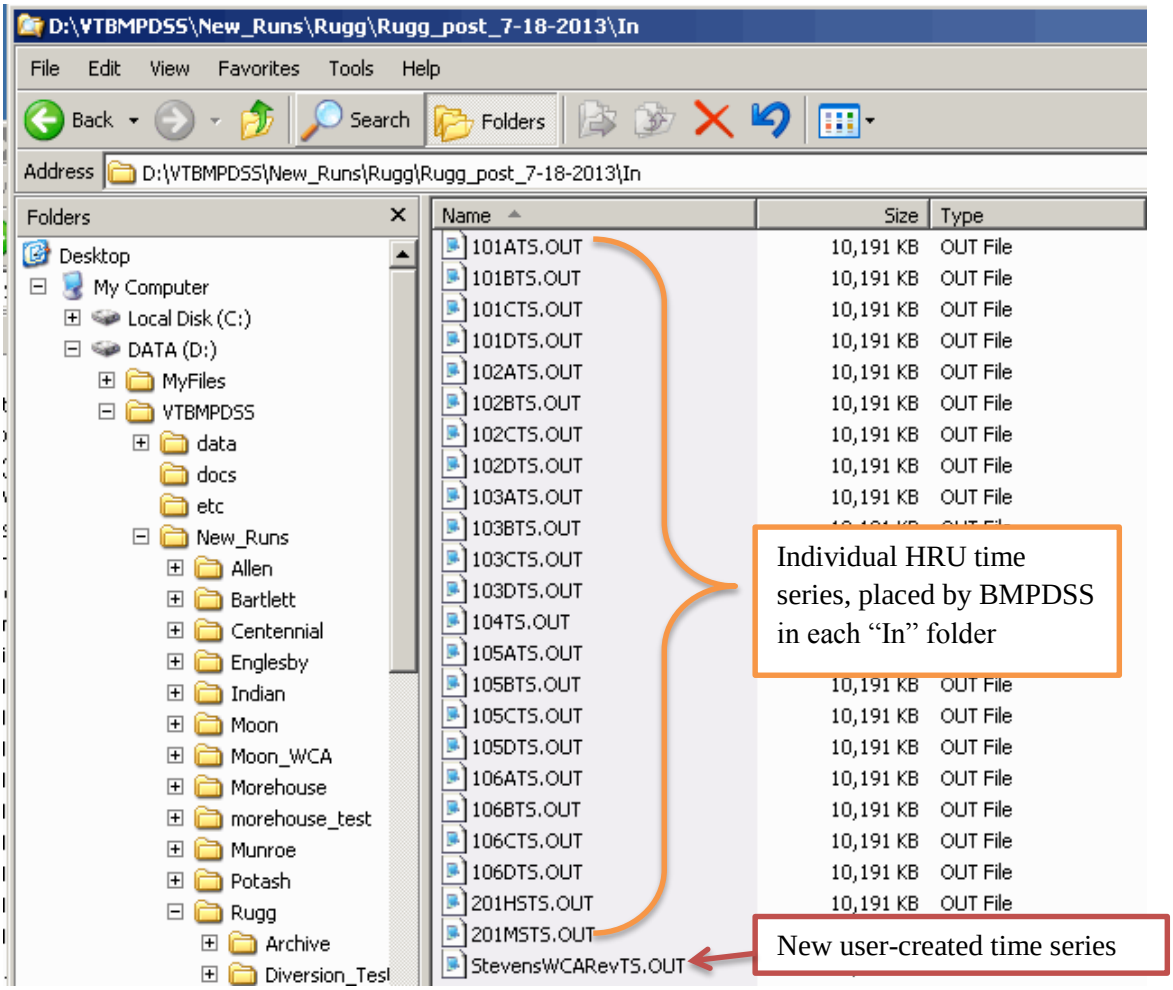
The Stevens-Rugg brook diversion in St Albans is a unique feature that has caused some challenges when modeling the structure in the VTBMPDSS. When modeling the Stevens brook watershed, the diversion was modeled as a "Regulator" which allows the user to input a pipe and a weir and route each of these outlets to a different location, effectively splitting the flow. The regulator in the Stevens Brook model includes a culvert that carries the discharge on downstream through Stevens Brook and a weir, which carries overflow to the diversion channel and essentially removed from Stevens Brook.

While it is fairly straightforward to remove the flow over the weir from Stevens Brook, adding that flow to Rugg Brook proved more difficult. In most cases flow splitter is used internally within a subwatershed, such as to route smaller storms through a BMP while allowing larger storms to bypass the system. During the set-up of the Englesby Brook watershed in BMPDSS it was discovered that when a flow splitter was used this way, the area draining to the splitter was being double counted, once each for the orifice and weir separately. This caused issues with the flow calculations further down the watershed. To resolve this issue, the BMPDSS code was modified to only count the area going through the pipe outlet. A side effect of the fix is that the weir flow doesn't promulgate properly downstream if it is routed separately from the orifice flow. If the flow splitter itself is set as an assessment point, the user will see that there is flow in the weir outflow column, proving that some water is indeed going through the weir. If another node is added downstream of this weir flow and viewed as an assessment point, no flow will show up.

My initial thought had been to include the portion of Stevens brook upstream of the diversion to the Rugg model. Because of the abovementioned reason, the flow from the diversion weir doesn't actually get added to Rugg Brook. Since the flow over the weir is able to be viewed as an assessment point, I made the weir flow the surface water flow (first column) in a new time series file (the other columns have been left blank for now. This would need to be changed if we modeled other parameters, like phosphorus). For the base Rugg model, the weir overflow from the Stevens base model was used, named StevensWCABaseTS.out. For the credit scenario, the time series "StevensWCARevTS.out" was used to reflect the changes associated with the most recent credit model.

The following steps are used to run Rugg Brook with diversion flow from Stevens brook.

1. Create a new input file for Rugg Brook with the BMPs configured as you wish.
2. Place the new time series file in the "In" folder associated with the input file.


D:\VTBMPDSS\New_Runs\Rugg\Rugg_post_7-18-2013\In
File Edit View Favorites Tools Help
Back Search Folders
Address D:\VTBMPDSS\New_Runs\Rugg\Rugg_post_7-18-2013\In
Folders
Desktop
My Computer
Local Disk (C:)
DATA (D:)
MyFiles
VTBMPDSS
data
docs
etc
New_Runs
Allen
Bartlett
Centennial
Englesby
Indian
Moon
Moon_WCA
Morehouse
morehouse_test
Munroe
Potash
Rugg
Archive
Diversion_Tesl
Name Size Type
101ATS.OUT 10,191 KB OUT File
101BTS.OUT 10,191 KB OUT File
101CTS.OUT 10,191 KB OUT File
101DTS.OUT 10,191 KB OUT File
102ATS.OUT 10,191 KB OUT File
102BTS.OUT 10,191 KB OUT File
102CTS.OUT 10,191 KB OUT File
102DTS.OUT 10,191 KB OUT File
103ATS.OUT 10,191 KB OUT File
103BTS.OUT
103CTS.OUT
103DTS.OUT
104TS.OUT
105ATS.OUT
105BTS.OUT 10,191 KB OUT File
105CTS.OUT 10,191 KB OUT File
105DTS.OUT 10,191 KB OUT File
106ATS.OUT 10,191 KB OUT File
106BTS.OUT 10,191 KB OUT File
106CTS.OUT 10,191 KB OUT File
106DTS.OUT 10,191 KB OUT File
201HSTS.OUT 10,191 KB OUT File
201MSTS.OUT
StevensWCARevTS.OUT
Individual HRU time series, placed by BMPDSS in each "In" folder
New user-created time series

3. Add the time series to the list of time series in Card 710 “Landuse Definition”. You can put whatever you want in the second column for the “Landname”. The last column should have the exact name of the file as it appears in the “In” folder.

```
c-----------------------------------------------------------------------------------------------
c
c710 LANDUSE DEFINITION
c
c LANDTYPE       = Unique landuse definition identifier
c LANDNAME       = Landuse name
c TIMESERIESFILE = File name containing input timeseries
c
c-----------------------------------------------------------------------------------------------
c  LANDTYPE       LANDNAME   TIMESERIESFILE
1       104     104TS.out
2       101A    101ATS.out
3       102A    102ATS.out
4       103A    103ATS.out
5       105A    105ATS.out
6       106A    106ATS.out
7       101B    101BTS.out
8       102B    102BTS.out
9       103B    103BTS.out
10      105B    105BTS.out
11      106B    106BTS.out
12      101C    101CTS.out
13      102C    102CTS.out
14      103C    103CTS.out
15      105C    105CTS.out
16      106C    106CTS.out
17      101D    101DTS.out
18      102D    102DTS.out
19      103D    103DTS.out
20      105D    105DTS.out
21      106D    106DTS.out
22      201MS   201MSTS.out
23      201HS   201HSTS.out
24      Ste     StevensDivertTS.OUT
c-----------------------------------------------------------------------------------------------
```

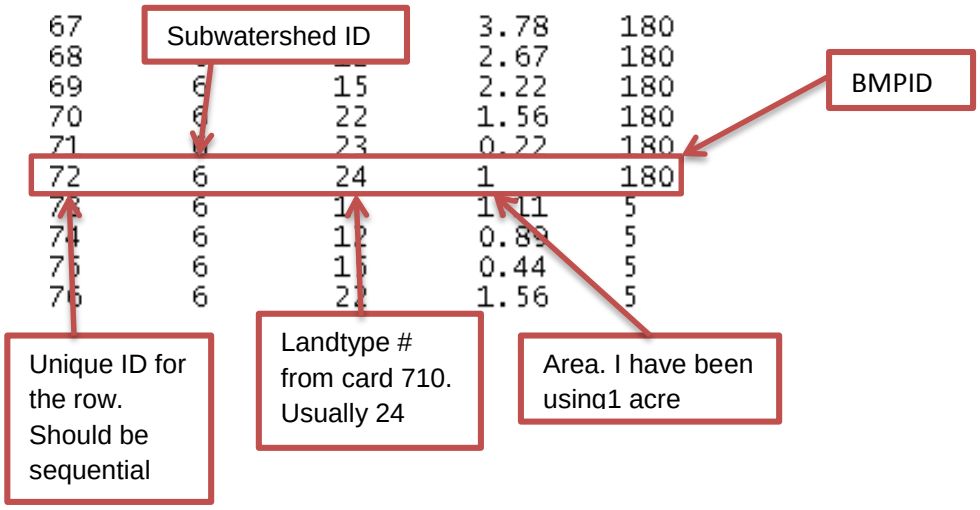
New Time Series = weir flow from Stevens-Rugg diversion.

4. In card 720 “BMP Site Information”, find the node that you want the flow to be added to. In the scenarios that I have been running, this has been BMPID 180, the multistage pond that represents the diversion channel. Add 1 acre to the drainage area of this BMP. This usually results in the area increasing from 10.45 to 11.45.

```
170     5       Junction        X       48.26   2       452602.7        256069.6
171     4       Conduit C       0       2       0       0
172     40      Virtualoutlet   X       0       2       453420.1        255396.8
173     40      Conduit C       0       2       0       0
174     21                              0       2       454124.1        254750.4
175     34                              2       0       0
176     18      Virtualoutlet   X       0       2       454356  253563
177     17      Conduit C       0       2       0       0
178     8       Virtualoutlet   X       0       2       453702.5        254909.9
179     36      Conduit C       0       0       0       0
180     6       MStagePond1     A       11.45   2       453011.2        256346.5
181     4       Conduit C       0       2       0       0
182     29      MStagePond1     A       3.34    2       454616.8        255044.6
183     29      Conduit C       0       2       0       0
184     30      MStagePond1     A       0.67    2       454307.5        255115.3
185     30      Conduit C       0       2       0       0
```

Add an acre here

5. Finally, add a line to card 770 “Land Routing” to represent the new time series file going into the pond. Find the rows that represent the HRUs draining to the diversion channel. Again, it is usually BMPID 180 for the diversion channel. Add a row for the diversion channel.



After these steps, you should be able to run the BMPDSS with the overflow from the diversion included.

Table A-2-1: Rugg Brook Expired Permit Discharges and Proposed Retrofits

BMP in BMPDSS Model	MS4 Draining to BMP	Permit Number	Project Name	Permit Owner	RDA/Other[1]	Permit Issued	Existing Manner of Discharge	Proposed Retrofit	Proposed System Upgrades under FRP[2]
No Channel Protection Volume (CPv) BMP covered under Permit	Town	2-0218	Cameron Drive Mobile Home Park	Private		Expired	overland flow to grass swale	N	Could be potential for GSI. No existing collection system.
	Town	2-0292	Teknor Apex Co.	Private	*superceded by 4979-9003	Superceded	no permit file available. Site plan unable to read.	N	Half of roof drains to Industrial Park Pond practice. Other half may be picked up with future Mylan Develpoment.
	Town	1-1194	Grice Brook Retirement Community	Private		Expired		N	Runoff primarily drains to swale which is captured by Tanglewoods Pond.
	Town	2-1168	Clyde Allen Drive Residential Subdivision	Private		Expired	driveway culverts	Y	Proposed Gravel Wetland
	Town	2-0300	Meadowbrook Lane Residential Subdivision	Private		Expired	overland flow to grass swale	N	Not enough space for retrofit
	Town	1-1268	VT Science & Education Center	Private	*superceded by 3348-9010	Abandonded	Stormwater lagoon	Y	Proposed retrofit to existing pond, including expansion and new outlet structure.
	Town	1-1349	Superior Ceramics Manufacturing Facility	Private	superceded by 3410-INDS	Superceded	existing detention pond in 1998	N	No Retrofit Proposed. Permit superceded.
Channel Protection Volume (CPv) BMP covered under Permit	Town	1-1428b	St Albans Milk and Maple	Private		Expired	Detention Pond	N	Meeting CPv Standard. No Proposed Retrofit.
	Town	1-1428a	St Albans Milk and Maple	Private		Expired	Detention Pond	Y	Proposed Retrofit. Regrade and expand pond.
	Town	1-1563 P3	Pineview Estates	Private		Expired	Detention Pond	Y	Add 2" low flow orifice.
	Town	1-1563 P2	Pineview Estates	Private		Expired	Detention Pond	Y	Reduce 3" low flow orifice to 2".
	Town	1-0930	Church of the Rock	Private		Expired	Detention Pond	Y	Remove 4" low flow orifice. Expand Pond.
	Town	1-1442	Sunset Terrace Phase 3	Private		Expired	Detention Pond	Y	Reduce 2" low flow to 1.5".
	Town	3567-9010	Barry Callebaut Inc	Private	*supercedes 2-	Expired	Detention Pond	Y	Reduce 8" low flow orifice to 2.5".
	VTRANS/Town	1-0908	Tanglewoods	Private		Expired	Detention Pond	Y	Expand and retrofit Detention Basin
	VTRANS/Town	1-1563 P4	Pineview Estates	Private		Expired	Detention Pond	N	Meeting CPv Standard. No Proposed Retrofit.
	VTRANS/Town	1-1563 P5	Pineview Estates	Private		Expired	Detention Pond	N	Meeting CPv Standard. No Proposed Retrofit.
	VTRANS/Town	1-1563 P1	Pineview Estates	Private		Expired	Detention Pond	Y	Add 2" low flow orifice.
	VTRANS/Town	1-1428c	St Albans Milk and Maple	Private		Expired	Detention Pond	Y	Reduce low flow orifice.
	VTRANS/Town	2-0291	Collins-Perley Athletic Complex	Private	*superceded by 5961-9010	Superceded	Detention Pond	N	No Retrofit Proposed. Permit superceded.

* Table Originally Prepared by Emily Schelley (VT DEC, last revised 1-31-14), Revised by WCA (2014).

[1] RDA: Residual Designation Authority- Private Permittees requests to have their expired stormwater system covered under an RDA permit, which overwrites their expired permit.

[2] Expired permit retrofits were determined based on direct benefit to the Flow Restoration Targets. Expired pemits with a CPv(extended detention of the 1-year design storm) BMP were assesed for retrofit opportunity, and if the flow reduction benefit was determined neglible, a retrofit was not proposed.

Table A-2-2: Rugg Brook Existing BMPs in BMPDSS

Model	MS4 Draining to Practice	Permit #	Project Name	BMP Owner	Permit Issued	***BMP Type in Model***
base	VTRANS/Town	1-1428b	St Albans Milk and Maple	Private	Expired	Detention
base- retrofit	VTRANS/Town	1-0908	Tanglewoods	Private	Expired	Detention
base	VTRANS/Town	1-1563 P4	Pineview Estates	Private	Expired	Detention
base	VTRANS/Town	1-1563 P5	Pineview Estates	Private	Expired	Detention
base	VTRANS/Town	1-1563 P1	Pineview Estates	Private	Expired	Detention
base	VTRANS/Town	1-1428c	St Albans Milk and Maple	Private	Expired	Detention
base	Town	2-0291	Collins-Perley Athletic Complex	Private	Expired	Detention
base	Town	1-1428a	St Albans Milk and Maple	Private	Expired	Detention
base	Town	1-1563 P3	Pineview Estates	Private	Expired	Detention
base	Town	1-1563 P2	Pineview Estates	Private	Expired	Detention
base	Town	1-0930	Church of the Rock	Private	Expired	Detention
base	Town	1-1442	Sunset Terrace Phase 3	Private	Expired	Detention
base	Town	3567-9010	Barry Callebaut Inc	Private	Expired	Detention
post 2002	VTRANS/Town	VTrans 138	VTRANS Median Site	VTRANS	no permit	Detention
post 2002	VTRANS/Town	5961-INDS	Collins-Perley Athletic Complex	Private	Current	Detention
post 2002	VTRANS/Town	4117-INDO	Mapleville Depot Offset Pond	Private	Current	Detention
post 2002	VTRANS/Town	4142-INDS	Comfort Inn	Private	Current	Detention
post 2002	VTRANS/Town	4098-INDS	Bove Residential Development	Private	Current	Detention
post 2002	VTRANS/Town	VTrans 80b	VTRANS Median Site	VTRANS	no permit	Detention
post 2002	VTRANS/ City	3287-INDS	CVPS-Service Center	Private	Current	Detention
post 2002	Town	3410-9010	Superior Ceramics Manufacturing Facility	Private	Current	Detention
post 2002	Town	4197-INDS	St Albans Industrial Park Lot 2, Superior Ceramics	Private	Current	Detention
post 2002	Town	4117-INDS	Mapleville Depot	Private	Current	Detention
post 2002	Town	3893-INDS	Parsons Meadow	Private	Current	Detention
post 2002	VTRANS/ City	5643-INDO	Stevens-Rugg Diversion	City	Current	Detention
post 2002	VTRANS/Town	VTrans 75c	VTRANS Median Site	VTRANS	no permit	Detention
post 2002	Town	4073-INDS (5577-INDS.A)	Harbor View Subdivision	Private	Current	Detention
post 2002	Town	6375-INDS	AFB Subdivision	Private	Current	Detention

Rugg Brook Flow Restoration Plan
BMPDSS Model Runs Summary
4/28/2015
Table A-3-1 Model Runs Summary

Model Run	Description	High Flow Reduction (%)	BMPDSS Model Run Date
Modified TMDL Target for Rugg Brook with 4.54 ac Non-Jurisdictional Future Growth		-15.30%	
VT DEC Post-2002 Condition Model	VT DEC's existing model, includes all Post-2002 BMPs	-2.49%	9/18/2013
WCA Revised Post-2002 Model (1/30/2015)	Revised Subwatersheds.	-2.50%	1/30/2015
Percent of target managed with revised Post-2002 model (1/30/2015)		16%	----
Credit_EX model	Proposed BMP scenario with only retrofits to existing BMPs with expired permits (9 projects).	-6.85%	10/10/2014
Percent of target managed with Credit_EX model run (10/10/14)		45%	----
Credit 1 model	Proposed BMP scenario with all proposed retrofits except SASH BMP.	-17.97%	10/13/2014
Percent of target managed with Credit 1 model run (10/13/14)		117%	----
Credit 2 model	Revised South Main St. practices, Nason St., and Twin Court. Add new SASH BMP.	-17.46%	1/30/2015
Percent of target managed with Credit 2 model run (1/30/2015)		114%	----

Rugg Brook Flow Restoration Plan
BMP List by BMPDSS Model Run
9/22/2016

Site Name	Stormwater Permit #	MS4 Impervious Owner	BMP Type	New or Existing Site	Ownership of Land where BMP is Located	Drainage Area (acres)	Impervious Acres Managed (ac)	Runoff Channel Protection Volume (CPv) Managed	
								cft	ac-ft
Credit 1 Model									
Industrial Park Pond	3348-9010/ 1-1268	Town	Detention	New	Town	38.6	9.0	49713	1.141
J+L Service Lot	NP	Town	Infiltration	New	Private	27.9	7.6	46174	1.060
Tanglewoods	1-0908	Town	Detention	Existing	Private	27.7	8.8	28140	0.646
Twin Court	1-0658	Town	Detention	New	Private	17.6	5.2	15682	0.360
Barry Callebaut Inc	3567-9010	Town	Detention	Existing	Private	10.4	6.9	8364	0.192
Nason St./ Green Mountain Dr.	1-0577	Town	Detention	New	Private	7.8	1.7	8189	0.188
Clyde Allen Dr.	2-1168	Town	Detention	New	Private	11.0	2.5	8015	0.184
St Albans Milk and Maple (P3)	1-1428c (P3)	Town	Detention	Existing	Private/Public Road	3.1	1.3	6447	0.148
St Albans Milk and Maple (P2)	1-1428a (P2)	Town	Detention	Existing	Private	1.7	1.4	4095	0.094
Freeborn St.	NP	Town	Underground Infiltration	New	Private/Public Road	2.9	1.3	3572	0.082
Church of the Rock	1-0930	Town	Detention	Existing	Private	3.2	1.4	2483	0.057
Pineview Estates (P2)	1-1563 (P2)	Town	Detention	Existing	Private	5.5	1.9	2047	0.047
Pineview Estates (P3)	1-1563 (P3)	Town	Detention	Existing	Private	4.9	0.9	1437	0.033
Sunset Terrace Phase 3	1-1442	Town	Detention	Existing	Private	1.8	0.7	958	0.022
Pineview Estates (P1)	1-1563 (P1)	Town	Detention	Existing	Private	1.0	0.3	697	0.016
Exit 19 South	NP	VTRANS	Detention	New	VTRANS	62.1	3.8	90169	2.070
Access Rd. East	NP	VTRANS	Detention	New	VTRANS/Priv	103.1	2.8	79279	1.820
Access Rd. West	Portion of 1-	VTRANS	Detention	New	VTRANS/Priv	13.7	0.6	28401	0.652
SDC87	NP	VTRANS	Median Filter	New	VTRANS	3.8	0.9	5579	0.128
SDC83b	NP	VTRANS	Median Filter	New	VTRANS	1.8	0.4	3339	0.077
SDC27	NP	VTRANS	Median Filter	New	VTRANS	1.6	0.4	2762	0.063
SDC280	NP	VTRANS	Median Filter	New	VTRANS	2.1	0.4	2741	0.063
SDC347	NP	VTRANS	Median Filter	New	VTRANS	1.4	0.3	2608	0.060
SDC83a	NP	VTRANS	Median Filter	New	VTRANS	1.7	0.3	2534	0.058
SDC342	NP	VTRANS	Median Filter	New	VTRANS	1.6	0.3	2358	0.054
SDC29	NP	VTRANS	Median Filter	New	VTRANS	2.3	0.4	2358	0.054
I-89/Holyoke Farm	NP	Town	Infiltration	New	Private	61.9	1.6	62117	1.426
Credit 2 Model									
J+L Service Lot-***REMOVED***	---	---	---	---	---	---	---	---	---
SASH/Nason St Connector	NP	City/ VTRANS	Detention	New	Private/VTRA NS	21.1	4.9	15682	0.360
S. Main St. Infiltration	NP	City	Infiltration	New	Private/ Cadillac Motel	6.6	3.5	15769	0.362
South Main St.-1	NP	City	Infiltration	New	City	0.9	0.2	1394	0.032
South Main St.-2	NP	City	Infiltration	New	City	4.1	1.2	4792	0.110
South Main St.-3	NP	City	Infiltration	New	City	1.0	0.4	2526	0.058

* NP = No permit *BMP Type: Detention= Stormwater Pond designed to detain the 1-yr design storm (1.94"). Underground Infiltration= Storage Tank under pavement or grass which infiltrates runoff into the subsurface soils.

Rugg Brook Flow Restoration Plan
A-3-3: MS4 Target Allocation and FRP Progress
4/28/2015

Table 1: Model Scenario Results Summary

Model Scenario	BMPDSS Model Run Date	High Flow Target, Q 0.3 (± %)	Low Flow Target, Q 95 (± %)
Existing Condition Post2002 Scenario	1/30/2015	-2.50%	-2.99%
Proposed BMP Scenario "Credit2"	1/30/2015	-17.46%	-2.99%

Table 2: TMDL Flow Target Allocation

				Approved TMDL With 15 acres Future Growth		Modified TMDL With **4.54** acres Future Growth	
MS4 Impervious Owner	Total Area w/in Watershed (acres)	Impervious Cover (acres)	% of Watershed Impervious Cover	Target High Flow **Reduction** (%) [1]	Target Low Flow **Increase** (%) [2]	Target High Flow **Reduction** (%)	Target Low Flow **Increase** (%) [3]
St. Albans City	70.5	18.54	8.2%	-1.31	1.37	-1.25	1.37
St. Albans Town	1556.69	162.36	71.6%	-11.46	12.04	-10.96	12.04
VTrans	131.83	45.72	20.2%	-3.23	3.39	-3.09	3.39
Watershed Total	**1759.02**	**226.62**		**-16.00**	**16.80**	**-15.30**	**16.80**

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.

3- The Low Flow Target was not modifed due to future growth

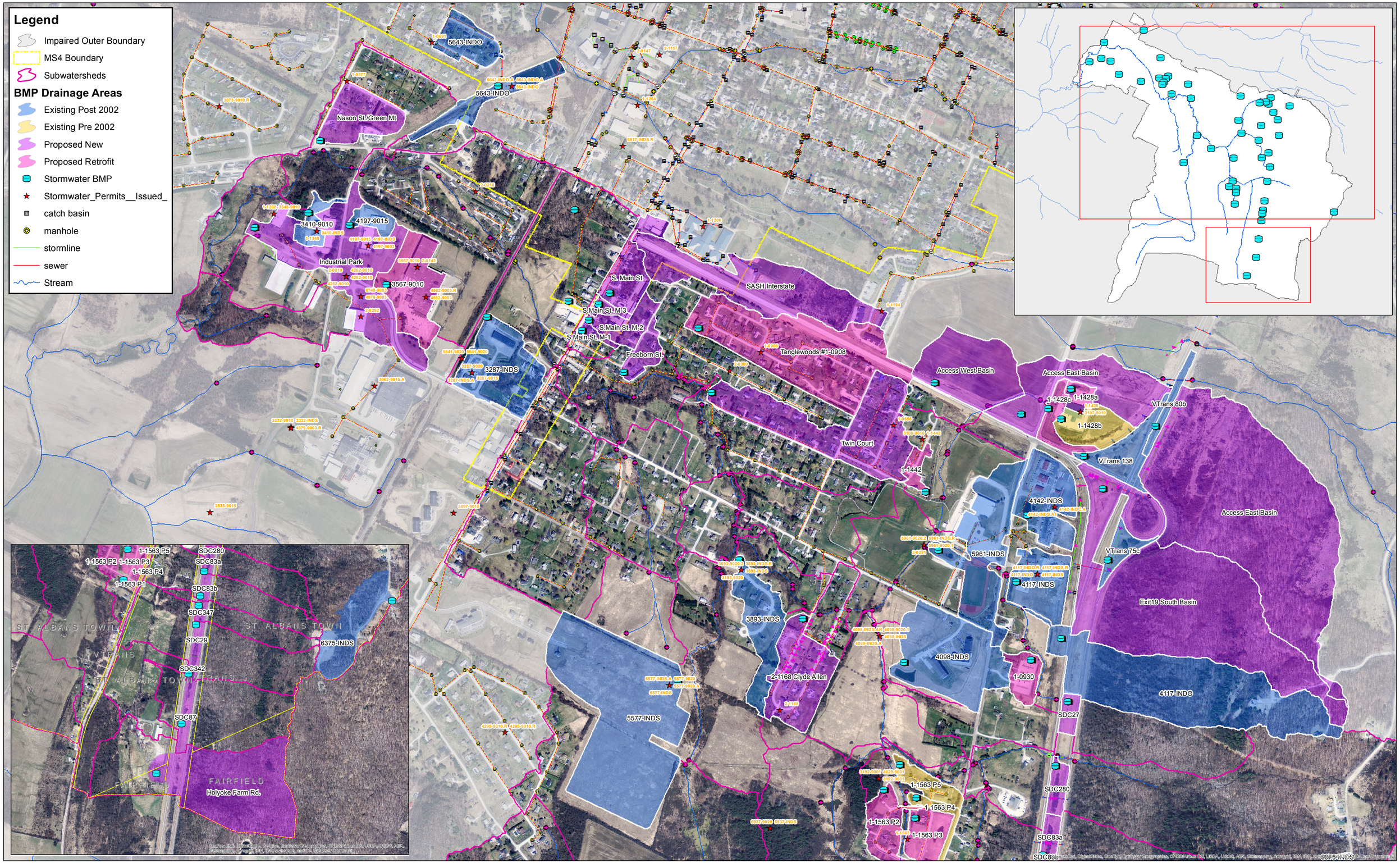
*Watershed delineation from file: "WCA_Rugg_post_subwats_81214.shp"

Table 3: Progress toward flow targets for **Approved TMDL** Flow Target with 15 acres of Future Growth

MS4 Impervious Owner	**Existing Condition "Post 2002"**				**Proposed BMP Scenario "Credit2"**			
	Managed Impervious Acres by DET or INF[1]	**Percent of High-flow Target addressed, %**	Managed Impervious Acres INF	Percent of Low-flow Target addressed, %	Managed Impervious Acres by DET or INF	**Percent of High-flow Target addressed, %**	Managed Impervious Acres INF	Percent of Low-flow Target addressed, %
St. Albans City	2.73	9.2%	0	0.0%	8.6	92.4%	4.43	0.3%
St. Albans Town	45.26	17.4%	0	0.0%	85.43	104.8%	1.04	0.1%
VTrans	8.89	12.1%	0	0.0%	30.09	131.1%	2.34	0.2%
		15.6%		**0.0%**		**109.1%**		**0.6%**
	TARGET NOT MET				TARGET MET			

Table 4: Progress toward flow targets for **Modifed TMDL** Flow Target with 4.54 acres of Future Growth

MS4 Impervious Owner	**Existing Condition "Post 2002"**				**Proposed BMP Scenario "Credit2"**			
	Managed Impervious Acres by DET or INF[1]	**Percent of High-flow Target addressed, %**	Managed Impervious Acres INF	Percent of Low-flow Target addressed, %	Managed Impervious Acres by DET or INF	**Percent of High-flow Target addressed, %**	Managed Impervious Acres INF	Percent of Low-flow Target addressed, %
St. Albans City	2.73	9.6%	0	0.0%	8.6	96.6%	4.43	0.3%
St. Albans Town	45.26	18.1%	0	0.0%	85.43	109.6%	1.04	0.1%
VTrans	8.89	12.7%	0	0.0%	30.09	137.1%	2.34	0.2%
		16.3%		**0.0%**		**114.1%**		**0.6%**
	TARGET NOT MET				TARGET MET			



WATERSHED CONSULTING ASSOCIATES, LLC

Existing and Proposed Stormwater BMPs
Rugg Brook Flow Restoration Plan
St. Albans, VT
February, 2015

N

0 0.03 0.06 0.12 0.18 0.24 Miles

1 in = 400 feet

Rugg Brook Flow Restoration Plan (FRP)
Task 4.2.Criteria Key
4/28/2015

Category	ID	Criteria	Technical Description	Description
Cost/Operations	A	Project Cost	The project costs were grouped into categories from >$50,000 to $1,000,000 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 the City's feedback on the ease of operation and maintenance for specific categories of practices.	This criteria is based on the City's feedback on 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 (1.98" in Burlington). 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 by for redevelopment projects, and 3) less than 20% WQ volume.	The WQ volume mitigated is an indictor 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.

Category	ID	Criteria	Technical Description	Description
Project Implementation	H	Permitabilty	Permitabilty is simplified into two categories to reflect the common scenarios in permitting, as 1) minimal permitting, versus 2) Complex permitting issues. An itemized list of permits was included to inform the ranking, but was not used in the scoring.	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 City. Properties owned by the City are ranked the highest, followed by privately owned land that has an expired permit, which provides leverage for owner participation.
Other Project Benefits/Constraints	J	Flood Mitigation	Flood mitigation is categorized by the scale of the impact.	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 storage the CP 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 culvert 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.

Rugg Brook Flow Restoration Plan (FRP)
Task 4.2. Scoring Key
4/28/2015

Category	ID	Criteria	Quality	Score
Cost/Operations	A	Relative Project Cost	Under $50,000	4
			$50,000-100,000	3
			$100,000-1,000,000	2
			Over $1,000,000	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)	> 1.0 ac-ft	6
			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	1
			0.5-1 ac-ft	0.75
			0.2- 0.5 ac-ft	0.5
			0.01-0.2	0.25
			0	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	3
			Non MS4 owned regulated (expired permit)	2
			Non MS4 owned/Participatory Owner	1
			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
			Natural Habitat Creation/Protection	1
			Outfall Erosion Control	1
			Potential Erodible soils/Bank Destabilization issues	-1
	N	Annual Total Suspended Solids (TSS) Yield Mitigated (lbs.) *WinSLAMM Model result	>2000	5
			1500-2000	4
			1000-1500	3
			500-1000	2
			<500	1
			<50	0
	O	Annual Total Phosphorus (TP) Yield Mitigated (lbs.) *WinSLAMM Model result	<5	6
			4-5	5
			3-4	4
			2-3	3
			0.5-2	2
			<0.5	1
	*Lake Champlain Phosphorus TMDL compliance metrics TBD. All projects which address > 20%of the WQ volume are considered meeting this standard.			

Category	ID	Criteria	Technical Description	Description
Cost/Operations	A	Project Cost	The project costs were grouped into categories from >$50,000 to $1,000,000 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 the City's feedback on the ease of operation and maintenance for specific categories of practices.	This criteria is based on the City's feedback on 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 (1.98" in Burlington). 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 by for redevelopment projects, and 3) less than 20% WQ volume.	The WQ volume mitigated is an indictor 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.

Category	ID	Criteria	Technical Description	Description
Project Implementation	H	Permitabilty	Permitabilty is simplified into two categories to reflect the common scenarios in permitting, as 1) minimal permitting, versus 2) Complex permitting issues. An itemized list of permits was included to inform the ranking, but was not used in the scoring.	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 City. Properties owned by the City are ranked the highest, followed by privately owned land that has an expired permit, which provides leverage for owner participation.
Other Project Benefits/Constraints	J	Flood Mitigation	Flood mitigation is categorized by the scale of the impact.	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 storage the CP 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 culvert 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.

Rugg Brook Flow Restoration Plan (FRP)
Task 4.2. Scoring Key
10/19/2016

Category	ID	Criteria	Quality	Score
Cost/Operations	A	Relative Project Cost	Under $50,000	4
			$50,000-100,000	3
			$100,000-1,000,000	2
			Over $1,000,000	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)	> 1.0 ac-ft	6
			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	1
			0.5-1 ac-ft	0.75
			0.2- 0.5 ac-ft	0.5
			0.01-0.2	0.25
			0	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	3
			Non MS4 owned regulated (expired permit)	2
			Non MS4 owned/Participatory Owner	1
			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
			Natural Habitat Creation/Protection	1
			Outfall Erosion Control	1
			Potential Erodible soils/Bank Destabilization issues	-1
	N	Annual Total Suspended Solids (TSS) Yield Mitigated (lbs.) *WinSLAMM Model result	>2000	5
			1500-2000	4
			1000-1500	3
			500-1000	2
			<500	1
			<50	0
	O	Annual Total Phosphorus (TP) Yield Mitigated (lbs.) *WinSLAMM Model result	<5	6
			4-5	5
			3-4	4
			2-3	3
			0.5-2	2
			<0.5	1
	*Lake Champlain Phosphorus TMDL compliance metrics TBD. All projects which address > 20%of the WQ volume are considered meeting this standard.			

Rugg Brook Flow Restoration Plan (FRP)
Task 4.2. BMP Ranking
10/19/2016

Site ID	MS4	Permit	Retrofit Description	Cost/Operations				Project Design Metrics										Project Implementation					Other Project Benefits/Constraints												Total Score
				A		B		C		D		E		F		G		H		I-Internal	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 Owner	Land Availabilty where BMP is located		Flood Mitigation		TMDL Flow Target Addressed (Q03, Q95)		Lake Champlain P TMDL addressed?		Other Benefits/Constraints		BMP TYPE in WinSLAMM	Annual Yield TSS Mitigated (lbs.)		Annual Yield TP 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	Score	
I-89/Holyoke Farm	Town	NP	Infiltration Basin	$100-1000	2	Ponds/Cons	0	2.68	3	1.43	6	1.43	1	>= 100% W	2	Primary	2	Complex issu	0	Farm	Non Town owned/Non	-2			High/Low	3		1	On Farm (-1	-2	BF	543.50	2	2.43	3	16.0
Industrial Park Pond	Town	3348-9010/1-1	Expand abandonded pond	$100-1000	2	Ponds/Cons	0	18.49	5	1.14	6	0	0	>= 20 % Wi	1	Primary	2	Plan complet	2	Town	Town owned	3			High	2		1	Engineering	1	WP	4515.00	5	9.31	6	25.0
Twin Court	Town	1-0658	Detention Basin.	$100-1000	2	Ponds/Cons	0	4.20	4	0.36	3	0	0	>= 20 % Wi	1	Primary	2	Plan complet	2	HOA	Non Town owned/Non	-2			High	2		1	Erosion miti	1	WP	0.00	0	0.04	0	16.0
Clyde Allen Dr.	Town	2-1168	Gravel Wetland	$100-1000	2	Ponds/Cons	0	2.43	3	0.18	2	0	0	>= 20 % Wi	1	Primary	2	Minimal Issu	2	Vermont Housing	Non Town owned regul	2	Infrastructur	2	High	2		1			WP	1912.80	4	4.84	5	19.0
Freeborn St.	Town	NP	Dry Well adjacent to parki	$100-1000	2	Undergrour	2	1.08	2	0.08	2	0.08	0.25	>= 20 % Wi	1	Primary	2	Minimal Issu	2	HOA	Unknown	0			High/Low	3		1	Erosion miti	1	BF	1070.48	3	2.89	3	18.3
Nason St./ Green Mountain Dr.	Town	1-0577	Bioretention with underdr	< $50	4	Ponds/Cons	0	1.47	2	0.19	2	0	0	>= 20 % Wi	1	Primary	2	Minimal Issu	2	Town	Town owned	3			WQ	1		1			WP	1692.00	4	5.07	6	18.0
S. Main St. Infiltration	City	NP	Underground Infiltration g	$100-1000	2	Undergrour	2	3.14	3	0.36	3	0.36	0.5	>= 100% W	2	Primary	2	Minimal Issu	2	Cadillac Motel	Unknown	0			High/Low	3		1			BF	3163.10	5	6.12	6	20.5
S. Main St.-1	City	NP	Dry well system in ROW	$50-100	3	Undergrour	2	0.22	1	0.02	1	0.02	0.25	>= 100% W	2	Primary	2	Minimal Issu	2	City	City Owned	3			High/Low	3		1	Potential Ut	-2	BF	312.66	1	0.77	2	18.3
S. Main St.-2	City	NP	Dry well system in ROW	$50-100	3	Undergrour	2	1.08	2	0.12	2	0.12	0.25	>= 100% W	2	Primary	2	Minimal Issu	2	City	City Owned	3			High/Low	3		1	Potential Ut	-2	BF	853.50	2	2.85	3	20.3
S. Main St.-3	City	NP	Dry well system in ROW	$50-100	3	Undergrour	2	0.41	1	0.06	1	0.06	0.25	>= 100% W	2	Primary	2	Minimal Issu	2	City	City Owned	3			High/Low	3		1	Potential Ut	-2	BF	539.14	2	0.94	2	18.3
SASH/Federal St Connector	VTRANS/City	NP	Incorporate detention of S	$100-1000	2	Ponds/Cons	0	4.26	4	0.36	3	0	0	>= 100% W	2	Primary	2	Minimal Issu	2	VTRANS	Non Town owned/Parti	1			High	2		1	Mobilization	1	BF	317.00	1	3.08	4	20.0
Exit 19 South	VTRANS	NP	Detention Basin	$100-1000	2	Ponds/Cons	0	6.93	5	1.74	6	0	0	>= 20 % Wi	1	Primary	2	Minimal Issu	2	VTRANS	Non Town owned/Parti	1			High	2		1			WP	1386.05	3	1.70	2	22.0
Access Rd. East	VTRANS	NP	Gravel Wetland	$50-100	3	Ponds/Cons	0	10.16	5	1.52	6	0	0	>= 20 % Wi	1	Primary	2	Minimal Issu	2	VTRANS/Town/Pr	Not Town owned/Non	-2			High	2		1	Potential Bi	-1	BF	704.75	2	3.61	4	19.0
Access Rd. West	VTRANS	NP	Gravel Wetland	$50-100	3	Ponds/Cons	0	0.57	1	0.65	4	0	0	>= 20 % Wi	1	Primary	2	Minimal Issu	2	VTRANS/Town/Pr	Not Town owned/Non	-2			High	2		1	Potential Bi	-1	BF	405.12	1	1.12	2	13.0
SDC87	VTRANS	NP	Median Filter	$100-1000	2	Ponds/Cons	0	1.90	2	0.13	2	0	0	>= 100% W	2	Primary	2	Minimal Issu	2	VTRANS	MS4 Owned	3			High	2		1			BF	143.80	1	0.34	1	18.0
SDC83b	VTRANS	NP	Median Filter	< $50	4	Ponds/Cons	0	0.58	1	0.08	2	0	0	>= 100% W	2	Primary	2	Minimal Issu	2	VTRANS	MS4 Owned	3			High	2		1			BF	53.37	0	0.46	1	19.0
SDC27	VTRANS	NP	Median Filter	< $50	4	Ponds/Cons	0	0.64	1	0.06	2	0	0	>= 100% W	2	Primary	2	Minimal Issu	2	VTRANS	MS4 Owned	3			High	2		1			BF	30.44	0	0.52	1	19.0
SDC280	VTRANS	NP	Median Filter	$50-100	3	Ponds/Cons	0	0.40	1	0.06	2	0	0	>= 100% W	2	Primary	2	Minimal Issu	2	VTRANS	MS4 Owned	3			High	2		1			BF	30.52	0	0.50	1	18.0
SDC347	VTRANS	NP	Median Filter	< $50	4	Ponds/Cons	0	0.43	1	0.06	2	0	0	>= 100% W	2	Primary	2	Minimal Issu	2	VTRANS	MS4 Owned	3			High	2		1	Predomine	-1	BF	41.23	0	0.27	1	18.0

Ascending			
ID #	Site ID	MS4	Permit
24	Tanglewoods	Town	1-0908
2	Industrial Park Pond	Town	3348-9010/1-1268
12	Exit 19 South	VTRANS	NP
23	Barry Callebaut Inc	Town	3567-9010
7	S. Main St. Infiltration	City	NP
9	S. Main St.-2	City	NP
11	SASH/Federal St Connector	VTRANS/City	NP
4	Clyde Allen Dr.	Town	2-1168
13	Access Rd. East	VTRANS	NP
16	SDC83b	VTRANS	NP
17	SDC27	VTRANS	NP
20	SDC83a	VTRANS	NP
21	SDC342	VTRANS	NP
22	SDC29	VTRANS	NP
8	S. Main St.-1	City	NP
10	S. Main St.-3	City	NP
5	Freeborn St.	Town	NP
15	SDC87	VTRANS	NP
18	SDC280	VTRANS	NP
6	Nason St./ Green Mountain Dr.	Town	1-0577
25	St Albans Milk and Maple (P2)	Town	1-1428a (P2)
26	St Albans Milk and Maple (P3)	Town	1-1428c (P3)
30	Church of the Rock	Town	1-0930
19	SDC347	VTRANS	NP
28	Pineview Estates (P2)	Town	1-1563 (P2)
1	I-89/Holyoke Farm	Town	NP
27	Pineview Estates (P1)	Town	1-1563 (P1)
29	Pineview Estates (P3)	Town	1-1563 (P3)
31	Sunset Terrace Phase 3	Town	1-1442
3	Twin Court	Town	1-0658

14	Access Rd. West	VTRANS	NP

	Decending
Retrofit Description	**Total Score**
Expand and retrofit Detention Basin	25.00
Expand abandonded pond and redirect parking lot/road runoff to pond.	25.00
Detention Basin	22.00
Reduce 8" low flow orifice to 2.5".	21.00
Underground Infiltration gallery in open space at Cadillac Motel Enterance	20.50
Dry well system in ROW	20.25
Incorporate detention of SASH runoff with Federal St. Connector Project	20.00
Gravel Wetland	19.00
Gravel Wetland	19.00
Median Filter	19.00
Median Filter	19.00
Median Filter	19.00
Median Filter	19.00
Median Filter	19.00
Dry well system in ROW	18.25
Dry well system in ROW	18.25
Dry Well adjacent to parking lot.	18.25
Median Filter	18.00
Median Filter	18.00
Bioretention with underdrain along roadway.	18.00
Regrade and expand pond.	18.00
Reduce low flow orifice.	18.00
Remove 4" low flow orifice. Expand Pond.	18.00
Median Filter	18.00
Reduce 3" low flow orifice to 2".	17.00
Infiltration Basin	16.00
Add 2" low flow orifice at 518.75'.	16.00
Add 2" low flow orifice.	16.00
Reduce 2" low flow to 1.5".	16.00
Detention Basin.	16.00

Gravel Wetland	13.00

Notes: Use "Select Order" Button to select "Decending" after the "1-Matrix-Fill" tab is updated.

Rugg Brook Flow Restoration Plan(FRP) Project
Task 4.2.1: Stormwater BMP Ranking

Table 1: Stormwater BMPs Ranked watershed-wide based on ranking matrix total score

Rank	Site ID	BMP Type	Retrofit Description	Total Score
1	Tanglewoods	Town	Expand and retrofit Detention Basin	25.00
2	Industrial Park Pond	Town	Expand abandonded pond and redirect parking lot/road runoff to pond.	25.00
3	Exit 19 South	VTRANS	Detention Basin	22.00
4	Barry Callebaut Inc	Town	Reduce 8" low flow orifice to 2.5".	21.00
5	S. Main St. Infiltration	City	Underground Infiltration gallery in open space at Cadillac Motel Enterance	20.50
6	S. Main St.-2	City	Dry well system in ROW	20.25
7	SASH/Federal St Connector	VTRANS/City	Incorporate detention of SASH runoff with Federal St. Connector Project	20.00
8	Clyde Allen Dr.	Town	Gravel Wetland	19.00
9	Access Rd. East	VTRANS	Gravel Wetland	19.00
10	SDC83b	VTRANS	Median Filter	19.00
11	SDC27	VTRANS	Median Filter	19.00
12	SDC83a	VTRANS	Median Filter	19.00
13	SDC342	VTRANS	Median Filter	19.00
14	SDC29	VTRANS	Median Filter	19.00
15	S. Main St.-1	City	Dry well system in ROW	18.25
16	S. Main St.-3	City	Dry well system in ROW	18.25
17	Freeborn St.	Town	Dry Well adjacent to parking lot.	18.25
18	SDC87	VTRANS	Median Filter	18.00
19	SDC280	VTRANS	Median Filter	18.00
20	Nason St./ Green Mountain Dr.	Town	Bioretention with underdrain along roadway.	18.00
21	St Albans Milk and Maple (P2)	Town	Regrade and expand pond.	18.00
22	St Albans Milk and Maple (P3)	Town	Reduce low flow orifice.	18.00
23	Church of the Rock	Town	Remove 4" low flow orifice. Expand Pond.	18.00
24	SDC347	VTRANS	Median Filter	18.00
25	Pineview Estates (P2)	Town	Reduce 3" low flow orifice to 2".	17.00
26	I-89/Holyoke Farm	Town	Infiltration Basin	16.00
27	Pineview Estates (P1)	Town	Add 2" low flow orifice at 518.75'.	16.00
28	Pineview Estates (P3)	Town	Add 2" low flow orifice.	16.00
29	Sunset Terrace Phase 3	Town	Reduce 2" low flow to 1.5".	16.00
30	Twin Court	Town	Detention Basin.	16.00
31	Access Rd. West	VTRANS	Gravel Wetland	13.00

Rugg Brook Flow Restoration Plan
Total Phosphorus and TSS Reductions by BMP
9/22/2016

Site Name	Ownership of Land where BMP is Located	BMP Type	Permit #	Drainage Area (acres)	Impervious Acres Managed (ac)	Percent of High-Flow Target	Cumulative Percent of High-Flow Target	WQ Modeling Results: Annual Total Suspended Solids (TSS) Yield Mitigated (lbs)	% TSS Reduction	Annual Total Phosphorus (TP) Yield Mitigated (lbs)	% TP Reduction
						%	%				
Industrial Park Pond	Town	Detention	3348-9010/ 1-1268	38.6	9.0	13.4%	29.4%	4515.0	73.90%	9.31	47.4%
Tanglewoods	Private	Detention	1-0908	27.7	8.8	13.2%	42.5%	903.0	19.40%	1.97	11.7%
S. Main St. Infiltration	Private/ Cadillac	Infiltration	NP	6.6	3.5	5.2%	47.8%	3163.1	90.80%	6.12	80.1%
SASH/Federal St Connector	Private/VTR ANS	Detention	NP	21.1	4.9	7.3%	55.1%	317.0	71.00%	3.08	53.0%
Twin Court	Private	Detention	1-0658	17.6	5.2	7.8%	62.8%	0.0	0.00%	0.04	0.3%
Barry Callebaut Inc	Private	Detention	3567-9010	10.4	6.9	10.3%	73.2%	53.0	1.70%	0.29	2.7%
Nason St./ Green Mountain Dr.	Private	Detention	1-0577	7.8	1.7	2.5%	75.7%	1692.0	74.20%	5.07	71.0%
Clyde Allen Dr.	Private	Detention	2-1168	11.0	2.5	3.8%	79.5%	1912.8	71.90%	4.84	63.1%
St Albans Milk and Maple (P3)	Private/Pub lic Road	Detention	1-1428c (P3)	3.1	1.3	1.9%	81.4%	6.0	0.40%	0.03	1.2%
South Main St.-2	City	Infiltration	NP	4.1	1.2	1.8%	83.2%	853.5	86.80%	2.85	83.8%
St Albans Milk and Maple (P2)	Private	Detention	1-1428a (P2)	1.7	1.4	2.2%	85.4%	5.0	0.30%	0.05	1.7%
Freeborn St.	Private/ Public Road	Undergroun d Infiltration	NP	2.9	1.3	1.9%	87.3%	1070.5	93.50%	2.89	90.8%
South Main St.-3	City	Infiltration	NP	1.0	0.4	0.7%	88.0%	539.1	92.00%	0.94	88.6%
Church of the Rock	Private	Detention	1-0930	3.2	1.4	2.1%	90.0%	49.3	12.30%	0.25	12.4%
Pineview Estates (P2)	Private	Detention	1-1563 (P2)	5.5	1.9	2.9%	92.9%	0.0	0.00%	0.03	0.7%
Pineview Estates (P3)	Private	Detention	1-1563 (P3)	4.9	0.9	1.3%	94.2%	27.4	3.20%	0.15	4.3%
Sunset Terrace Phase 3	Private	Detention	1-1442	1.8	0.7	1.0%	95.2%	7.1	1.70%	0.03	1.9%
Pineview Estates (P1)	Private	Detention	1-1563 (P1)	1.0	0.3	0.5%	95.7%	2.2	0.60%	0.01	0.8%
South Main St.-1	City	Infiltration	NP	0.9	0.2	0.3%	54.3%	312.7	90.80%	0.77	11.7%
VTRANS Projects											
Exit 19 South	VTRANS	Detention	NP	62.1	6.9	19.0%	73.2%	1386.1	96.90%	1.70	23.3%
Access Rd. East	VTRANS/Pri v	Detention	NP	103.1	2.8	4.1%	105.8%	704.8	99.10%	3.61	92.5%
Access Rd. West	VTRANS/Pri v	Detention	Portion of 1-1428	13.7	0.6	0.8%	106.6%	405.1	99.30%	1.12	93.5%
SDC87	VTRANS	Median Filter	NP	3.8	0.9	1.4%	108.0%	143.8	100.00%	0.34	100.0%
SDC83b	VTRANS	Median Filter	NP	1.8	0.4	0.5%	108.5%	53.4	99.10%	0.46	91.1%
SDC27	VTRANS	Median Filter	NP	1.6	0.4	0.6%	109.2%	30.4	99.10%	0.52	89.9%
SDC280	VTRANS	Median Filter	NP	2.1	0.4	0.6%	109.7%	30.5	99.40%	0.50	93.0%
SDC347	VTRANS	Median Filter	NP	1.4	0.3	0.5%	110.2%	41.2	99.40%	0.27	94.0%
SDC83a	VTRANS	Median Filter	NP	1.7	0.3	0.4%	110.6%	53.2	99.40%	0.35	93.5%
SDC342	VTRANS	Median Filter	NP	1.6	0.3	0.5%	111.0%	48.3	99.00%	0.40	89.9%
SDC29	VTRANS	Median Filter	NP	2.3	0.4	0.6%	111.6%	68.9	99.40%	0.54	93.8%
I-89/Holyoke Farm	Private	Infiltration	NP	61.9	1.6	2.5%	114.1%	543.5	100.00%	2.43	100.0%

* NP = No permit

*BMP Type: Detention= Stormwater Pond designed to detain the 1-yr design storm (1.94"). Underground Infiltration= Storage Tank under pavement or grass which infiltrates runoff into the subsurface soils.

Rugg Brook FRP
Appendix A-6
Proposed implementation schedule by MS4.
9/22/2016

St. Albans City Cost Estimates

Project Name	Imp acres	Design Control Volume (ac-ft)	Base Unit Cost ($/cft)	Site Adjustment Factor	Base Construction Cost	Permits & Engineering Contingency	BMP Footprint Area (Acres) if Land Must be Acquired	Land Cost	Final Project Cost	Final Project Cost Rounded to Nearest $1,000	St. Albans City Cost Allocation (% of total project cost)	St. Albans City Allocation ($)	Cost/Imp Acre	O&M	Proposed Implementation Schedule
SASH/Nason St Connecto	4.3	0.39	$2	2	$67,431	$23,601	0.4	$48,000	$139,032	**$139,000**	25%	$34,750	$21,369	$2,023	Phase 1 (1-3 years)
South Main St.-1	0.2	0.01	$22	1.5	$14,375	$5,031	0	$0	$25,000	**$25,000**	100%	$25,000	$88,209	$431	Phase 3 (7-9 years)
South Main St.-2	1.1	0.03	$22	1.5	$43,124	$15,094	0	$0	$58,218	**$58,000**	100%	$58,000	$53,906	$1,294	Phase 3 (7-9 years)
South Main St.-3	0.4	0.02	$22	1.5	$28,750	$10,062	0	$0	$38,812	**$39,000**	100%	$39,000	$94,663	$862	Phase 3 (7-9 years)
S. Main St. Infiltration	3.1	0.28	$12	1	$146,362	$51,227	0.50	$59,760	$257,348	**$257,000**	100%	$257,000	$62,926	$4,391	Phase 3 (7-9 years)
									Total	**$518,000**	**Total**	**$413,750**			

** Although this project is a retrofit of an existing BMP, it was determined that due to site specific complexity, costs would be comparable to a ne
As such, a site adjustment factor of 2 was used.

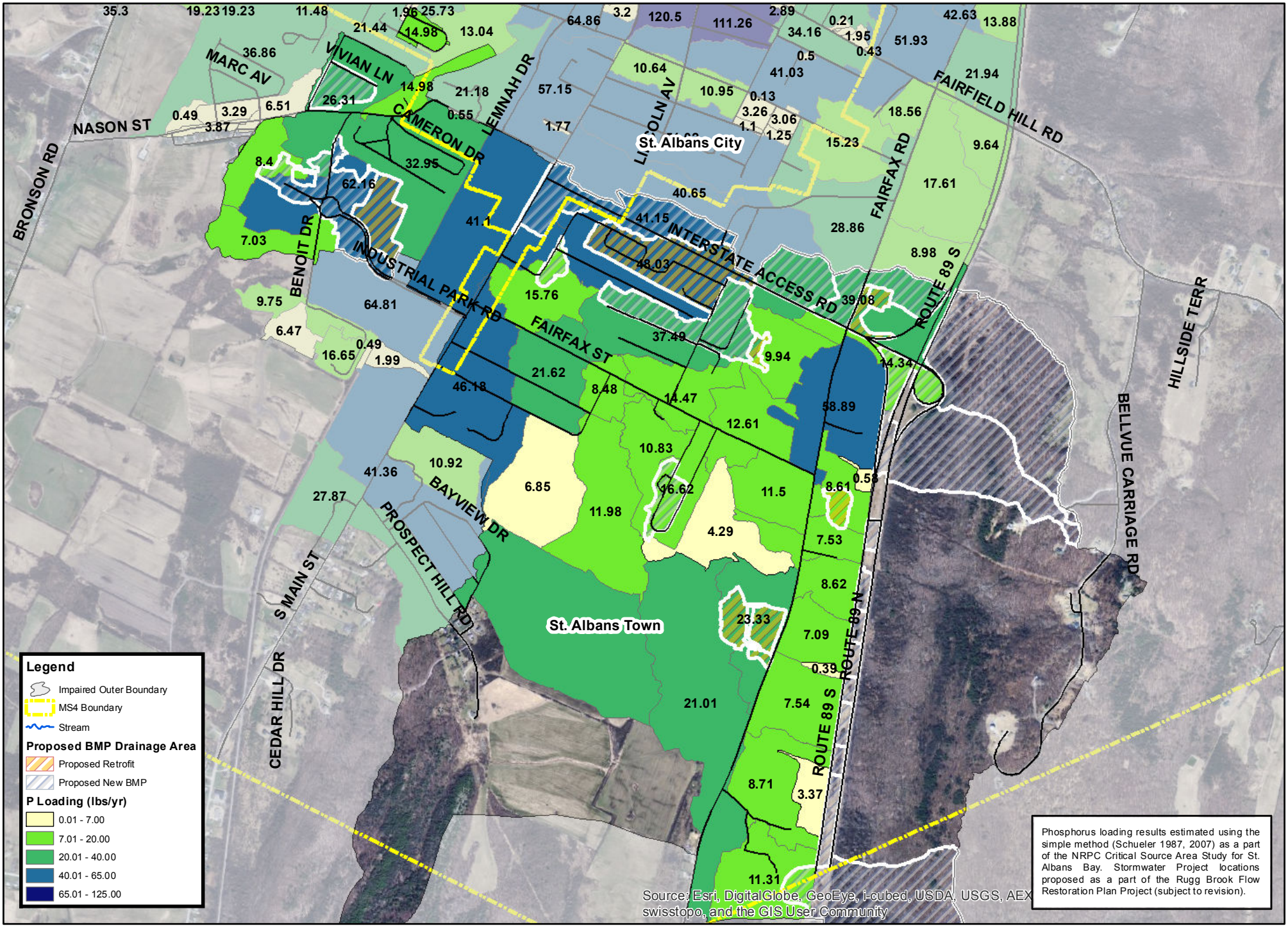
St. Albans Town Cost Estimates

Project Name	Imp acres	Design Control Volume (ac-ft)	Base Unit Cost ($/cft)	Site Adjustment Factor	Base Construction Cost	Permits & Engineering Contingency	BMP Footprint Area (Acres) if Land Must be Acquired	Land Cost	Final Project Cost	Final Project Cost Rounded to Nearest $1,000	St. Albans Town Cost Allocation (% of total project cost)	St. Albans Town Cost Allocation ($)	Cost/Imp Acre	O&M	Proposed Implementation Schedule
Freeborn St.	1.1	0.08	Itemized Cost Estimate*						$ 120,000	$ 120,000	100%	$120,000	$0	$0	Construction Complete
Industrial Park Pond	18.5	1.14	$2	1.5	$149,106	$ 52,187	0.262	$31,440	$ 232,733	$ 233,000	100%	$233,000	$10,887	$4,473	Phase 1 (1-3 years)
Pineview Estates (P1)	0.2	0.02	$2	0.25	$348	$ 122	0	$0	$ 10,000	$ 10,000	100%	$10,000	$2,045	$10	Phase 1 (1-3 years)
SASH/Nason St Connecto	4.3	0.39	$2	2	$67,431	$ 23,601	0.4	$48,000	$ 139,032	$ 139,000	50%	$69,500	$21,369	$2,023	Phase 1 (1-3 years)
Tanglewoods	7.7	0.65	$2	0.5	$28,140	$ 9,849	0	$0	$ 37,989	$ 38,000	100%	$38,000	$4,934	$844	Phase 1 (1-3 years)
Twin Court	4.2	0.36	$2	2	$62,726	$ 21,954	0.134	$16,080	$ 100,761	$ 101,000	100%	$101,000	$20,162	$1,882	Phase 1 (1-3 years)
Access Rd West	0.6	0.65	Itemized Cost Estimate*						$ 250,000	$ 250,000	50%	$125,000	$0	$0	Phase 2 (4-6 years)
St Albans Milk and Maple	1.3	0.15	$2	0.25	$3,223	$ 1,128	0	$0	$ 10,000	$ 10,000	100%	$10,000	$3,347	$97	Phase 2 (4-6 years)
Sunset Terrace Phase 3	0.3	0.02	$2	0.25	$479	$ 168	0	$0	$ 10,000	$ 10,000	100%	$10,000	$2,488	$14	Phase 2 (4-6 years)
Access Rd East	10.2	1.82	Itemized Cost Estimate* (Significant land cost included)						$ 820,000	$ 820,000	50%	$410,000	$0	$0	Phase 3 (7-9 years)
Pineview Estates (P2)	1.7	0.05	$2	0.25	$1,024	$ 358	0	$0	$ 10,000	$ 10,000	100%	$10,000	$818	$31	Phase 3 (7-9 years)
St Albans Milk and Maple	1.4	0.09	$2	0.25	$2,047	$ 717	0	$0	$ 25,000	$ 25,000	100%	$25,000	$1,960	$61	Phase 3 (7-9 years)
Clyde Allen Dr.	2.4	0.18	Itemized Cost Estimate*						$ 250,000	$ 250,000	100%	$250,000	$0	$0	Phase 4 (10-13 years)
I-89/Holyoke Farm	2.7	1.43	$4	1	$248,466	$ 49,693	0.6	$72,000	$ 370,159	$ 370,000	50%	$185,000	$111,254	$7,454	Phase 4 (10-13 years)
NWMC-South Pond B	1.0	0.15	$2	0.25	$3,267	$ 1,143		$0	$ 25,000	$ 25,000	100%	$25,000	$4,643	$98	Phase 4 (10-13 years)
Pineview Estates (P3)	0.5	0.03	$2	0.25	$719	$ 144	0	$0	$ 10,000	$ 10,000	100%	$10,000	$1,597	$22	Phase 4 (10-13 years)
Barry Callebaut Inc	7.0	0.19	$2	0.25	$4,182	$ 836	0	$0	$ 10,000	$ 10,000	100%	$10,000	$716	$125	Phase 5 (14-17 years)
Church of the Rock	1.4	0.06	$2	0.25	$1,241	$ 248	0	$0	$ 25,000	$ 25,000	100%	$25,000	$1,049	$37	Phase 5 (14-17 years)
Exit 19 South	6.9	2.07	Itemized Cost Estimate*						$ 360,000	$ 360,000	25%	$90,000	$0	$0	Phase 5 (14-17 years)

Grice Brook Retirement C	2.8	1.35	$2	1	$117,612	$ 23,522	0.86	$102,960	$ 244,094	$ 244,000	100%	$244,000	$51,322	$3,528	Phase 5 (14-17 years)
Nason St./ Green Mounta	1.5	0.19	$10	1	$81,893	$ 16,379	0.0	$0	$ 98,271	$ 98,000	100%	$98,000	$66,851	$2,457	Phase 5 (14-17 years)
									Total	**$3,038,000**	**Total**	**$1,978,500**			

* An itemized cost estimate was completed for this project, which was considered to be a more accurate representation of the cost of this project and used instead of the cost estimate method used for remaining projects.

** Although this project is a retrofit of an existing BMP, it was determined that due to site specific complexity, costs would be comparable to a new BMP. As such, a site adjustment factor of 1 was used.



WATERSHED CONSULTING ASSOCIATES, LLC

Potential Phosphorus Loading Overlay with Proposed Stormwater Projects
Rugg Brook Flow Restoration Plan
St. Albans, VT

Memorandum

To: Amanda Holland (NRPC), Carrie Johnson (St. Albans Town), Carrie Johnson (St. Albans Town), Chip Sawyer (St. Albans City), Jennifer Callahan (VTRANS)

From: Matt Montgomery (WCA-Sub), Andres Torizzo & Joanie Stultz, Watershed Consulting Associates, LLC

CC: Rachel Marvin, Jason Booth, A+E

Date: April 28, 2015

Re: *Rugg Brook FRP:* ***Natural Resources Screening for Select Proposed Stormwater BMPs***

Dear MS4 Partners:

Matt Montgomery, of Vermont Compliance Monitoring, LLC, visited select proposed Stormwater BMP sites on January 5th, 2015 to screen for potential natural resource concerns at sites where there was suggestive evidence of wetland vegetation on previous site visits. The following attached report includes a summary of his field findings. The results were included in the considerations for the proposed projects. The results were considered for the proposed projects. The sites visited include the Industrial Park Pond (Industrial Park), Nason St/Green Mt. Dr., and Clyde Allen Dr. All other sites were determined to not have potential natural resource concerns, or were assessed under the VTRANS FRP Contract.

Sincerely on behalf of the project team,

Andres Torizzo
WCA Principal

Joanie Stultz, E.I.
WCA Staff Engineer

Rugg Brook Watershed in St. Albans, VT
(All sites visited on 01.05.2015)

Site: Industrial Park Pond Retrofit
Regulated Natural Resources present: Probably
Follow up required: Yes

An apparent stormwater detention pond exists up-gradient and to the north of several culvert outfalls at this site. The channel below these outfalls is incised and has had several recent bank failures (Figure 1), suggestive of substantial peak stormwater flow through the investigated area. Intercepting and detaining these flows would be expected to reduce sediment and pollutant loading to the brook.
There is a distinct plant community of common riparian and wetland species along the channel's flow path and below the adjacent stormwater detention pond. Representative genera include *Salix, Alnus, Cornus, Solidago, Phalaris,* and *Typha*.

Additional investigation by a wetland consultant during the growing season and regulatory coordination would be required prior to developing stormwater treatment measures at the site as a small area of jurisdictional wetland appears to be present. If it is confirmed to be jurisdictional, the wetland may be too small and of marginal habitat quality to be protected by the COE or VT statute.

Site specific considerations: The Implementation of a riparian buffer along Rugg Brook on the adjoining agricultural property to the west (Figure 2) would be an effective and inexpensive way to minimize nutrient and sediment loading in the watershed.

Figure 1-Recent bank collapse

Figure 2-Riparian buffer needed on adjacent property

Site: Nason Street/ Green Mountain Drive
Regulated Natural Resources present: No
Follow up required: No

Buried gas and water lines are present in this area and coordination with the utilities look to be the most relevant consideration for work at this site. VELCO also likely has an easement through the area due to their transmission lines directly overhead (Figure 3).

Best Management Practices during excavation would be necessary to control sediment and limit off-site discharges to the brook via the existing culverts that cross under Nason Street at the intersection of Green Mountain Drive. Otherwise there are no apparent natural resource or regulatory concerns at this location.

Figure 3-VELCO Substation next to investigated area

Site: Clyde Allen Drive
Regulated Natural Resources present: Yes
Follow up required: Yes

Figure 4-Small wetland community along Clyde Allen Dr.

A small diameter culvert conveys parking lot and potentially roof top run-off from the adjacent apartment complex into the investigated area. A small wetland exists at this location and is found between this culvert outfall and Rugg brook (Figure 4). It is dominated by narrow-leaved cattail (*Typha angustifolia)*. The presence of this species often indicates brackish or saline hydrology so the community is likely already improving water quality by intercepting and retaining some of the wintertime deicing salts from the parking lot and sidewalks above.

Enlarging the wetland to lengthen the flow path through this dense and erect vegetation would be a simple solution to further improve the quality of stormwater runoff. The wetland may not be protected by the COE or VT statute since it is too small to offer much habitat value and may occur in a man-made basin. Any work at the location however would require regulatory coordination to confirm.

Figure 5-Fertilized lawn to the edge of Rugg Brook

Site specific considerations: Implementing a 'no-mow' riparian buffer along the edge of Rugg Brook would be an effective low-cost measure to help minimize nutrient export from this site. The fertilized (it was still very green) lawnscape behind the apartment complex extends to the water's edge (Figure 5).

Rugg Brook FRP
Cost Share for Joint MS4 Projects
9/22/2016

For each proposed Rugg Brook FRP project with multiple MS4 jurisdiction, WCA completed an assessment of the impervious area breakdown as well as runoff production from each MS4's contributing drainage area. The % breakdown is presented below. The average of the impervious % and flow % allocation was calculated, in order to account for the fact that more pollutants will be contributed by impervious surfaces than wooded, open space. The average % was then rounded to the nearest quarter percentile (25%, 50%, 75%).

I-89/Holyoke Farm

$370,000		
	VTRANS	Town
Runoff Volume 1-Yr (acft)	0.07	1.53
Percent Flow	5%	95%
Impervious Acres	6.12	0.11
Percent Impervious	85%	15%
Percent Cost Allocation	**45%**	**55%**
	50%	**50%**
Cost Share	$185,000	$185,000

Access Rd. East

$820,000		
	VTRANS	Town
Runoff Volume 1-Yr (acft)	0.94	1.86
Percent Flow	34%	66%
Impervious Acres	6.38	3.44
Percent Impervious	65%	35%
Percent Cost Allocation	**49%**	**51%**
	50%	**50%**
Cost Share	$ 410,000	$ 410,000

Access Rd. West

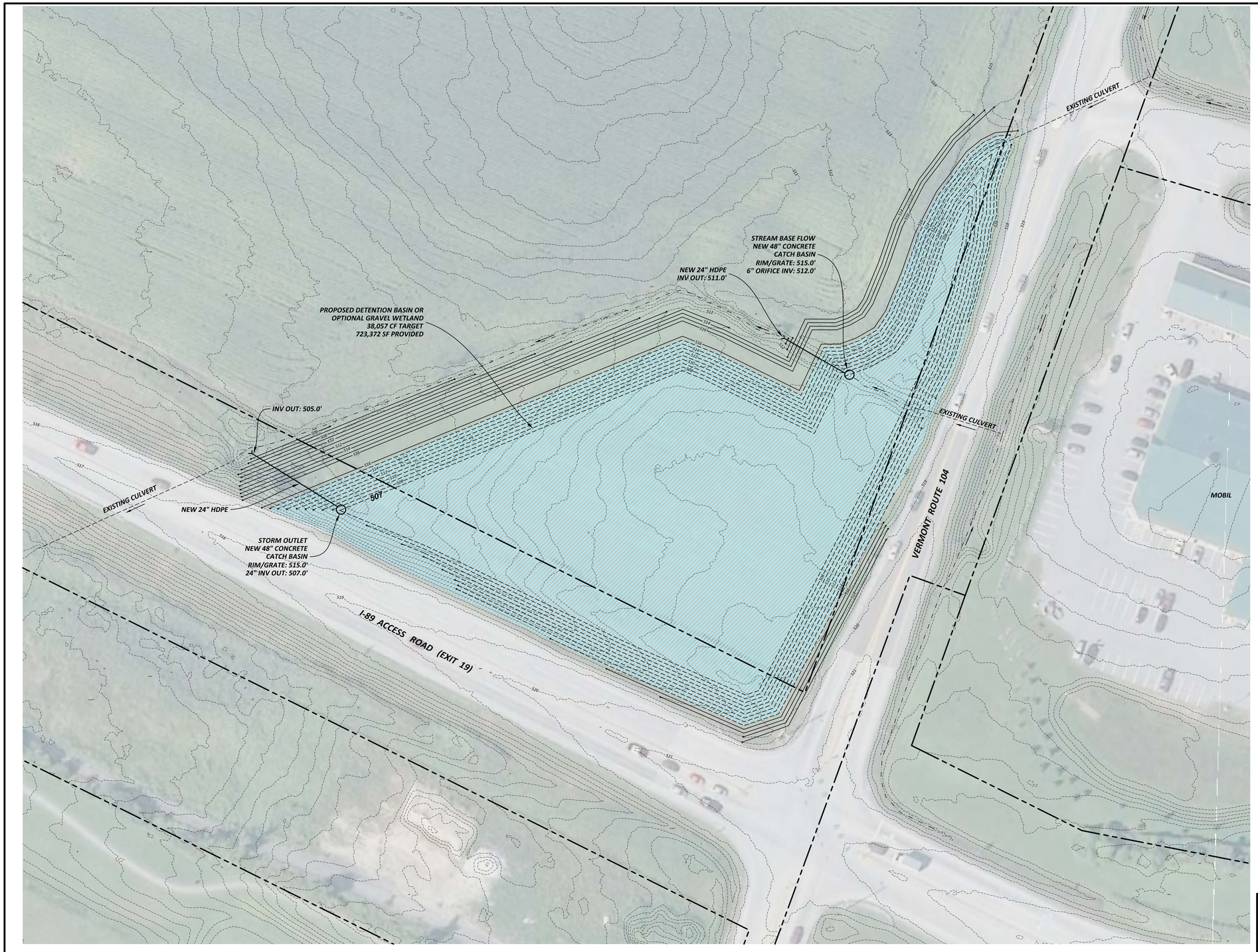
$250,000		
	VTRANS	Town
Runoff Volume 1-Yr (acft)	0.09	0.77
Percent Flow	11%	89%
Impervious Acres	0.58	0
Percent Impervious	100%	*
Percent Cost Allocation	**55%**	**45%**
	50%	**50%**
Cost Share	$ 125,000	$ 125,000

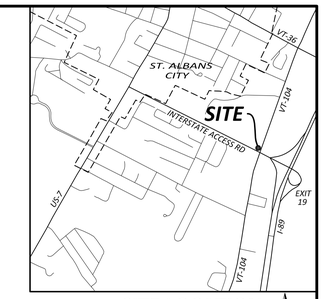
Exit 19 South

$370,000		
	VTRANS	Town
Runoff Volume 1-Yr (acft)	0.96	1.079
Percent Flow	47%	53%
Impervious Acres	6.12	0.11
Percent Impervious	98%	2%
Percent Cost Allocation	**73%**	**27%**
	75%	**25%**
Cost Share	$ 277,500	$ 92,500

SASH/Nason St Connector

$139,000			
	Vtrans	**Town**	**City**
Runoff Volume 1-Yr (acft)	0.14	0.35	0.16
Percent Flow	21%	54%	25%
Impervious Acres	1.48	2.15	1.53
Percent Impervious	29%	42%	30%
Percent Cost Allocation	**25%**	**48%**	**27%**
	25%	**50%**	**25%**
Cost Share	$ 34,750	$ 69,500	$ 34,750





SITE LOCATION

NTS

N

LEGEND

- PROPERTY LINE
- EXISTING CONTOUR
- PROPOSED CONTOUR
- EXISTING STORM LINE
- PROPOSED STORM LINE
- DRAINAGE FLOW PATH

NOTES

1. THIS IS NOT A BOUNDARY SURVEY. BOUNDARY INFORMATION IS FROM TOWN TAX MAPS.

2. EXISTING TOPOGRAPHY WAS CREATED FROM ROCK RIVER LiDAR (2008).

40 0 20 40 80 160

(IN FEET)
1 inch = 40 ft.

CONCEPT

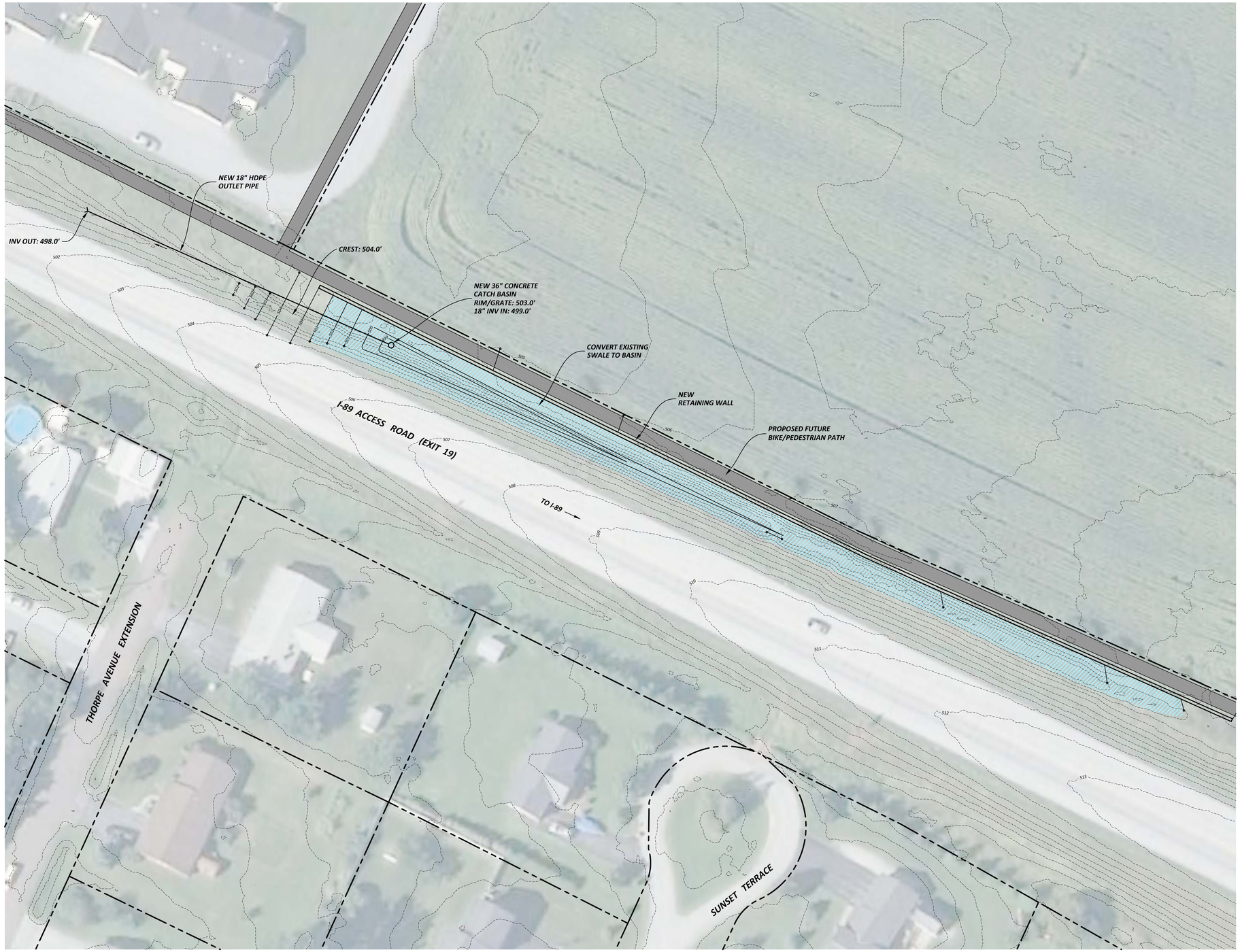
RUGG BROOK FLOW RESTORATION PLAN

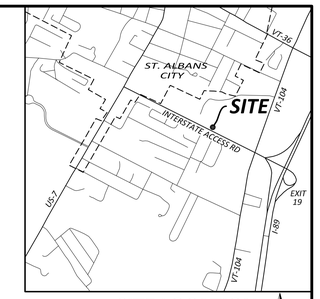
ST. ALBANS, VERMONT

INTERSTATE ACCESS EAST 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:	4-7-15	CHECKED BY:	AT	SHEET:	1 OF 1





SITE LOCATION

NTS

N

LEGEND

- PROPERTY LINE
- EXISTING CONTOUR
- PROPOSED CONTOUR
- PROPOSED STORM LINE

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).

30 0 15 30 60 120

(IN FEET)
1 inch = 30 ft.

CONCEPT

RUGG BROOK FLOW RESTORATION PLAN

ST. ALBANS, VERMONT

INTERSTATE ACCESS WEST 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

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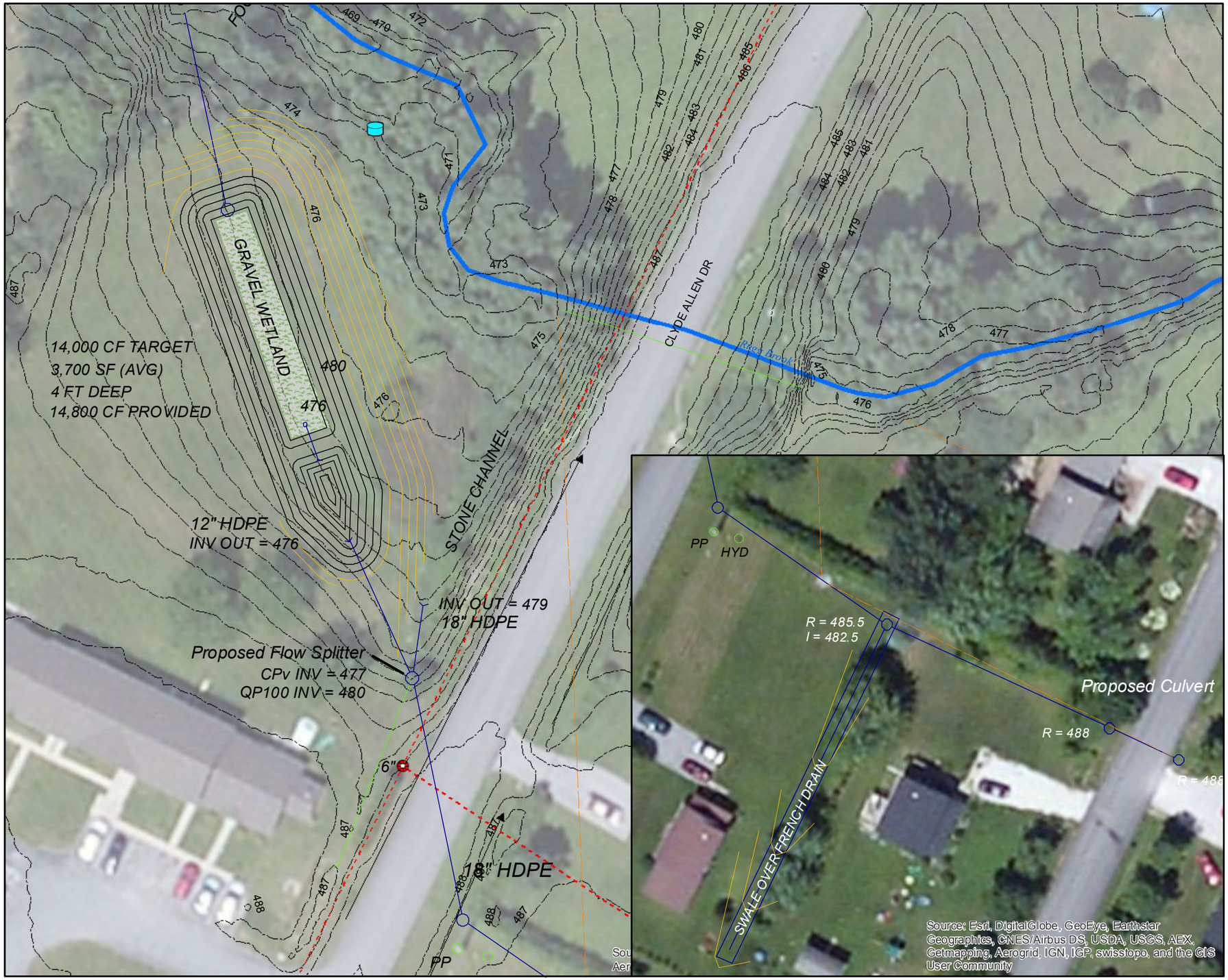
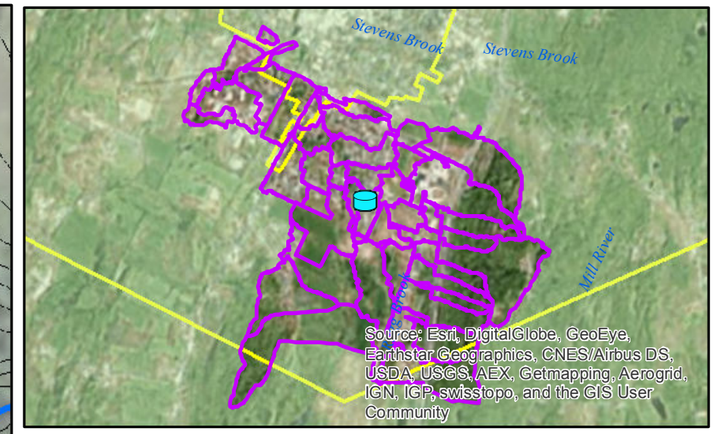
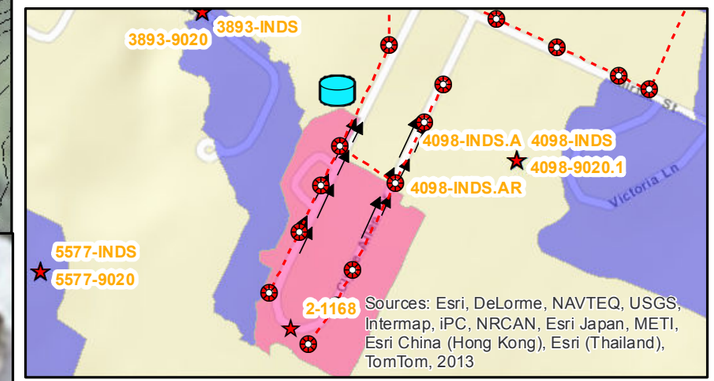






LEGEND

- Rugg Brook
- PROPOSED 1' CONTOUR- Fill
- PROPOSED STORM PIPE
- PROPOSED 1' CONTOUR
- EXISTING STORM PIPE
- ABANDONED PIPE
- Proposed Gravel Wetland
- EXISTING 1' CONTOUR
- Proposed_Retrofits
- Sanitary Manhole
- Sanitary line
- Overland flow
- Permit

BMP Drainage Area

- Proposed Retrofit
- Proposed New
- Existing Post 2002
- Existing Pre 2002

NOTES:

The proposed retrofit involves installation of a gravel wetland in an existing grassed lawn. The practice will provide detention and filtration for the 1-year design storm volume. The property is owned by the Vermont Housing Authority. A new footing drain will be installed to drain a wet area on the East side of Clyde Allen Dr to the new practice.

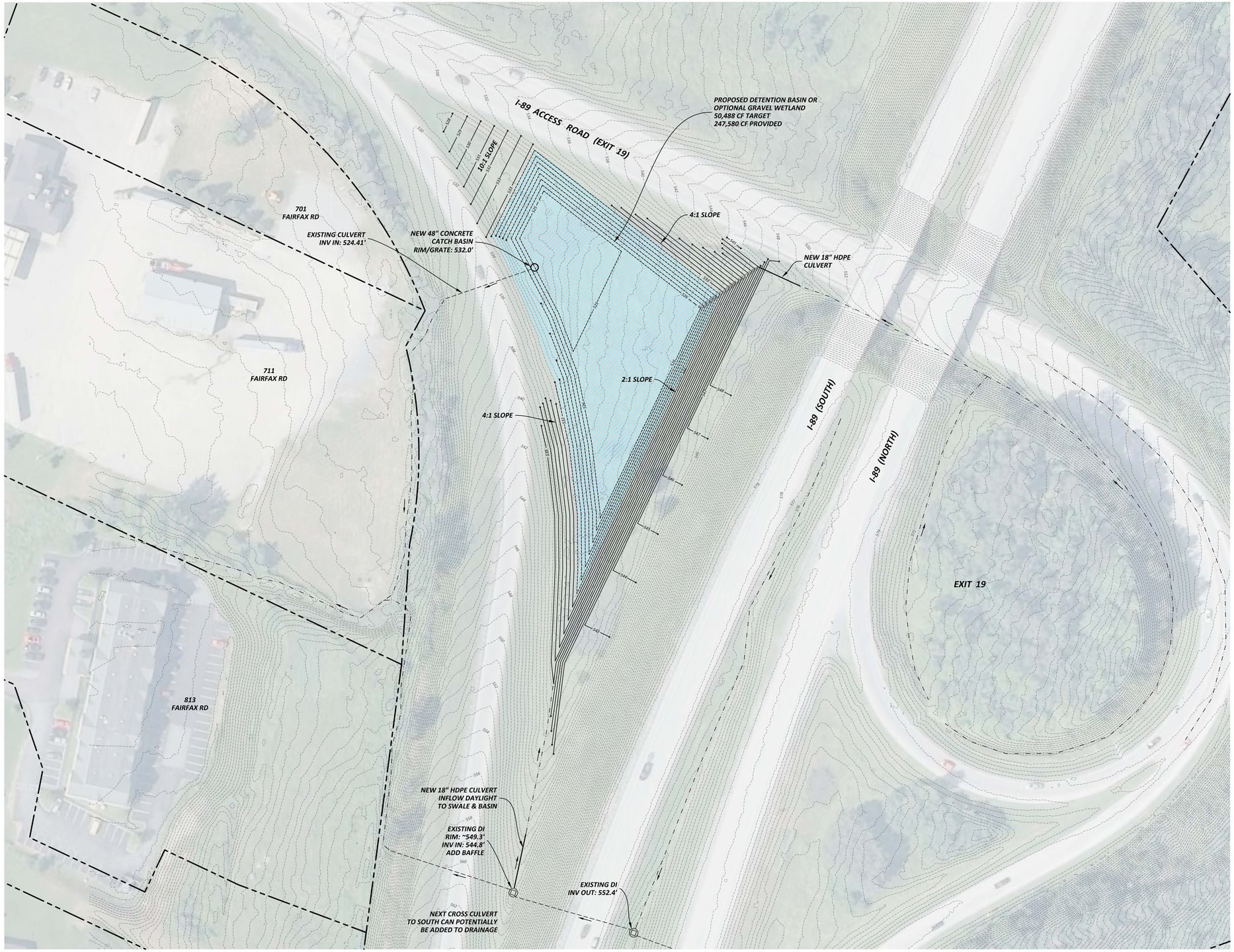
1 inch = 40 feet

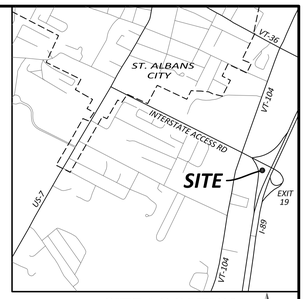
0 40 80 160 Feet

N S

WATERSHED CONSULTING ASSOCIATES, LLC

RUGG BROOK FLOW RESTORATION STUDY ST. ALBANS, VERMONT		
Clyde Allen Dr. Gravel Wetland		
DATE: 4-3-15	DRAWN BY:JS	SCALE:NOTED





SITE LOCATION

NTS

LEGEND

- PROPERTY LINE
- EXISTING CONTOUR
- PROPOSED CONTOUR
- EXISTING STORM LINE
- PROPOSED STORM LINE
- DRAINAGE FLOW PATH

NOTES

1. THIS IS NOT A BOUNDARY SURVEY. BOUNDARY INFORMATION IS FROM TOWN TAX MAPS.
2. EXISTING TOPOGRAPHY WAS CREATED FROM ROCK RIVER LiDAR (2008).

40 0 25 40 100 200

(IN FEET)
1 inch = 50 ft.

CONCEPT

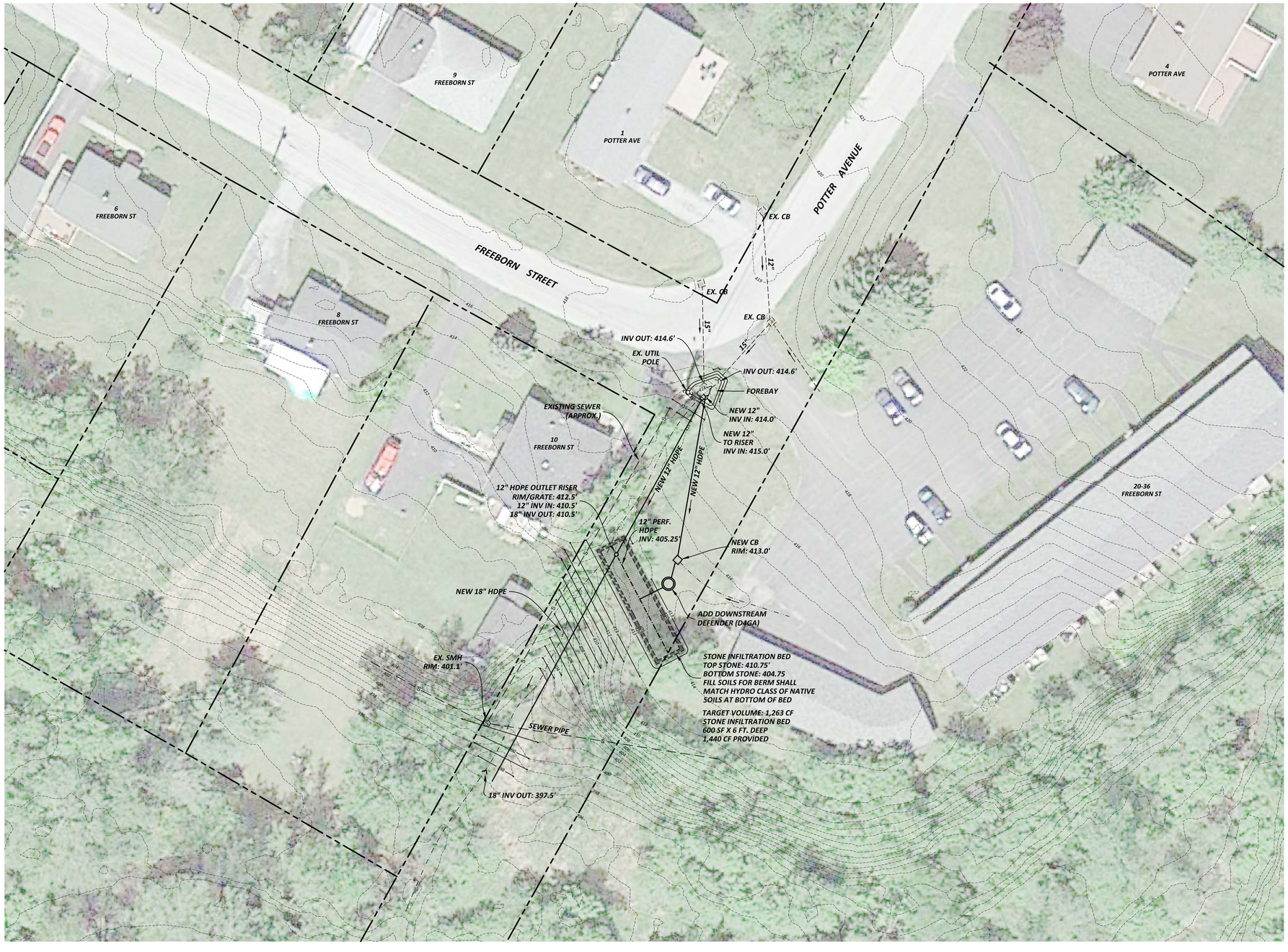
RUGG BROOK FLOW RESTORATION PLAN

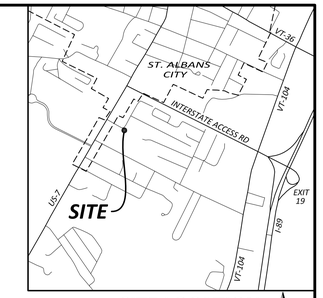
ST. ALBANS, VERMONT

INTERSTATE EXIT 19 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:	4-17-15	CHECKED BY:	AT	SHEET:	1 OF 1





SITE LOCATION
NTS

LEGEND

- PROPERTY LINE
- EXISTING CONTOUR
- PROPOSED CONTOUR
- EXISTING STORM LINE
- PROPOSED STORM LINE
- DRAINAGE FLOW PATH

NOTES

1. THIS IS NOT A BOUNDARY SURVEY. BOUNDARY INFORMATION IS FROM TOWN TAX MAPS.
2. EXISTING TOPOGRAPHY WAS CREATED FROM ROCK RIVERLIDAR (2008).

20 0 10 20 40 80

(IN FEET)
1 inch = 20 ft.

CONCEPT

RUGG BROOK FLOW RESTORATION PLAN

ST. ALBANS, VERMONT

FREEBORN STREET 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:	3-26-15	CHECKED BY:	AT	SHEET:	1 OF 1

FARM PROPERTY
HOLYOKE FARM RD.

ROUTE 89 S

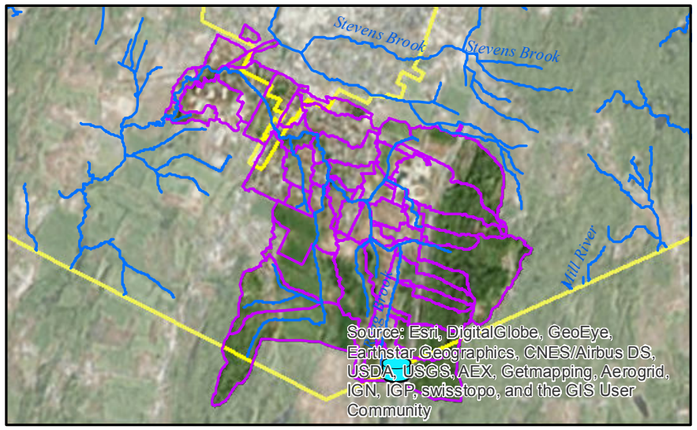
Surface discharge to infiltration basin

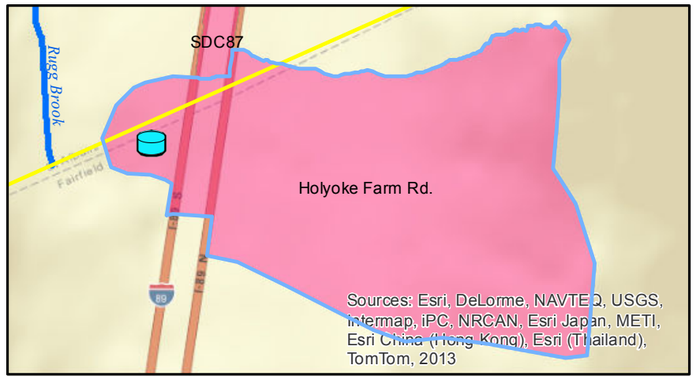
200' x 70'
3' deep stone basin

Proposed 18" Stormpipe to infiltration basin

Rugg Brook

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community





LEGEND

- Proposed Storm Pipe
- Storm line
- Swale
- EXISTING 1' CONTOUR
- Proposed Infiltration Basin
- city_town_BNDS
- Stormwater Permit

BMP Drainage Area

- Proposed Retrofit
- Proposed New
- Existing Post 2002
- Existing Pre 2002
- Rugg Brook

The proposed retrofit is an infiltration basin on the back lot of an active farm, off Holyoke Farm Rd. The BMP would mitigate runoff from two I-89 culverts, as well as a portion of the farm. The proposed basin is a 3 foot deep stone basin, with surface ponding storage. The surface could either be left as stone, or reseeded with grass for ease of maintenance. The depth to groundwater needs to be verified. This project has opportunity to also address potential BMP requirements on the Farm to comply with the Lake Champlain Phosphorus TMDL.

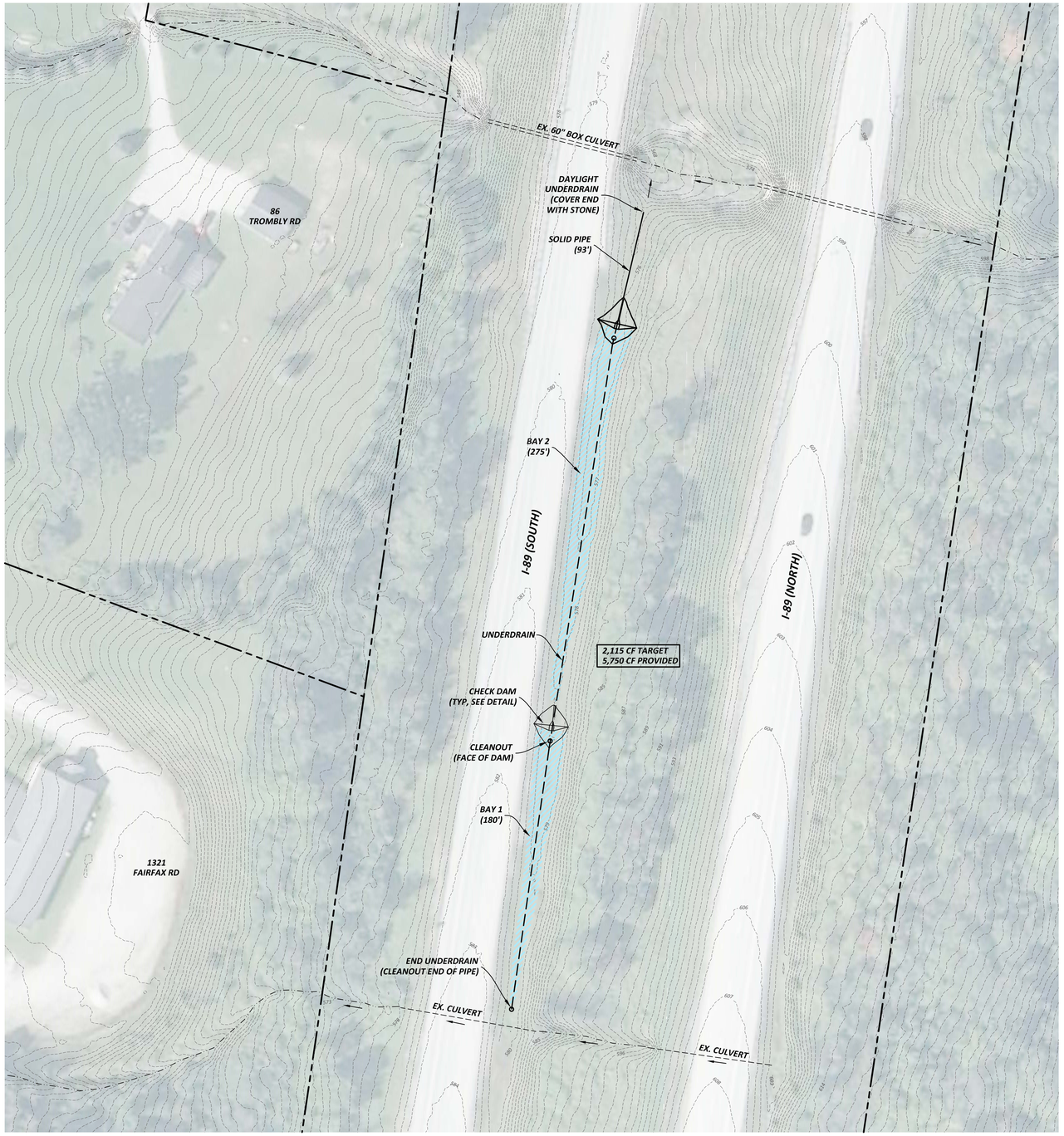
WATERSHED CONSULTING ASSOCIATES, LLC

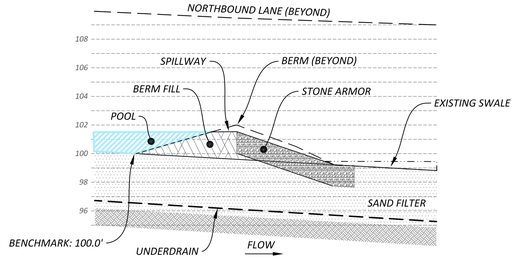
1 inch = 67 feet

0 40 80 160 240 Feet

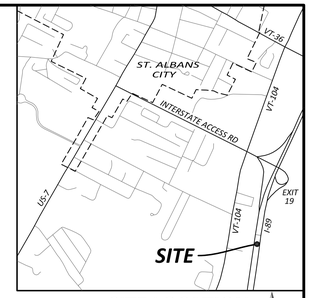
N S

RUGG BROOK FLOW RESTORATION STUDY ST. ALBANS, VERMONT		
I-89/Holyoke Farm Infiltration Basin		
DATE: 2-17-15	DRAWN BY:JS	SCALE:NOTED



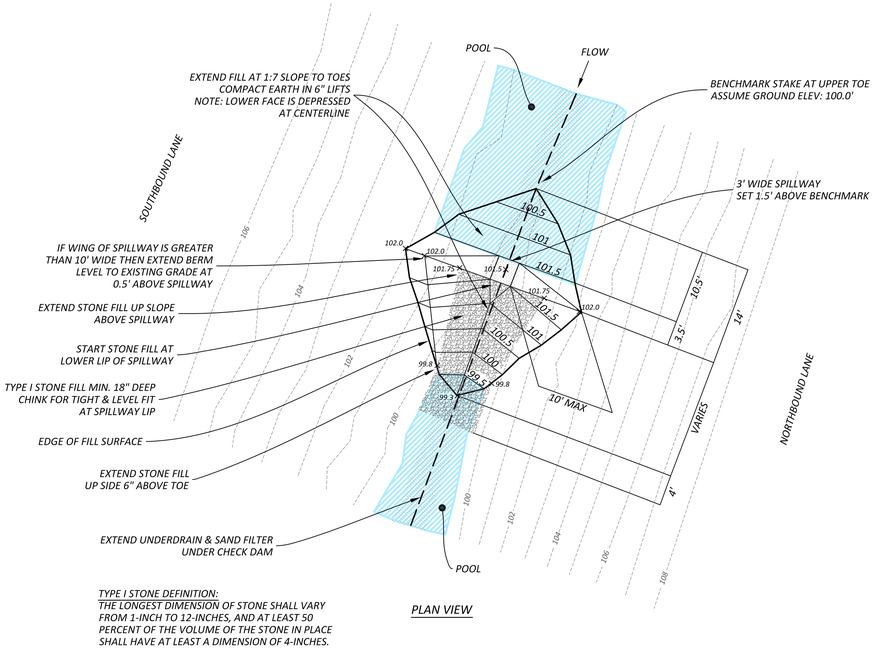


SECTION ALONG FLOW PATH



SITE LOCATION

NTS



TYPE I STONE DEFINITION:
THE LONGEST DIMENSION OF STONE SHALL VARY FROM 1-INCH TO 12-INCHES, AND AT LEAST 50 PERCENT OF THE VOLUME OF THE STONE IN PLACE SHALL HAVE AT LEAST A DIMENSION OF 4-INCHES.

PLAN VIEW

CHECK DAM DETAIL

NTS

NOTES

1. THIS IS NOT A BOUNDARY SURVEY. BOUNDARY INFORMATION IS FROM TOWN TAX MAPS.
2. EXISTING TOPOGRAPHY WAS CREATED FROM ROCK RIVERLiDAR (2008).

40 0 20 40 80 160

(IN FEET)
1 inch = 40 ft.

LEGEND

- PROPERTY LINE
- EXISTING CONTOUR
- PROPOSED CONTOUR
- EXISTING STORM LINE
- PROPOSED UNDERDRAIN
- DRAINAGE FLOW PATH

CONCEPT

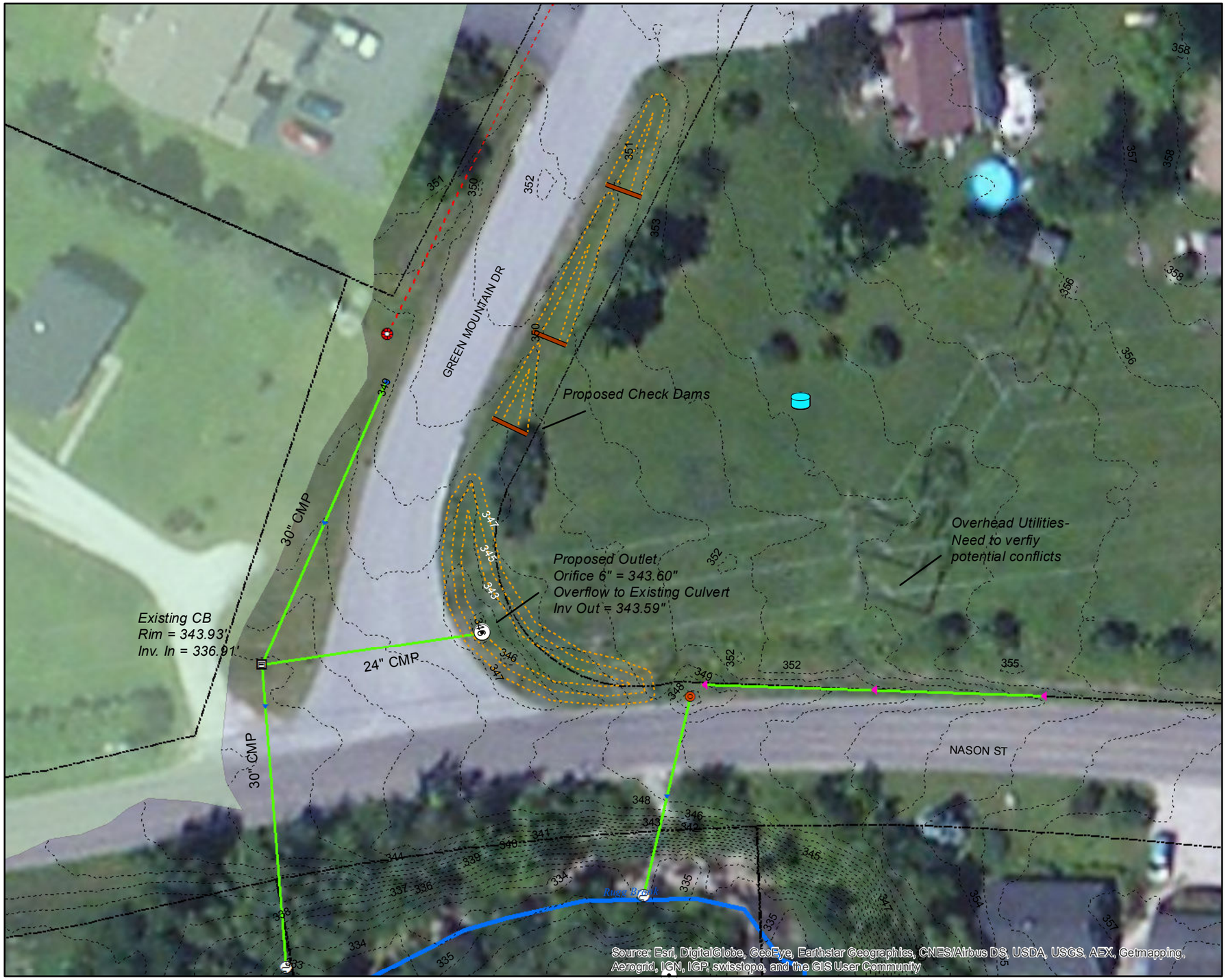
RUGG BROOK FLOW RESTORATION PLAN

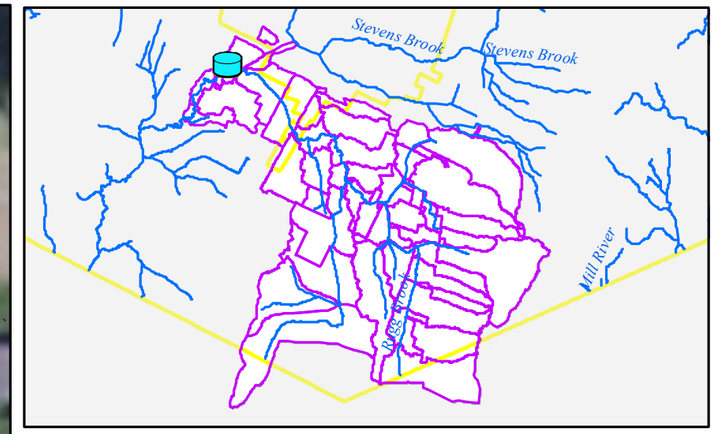
ST. ALBANS, VERMONT

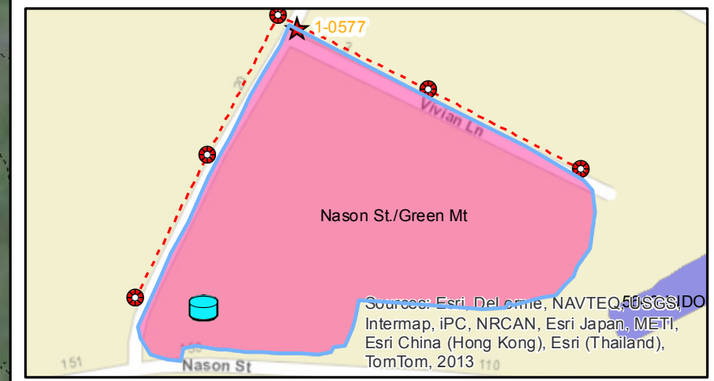
INTERSTATE MEDIAN SITE 280 STORMWATER IMPROVEMENT PLAN

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:	4-17-15	CHECKED BY:	AT	SHEET:	1 OF 1







LEGEND

- Proposed Retrofit
- PROPOSED 2' CONTOUR
- Proposed Structure
- Proposed Check Dam
- Storm line
- Sanitary line
- Swale
- PROPERTY BOUNDARY
- EXISTING 1' CONTOUR
- Outer Boundary
- Catch Basin
- Sanitary Manhole
- city_town_BNDS
- Stormwater Permit

BMP Drainage Area

- Proposed Retrofit
- Proposed New
- Existing Post 2002
- Existing Pre 2002
- Rugg Brook

The proposed retrofit involves regrading and expanding the existing depression in the right-of-way to increase storage. A low-flow orifice would be installed to provide detention of the 1-year storm volume, with high-flow bypass via the existing 24" culvert. Check dams would be placed in the existing swale as well as regrading of the swale to increase storage and water quality benefits.

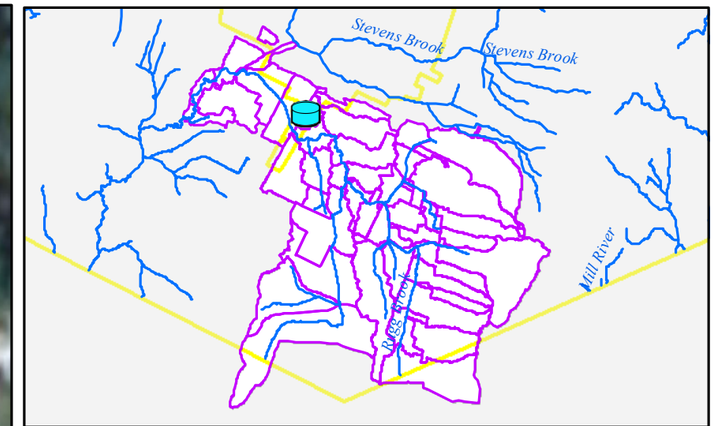
WATERSHED CONSULTING ASSOCIATES, LLC

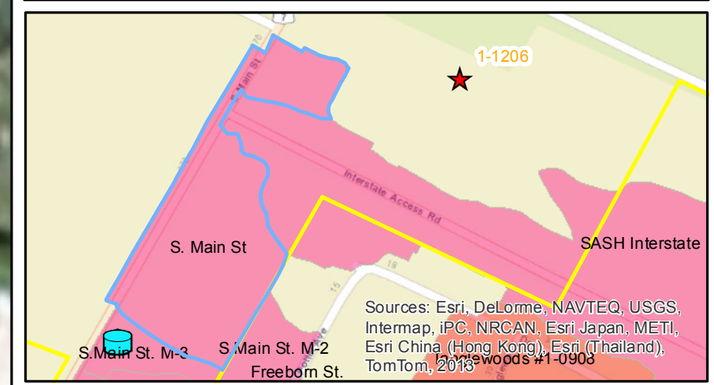
1 inch = 33 feet

0 40 80 Feet

N S

RUGG BROOK FLOW RESTORATION STUDY		
ST. ALBANS, VERMONT		
Nason St/Green Mt. Dr. Detention Basin		
DATE: 2-17-15	DRAWN BY:JS	SCALE:NOTED





LEGEND

- Proposed Retrofit
- Proposed Infiltration Basin
- Catchbasin
- Sanitary Manhole
- Storm line
- Sanitary line
- Overland flow
- Proposed Structure
- city_town_BNDS
- Stormwater Permit

BMP Drainage Area

- Proposed Retrofit
- Proposed New
- Existing Post 2002
- Existing Pre 2002

The proposed retrofit involves installation of an underground infiltration basin in an existing grassed lawn. The practice will provide infiltration of the 1-year design storm volume. An easment from the property owner would be needed. Both the City and privately owned impervious contribute runoff to the BMP. Location of water main and electric utilities need to be verified.

WATERSHED CONSULTING ASSOCIATES, LLC

1 inch = 25 feet

0 40 80 Feet

N S

RUGG BROOK FLOW RESTORATION STUDY		
ST. ALBANS, VERMONT		
South Main St./Route 7 Infiltration Basin		
DATE: 2-17-15	***DRAWN BY:JS***	***SCALE:NOTED***

M3
55' x 10'

M2
30' x 10' (2)

M1
30' x 10'

24" RCP

30" RCP

S.MAIN ST

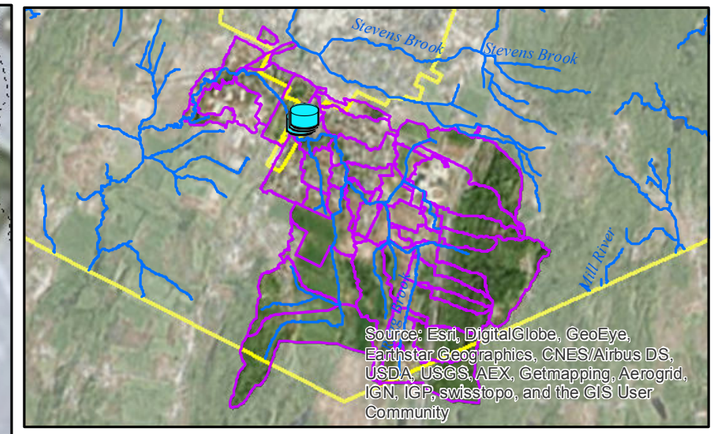
THE CADILLAC MOTEL
213 S MAIN ST.

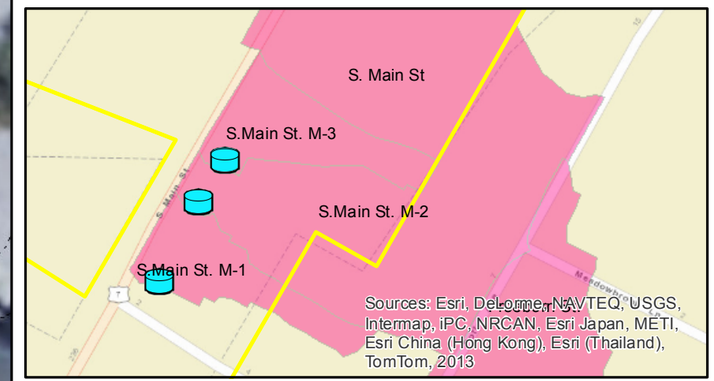
Existing Rim = 403.82'
30" RCP Inv In = 397.75'
24" RCP Inv In = 397.75'
30" RCP Inv Out = 397.65'

Existing Rim = 400.93'
30" RCP Inv In = 394.76'
24" RCP Inv In = 395.01'
30" RCP Inv Out = 394.60'

Sources: Esri, DeLorme, NAVTEQ, USGS, Interma
(Thailand), TomTom, 2013, Source: Esri, DigitalGlo
USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Example of a Planted Stormwater Curb Extension proposed for Route 7 retrofits (VA Design Manual, 2013)





LEGEND

- Proposed Retrofit
- Proposed Catch Basin
- Proposed Overflow Outlet
- Proposed Curb Extension Planter
- Proposed Underground Infiltration Bed
- Catchbasin
- Sanitary Manhole
- Storm line
- Sanitary line
- Overland flow
- Proposed_Stormline
- city_town_BNDS
- PROPERTY BOUNDARY
- EXISTING 1' CONTOUR

BMP Drainage Area

- Proposed Retrofit
- Proposed New
- Existing Post 2002
- Existing Pre 2002

The proposed retrofit includes four 3 foot curb extentions, with curb cuts to allow surface runoff to enter the system and pond up to a maximum of 6" . The surface of the curb extensions can be either planted with salt tolerant grasses or pea gravel. Surface runoff will infiltrate into a 5 foot infiltration bed, below grade. The existing grassed ROW between the road and sidewalk would be reseeded and maintained with grass post construction. Overflow will be safetly routed to a surface outlet pipe tied to the existing 30" RCP stormline.

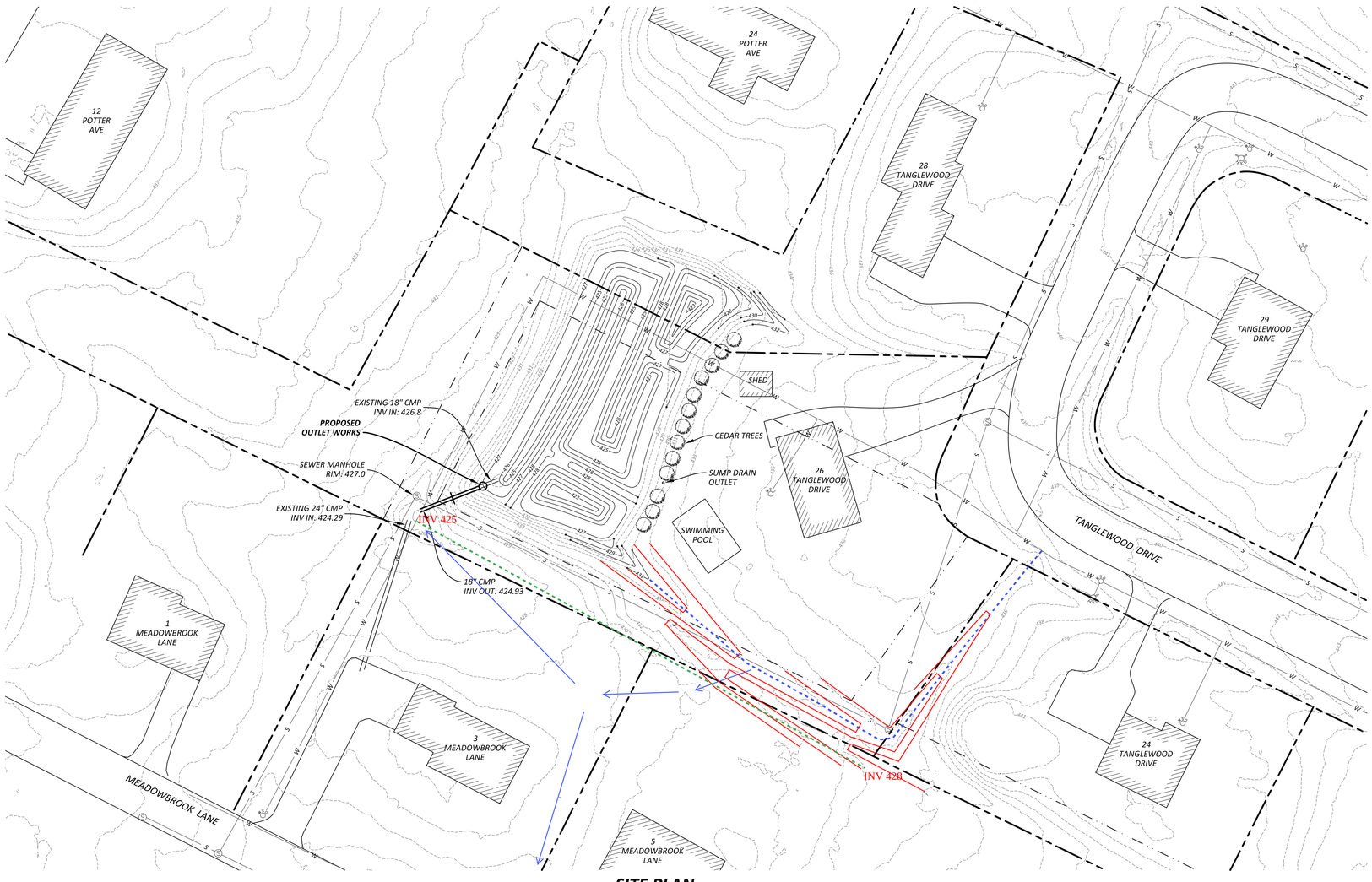
WATERSHED CONSULTING ASSOCIATES, LLC

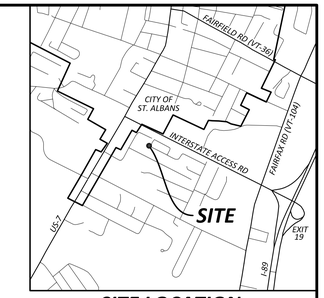
1 inch = 36 feet

0 40 80 Feet

N S

RUGG BROOK FLOW RESTORATION STUDY		
ST. ALBANS, VERMONT		
South Main St./Route 7 Stormwater Curb Extensions		
DATE: 2-17-15	DRAWN BY:JS	SCALE:NOTED





SITE LOCATION

NTS

SITE PLAN

30 0 15 30 60 120

(IN FEET)
1 inch = 30 ft.

LEGEND

- PROPERTY LINE
- EASEMENT
- EXISTING CONTOUR
- FINISH GRADE CONTOUR
- w — WATER LINE
- s — SEWER LINE
- WATER SHUTOFF VALVE
- HYDRANT
- SEWER MANHOLE

NOTES

1. THIS IS NOT A BOUNDARY SURVEY.

2. EXISTING STORM BASIN TOPOGRAPHY AND STORM INFRASTRUCTURE IS FROM TOTAL STATION SURVEY CONDUCTED BY THIS OFFICE ON 3-7-14. SUPPLEMENTAL EXISTING TOPOGRAPHY GENERATED FROM 2008 LiDAR.

3. UNDERGROUND UTILITIES, PROPERTY BOUNDARIES AND EASEMENTS SHOWN ARE FROM PLAN BY BENCHMARK SURVEYING, P.C.TITLED "TANGLEWOOD ESTATES UTILITIES PLAN" DATED 11/9/93 (VERMONT STATE WASTEWATER/WATER SUPPLY PERMIT #EC-6-1503-1). LOCATION OF UNDERGROUND UTILITIES HAVE NOT BEEN FIELD VERIFIED.

DRAFT

TANGLEWOOD ESTATES

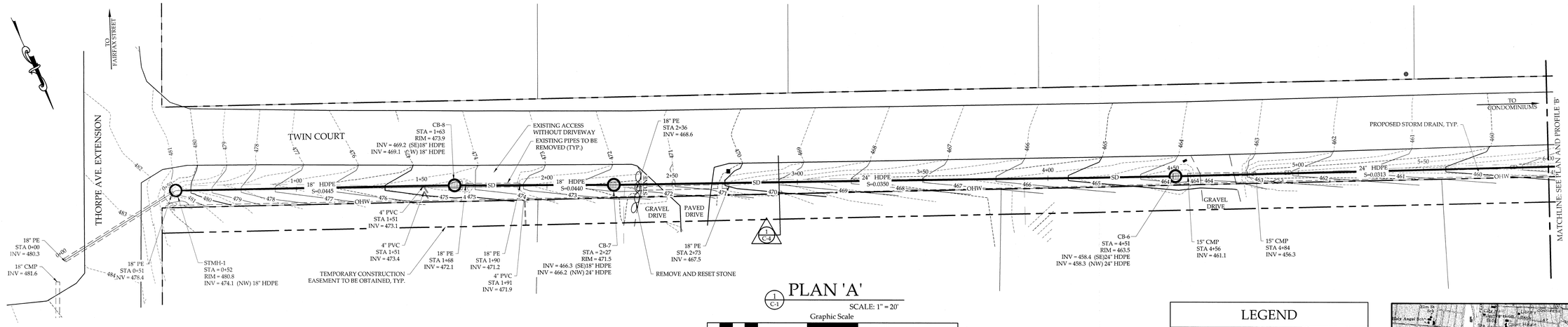
TANGLEWOOD CIRCLE/ST. ALBANS, VERMONT

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	SCALE:	NOTED
DATE:	5-15-14.	CHECKED BY:	AT	SHEET:	1 OF 1

TANGLEWOOD ESTATES.dwg



1 / C-1 PLAN 'A'

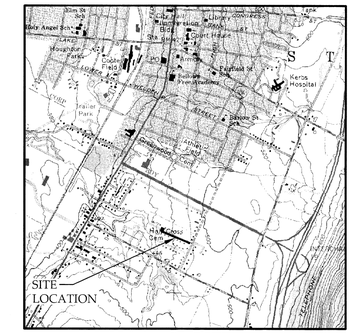
SCALE: 1" = 20'

Graphic Scale

20 0 20 40 80 feet

LEGEND

●	IRON PIN FOUND
	EXISTING WATER SHUT OFF
	EXISTING MAILBOX
	EXISTING UTILITY POLE & GUY WIRE
	EXISTING SEWER MANHOLE
	PROPOSED CATCH BASIN
	APPROXIMATE PROPERTY LINE
	TEMPORARY CONSTRUCTION EASEMENT TO BE OBTAINED
420	EXISTING CONTOUR
420	PROPOSED CONTOUR
OHW	EXISTING OVERHEAD WIRES
S	EXISTING SEWER LINE
SD	PROPOSED STORMWATER DRAIN
	EXISTING SWALE CENTERLINE / EDGE OF STREAM
	EXISTING WETLANDS
	EXISTING TREES



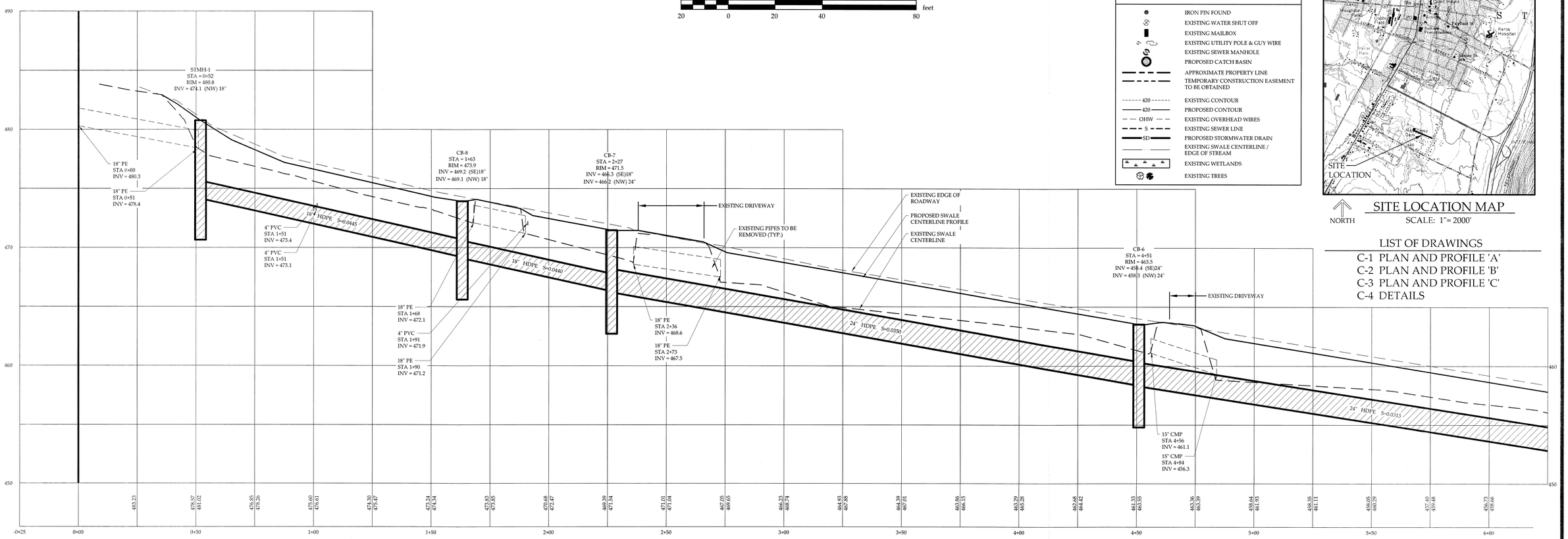
NORTH

SITE LOCATION MAP

SCALE: 1" = 2000'

LIST OF DRAWINGS

C-1 PLAN AND PROFILE 'A'
C-2 PLAN AND PROFILE 'B'
C-3 PLAN AND PROFILE 'C'
C-4 DETAILS



2 / C-1 PROFILE 'A'

SCALE: HORIZONTAL : 1" = 20'
VERTICAL: 1" = 4"

PRELIMINARY
10/1/2014

PLAN REFERENCES:

1) TOPOGRAPHIC SURVEY RECEIVED ELECTRONICALLY ON 1/4/12 AND PREPARED BY BUTTON PROFESSIONAL LAND SURVEYORS OF SO. BURLINGTON, VT.

2) RECORD DRAWING - "PLAN AND PROFILE, RUGG BROOK MUNICIPAL SEWER, TOWN OF ST. ALBANS, VERMONT". DATED: MAR. '83, RECORD DRAWING DATED: OCT. 24 1983, SCALE: HORZ.-1"= 40', VERT.-1"= 4', PROJ. NO.: 5051, SHEET 2 OF 8, PREPARED BY ENGINEERS INCORPORATED OF VERMONT, WILLISTON, VERMONT.

3) "CONDOMINIUM PLAT, TWIN COURT DEVELOPMENT LLC, 269 COON HILL ROAD, COLCHESTER, VERMONT 05446, TOWN OF ST. ALBANS, VERMONT" DATED: FEBRUARY 4, 2004, LAST REVISED: 02/12/04, SCALE: 1 INCH = 30 FEET, JOB NO.: 3160, PREPARED BY BROOKS LAND SURVEYORS OF SO. BURLINGTON, VT.

NOTES:

1) THIS DRAWING IS NOT A BOUNDARY SURVEY PLAT. BOUNDARY LINE INFORMATION SHOWN IS BASED ON PLAN REFERENCE #3. THE PROPERTY LINES, EASEMENTS AND OTHER REAL PROPERTY DESCRIPTIONS PROVIDED ON THIS DRAWING ARE FOR ILLUSTRATION PURPOSES ONLY. THEY DO NOT DEFINE LEGAL RIGHTS OR MEET LEGAL REQUIREMENTS FOR A LAND SURVEY AS DESCRIBED IN V.S.A. TITLE 27 SECTION 1403 AND SHALL NOT BE USED IN LIEU OF A SURVEY AS THE BASIS OF ANY LAND TRANSFER OR ESTABLISHMENT OF ANY PROPERTY RIGHT.

2) THE CONTRACTOR SHALL BE RESPONSIBLE FOR FIELD VERIFYING AND DETERMINING THE LOCATION, SIZE, AND ELEVATION OF ALL EXISTING UTILITIES PRIOR TO THE START OF CONSTRUCTION. THE ENGINEER SHALL BE NOTIFIED IN WRITING OF ANY DISCREPANCIES OR UTILITIES FOUND INTERFERING WITH THE PROPOSED CONSTRUCTION. APPROPRIATE REMEDIAL ACTION SHALL BE TAKEN BEFORE PROCEEDING WITH THE WORK.

3) THIS TOPOGRAPHIC SURVEY WAS CONDUCTED WITHOUT THE BENEFIT OF "DIG SAFE" MARKINGS. UTILITY LOCATIONS SHOWN ARE APPROXIMATE AND ARE NOT WARRANTED TO BE EXACT OR COMPLETE. THE CONTRACTOR SHALL CONTACT "DIG SAFE" BEFORE COMMENCING ANY WORK AND SHALL PRESERVE ALL EXISTING UTILITIES NOT SPECIFIED TO BE REMOVED OR ABANDONED AS PART OF THE PROJECT.

PLAN AND PROFILE 'A'
TOWN OF ST. ALBANS
TWIN COURT
ST. ALBANS, VERMONT

RUGGIANO engineering, inc.
5 LAKE STREET
ST. ALBANS, VERMONT 05478
PHONE - (802) 524-9300 FAX - (802) 524-9700

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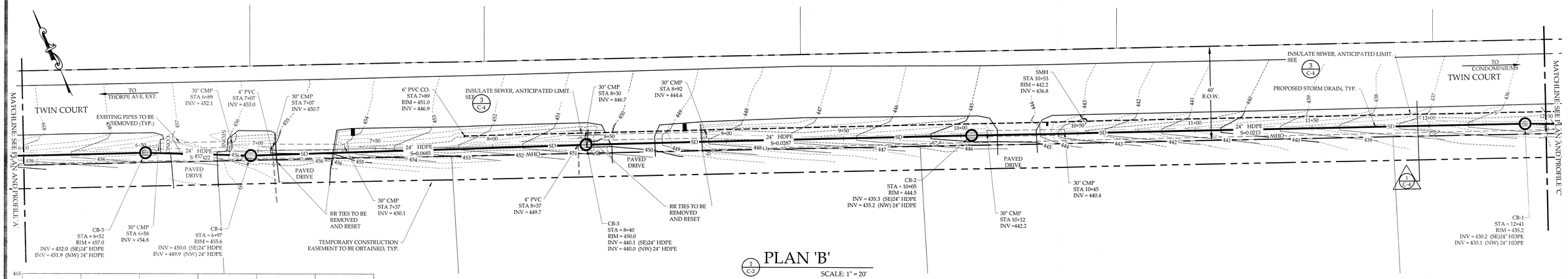
PROJECT NO.....11058
DRAWN BY.....DJL
CHECKED BY.....XXX
SCALE.....1" = 20'
DATE.....07/27/12

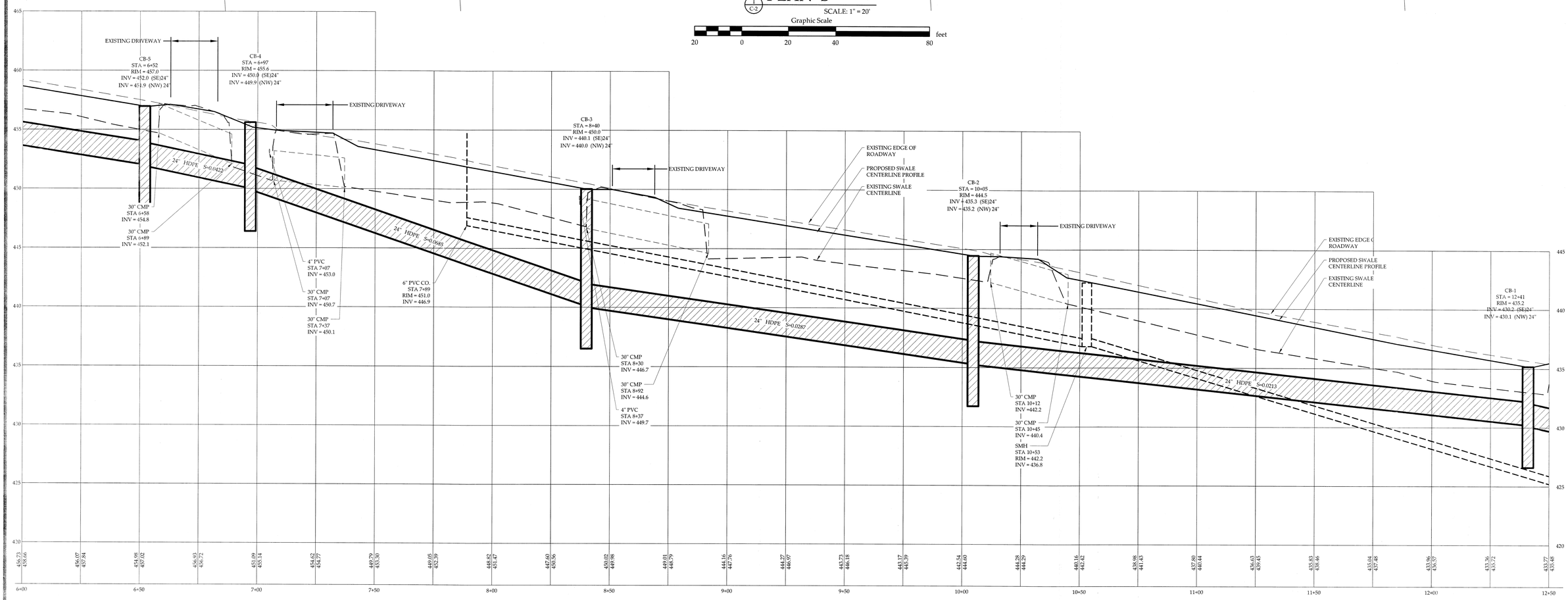
SHEET NO.
C-1
1 OF 4 SHEETS



1 C-2 PLAN 'B'

SCALE: 1" = 20'

Graphic Scale: 20 0 20 40 80 feet



2 C-2 PROFILE 'B'

SCALE: HORIZONTAL : 1" = 20'
VERTICAL: 1" = 4"

PRELIMINARY
10/1/2014

PLAN AND PROFILE 'B'
TOWN OF ST. ALBANS
TWIN COURT
ST. ALBANS, VERMONT

RUGGIANO engineering, inc.
5 LAKE STREET
ST. ALBANS, VERMONT 05478
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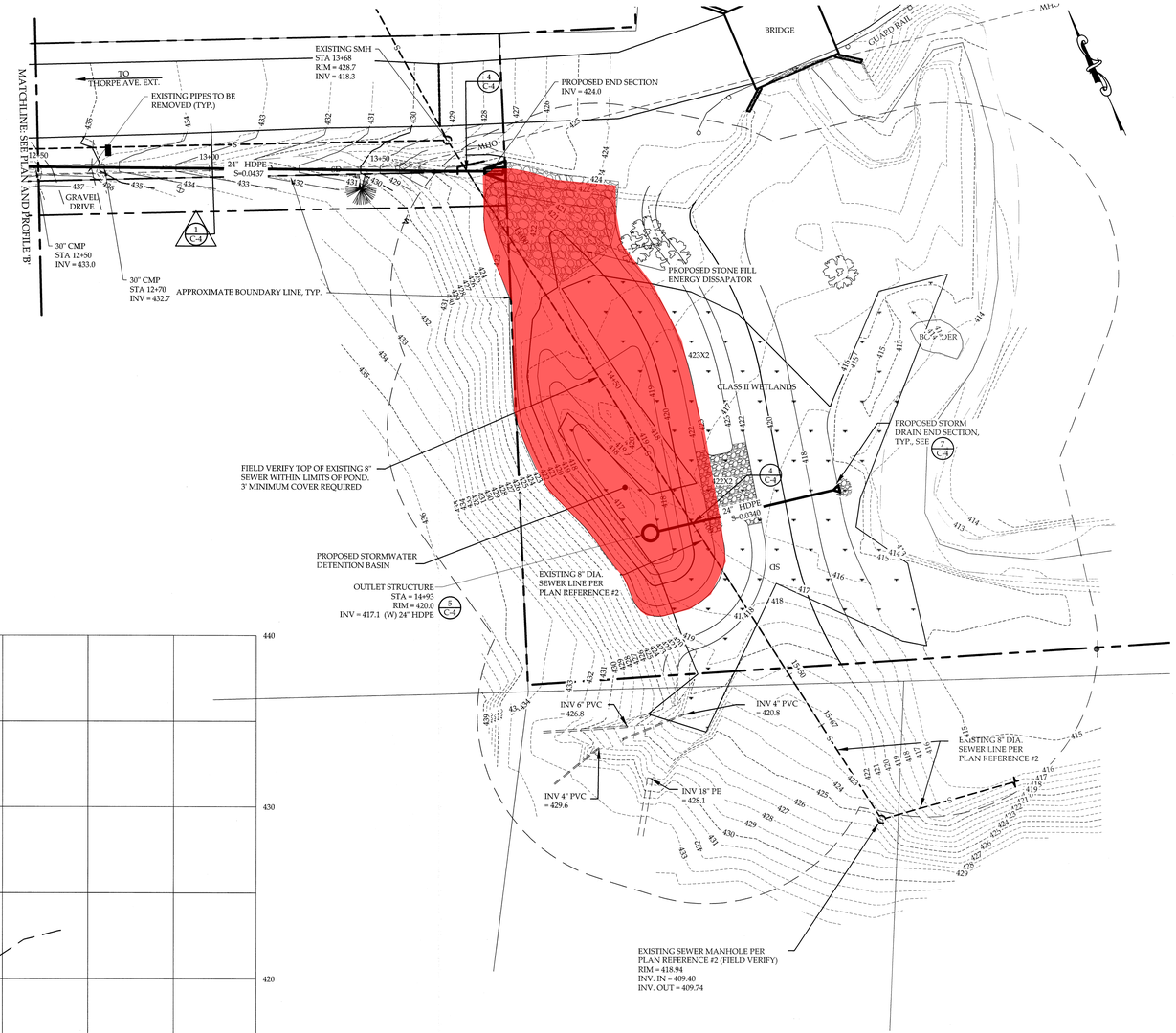
PROJECT NO.....11058
DRAWN BY.....DJL
CHECKED BY.....XXX
SCALE.....1" = 20'
DATE.....07/27/12

SHEET NO.
C-2
2 OF 4 SHEETS

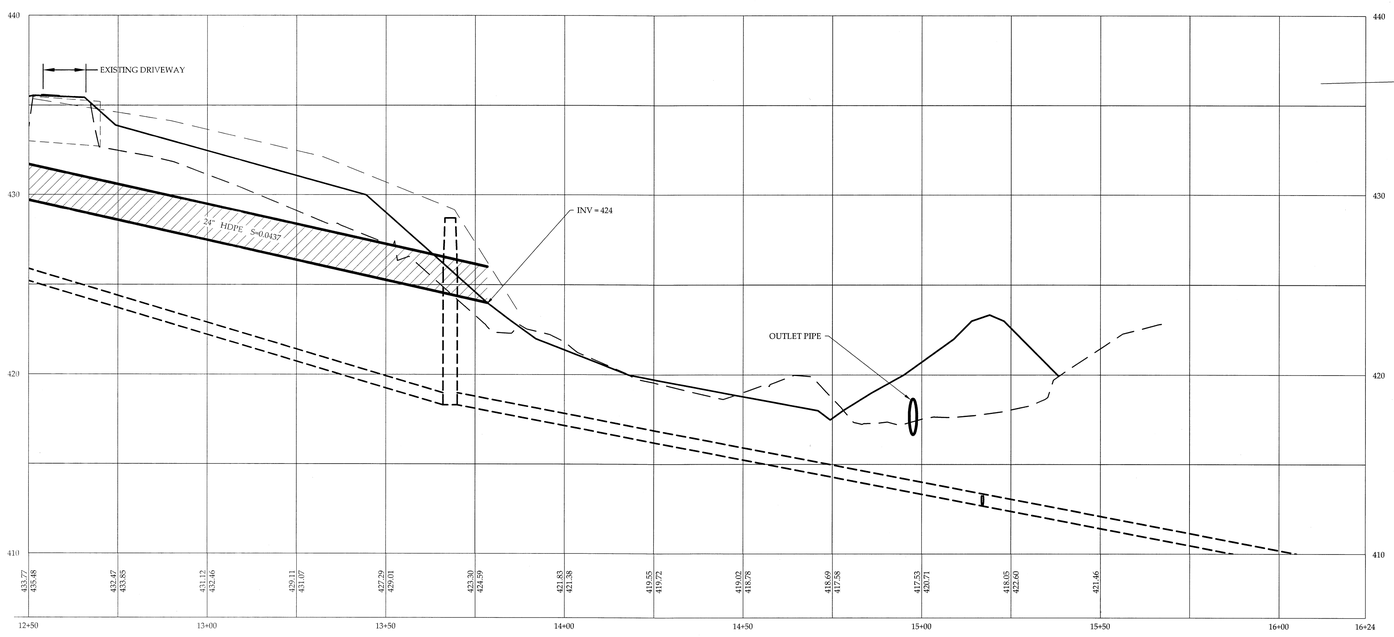


3/C-2 PLAN 'C'

SCALE: 1" = 20'

Graphic Scale

20 0 20 40 80 feet



2/C-1 PROFILE 'C'

SCALE: HORIZONTAL : 1" = 20'
VERTICAL: 1" = 4"

PRELIMINARY
10/1/14

PLAN AND PROFILE 'C'
TOWN OF ST. ALBANS
TWIN COURT
ST. ALBANS, VERMONT

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5 LAKE STREET
ST. ALBANS, VERMONT 05478
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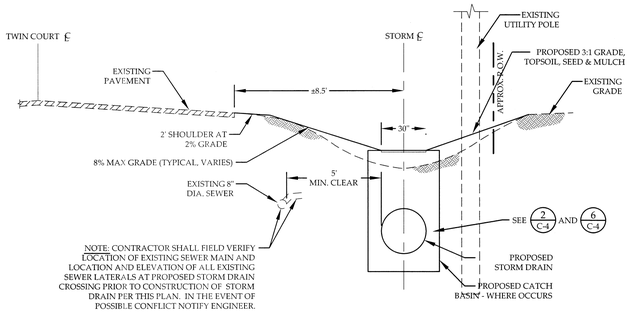
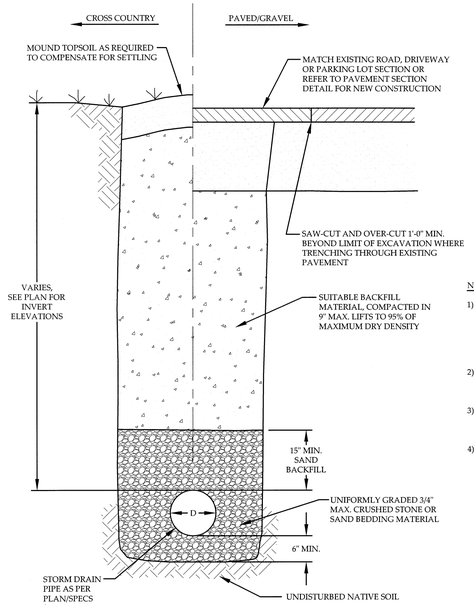
PROJECT NO.....11058
DRAWN BY.....DJL
CHECKED BY.....XXX
SCALE.....1" = 20'
DATE.....07/27/12

SHEET NO.
C-3
3 OF 4 SHEETS



1/C-4 TYPICAL STORM DRAIN / UTILITY SECTION

NOT TO SCALE



NOTES:

1) ALL DISTURBED CROSS-COUNTRY AREAS SHALL BE RESTORED WITH 4" TOPSOIL, SEED, FERTILIZER AND MULCH IN ACCORDANCE WITH THE PROJECT SPECIFICATIONS. THE CONTRACTOR SHALL MAINTAIN EROSION CONTROL, WATER, ETC. UNTIL A VIABLE STAND OF GRASS HAS BEEN ESTABLISHED TO THE SATISFACTION OF THE ENGINEER.

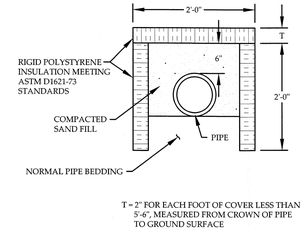
2) THE CONTRACTOR SHALL PROVIDE SHORING OR TAPER SIDES OF ALL TRENCHES DEEPER THAN 4 FT. DURING CONSTRUCTION IN ACCORDANCE WITH V.O.S.H.A. STANDARDS.

3) THE CONTRACTOR SHALL PROVIDE AND COORDINATE ALL NECESSARY TRAFFIC CONTROLS IN ACCORDANCE WITH STATE AND LOCAL REGULATIONS.

4) WHERE TRENCHING IN UNSTABLE SOILS THE TRENCH BOTTOM SHALL BE OVEREXCAVATED AND STABILIZED USING MIRAFI 500X (OR APPROVED EQUIVALENT) GEOTEXTILE FABRIC AND 6" MIN. CRUSHED STONE. WET TRENCHES SHALL BE DEWATERED PRIOR TO INSTALLING BEDDING MATERIAL.

2/C-3 TYPICAL STORM DRAIN TRENCH

NOT TO SCALE



NOTES:

1) INSTALL INSULATION SO AS TO PREVENT GAPS WHERE FROST COULD PENETRATE.

2) CAREFULLY BACKFILL AS NOT TO DAMAGE OR DISPLACE INSULATION. REMOVE AND REPLACE ANY DAMAGED SHEETS.

3/C-4 WATER/SEWER INSULATION DETAIL

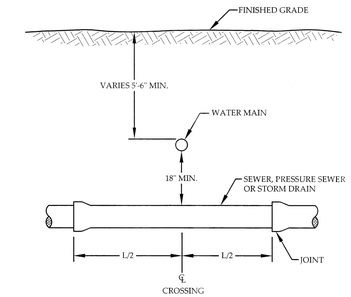
NOT TO SCALE

NOTES:

1) USE FULL LENGTH OF WATER MAIN AND POSITION JOINTS AS FAR FROM SEWER AS POSSIBLE.

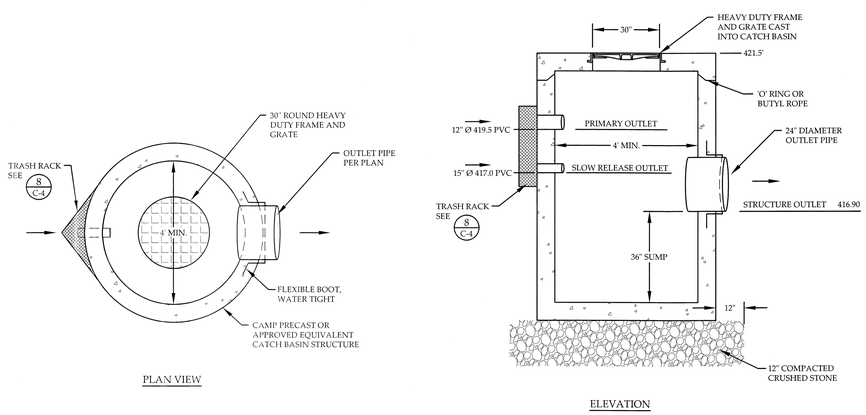
2) IF SEWER IS ABOVE MAIN, MAINTAIN 18" VERTICAL SEPARATION (MINIMUM) AND ENCASE SEWER IN CONCRETE, EXTENDING BEYOND THE FIRST JOINT IN BOTH DIRECTIONS.

3) WHEN IT IS IMPOSSIBLE TO MAINTAIN THE 18" VERTICAL SEPARATION, AND IF APPROVED BY THE ENGINEER, THE SEWER PIPE MUST ALSO BE CONSTRUCTED TO WATER MAIN STANDARDS FOR A MINIMUM DISTANCE OF 20 FEET EITHER SIDE OF THE CROSSING, OR A TOTAL OF THREE PIPE LENGTHS, WHICHEVER IS GREATER. THE SECTION CONSTRUCTED TO WATER MAIN STANDARDS MUST BE PRESSURE TESTED TO MAINTAIN 50 PSI FOR 15 MINUTES WITHOUT LEAKAGE PRIOR TO BACKFILLING BEYOND 1 FOOT ABOVE THE PIPE TO ASSURE WATER TIGHTNESS.



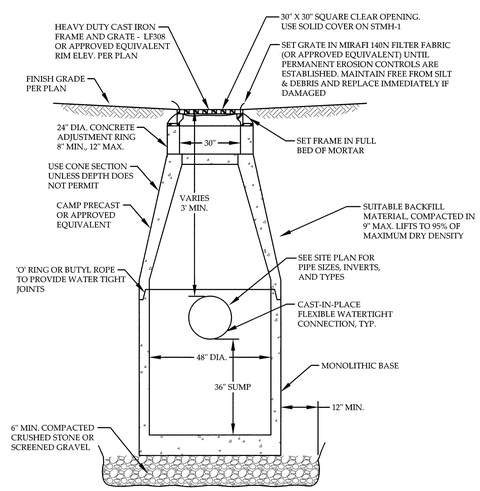
4/C-4 WATER/SEWER DRAIN CROSSING

NOT TO SCALE



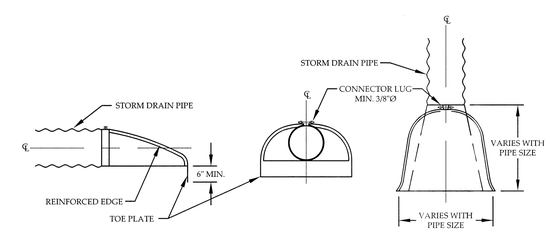
5/C-4 POND OUTLET STRUCTURE

NOT TO SCALE



6/C-4 TYPICAL CATCH BASIN

NOT TO SCALE



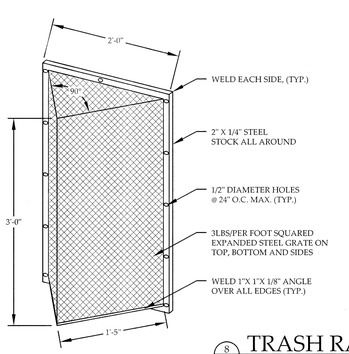
NOTE:

1) FLARED END SECTIONS SHALL BE INSTALLED AT ALL LOCATIONS WHERE STORM PIPING IS DAYLIGHTED EXCEPT WHERE HEADWALLS ARE TO BE CONSTRUCTED AS SHOWN ON THE SITE PLANS.

2) END SECTIONS SHALL BE INSTALLED AS PER MANUFACTURER'S SPECIFICATIONS, SUBJECT TO THE APPROVAL OF THE ENGINEER.

7/C-4 TYPICAL FLARED END SECTION DETAIL

NOT TO SCALE



NOTES:

1) TRASH RACK TO BE CENTERED OVER OPENING.

2) STEEL TO CONFORM TO ASTM A-36.

3) ALL SURFACES TO BE COATED WITH COLD GALVANIZING COMPOUND AFTER WELDING.

4) TRASH RACK TO BE FASTENED TO THE WALL WITH 1/2" MASONRY ANCHORS. TRASH RACK TO BE REMOVABLE.

8/C-4 TRASH RACK

NOT TO SCALE

PRELIMINARY
10/1/2014

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PROJECT NO.....11058
DRAWN BY.....DJL
CHECKED BY.....XXX
SCALE.....AS NOTED
DATE.....07/27/12

SHEET NO.
C-4
4 OF 4 SHEETS