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# ENGLESBY BROOK FLOW RESTORATION PLAN

FINAL REPORT

BURLINGTON, VT

Stone Project ID: 14-171

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## **ACKNOWLEDGEMENTS**

This project was completed by Stone Environmental, Inc., Horsley Witten Group, and Stantec.

## **DISCLAIMER**

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

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## EXECUTIVE SUMMARY

Stone Environmental, Inc., and its partners Horsley Witten Group and Stantec, were retained by the City of Burlington to develop a Flow Restoration Plan (FRP) for Englesby Brook. The FRP was developed in accordance with the MS4 General Permit (3-9014), subpart IV.C.1. The purpose of the FRP is to serve as a planning tool for the MS4 entities in the Englesby Brook watershed (the cities of Burlington and South Burlington, the Vermont Agency of Transportation (VTTrans) and the University of Vermont (UVM)) to implement stormwater Best Management Practices (BMPs) in an effort to return Englesby Brook to its attainment condition.

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

As part of this effort, a comprehensive evaluation of the future growth allocation contained in the TMDL was completed. This is important because the TMDL requires reductions from currently developed areas that are equal to the anticipated future impacts of new impervious surfaces that will not be subject to State of Vermont stormwater permitting requirements (“non-jurisdictional”). Our analysis shows that the TMDL significantly overstates the amount of non-jurisdictional impervious surface that is likely to be constructed over the next fifteen years in the Englesby Brook watershed, and thus the needed reduction in peak flows to achieve the desired flow regime.

A suite of potential BMPs and retrofit projects were identified as part of FRP development which fall into the following categories:

- Retrofits to existing stormwater management practices in the watershed to improve control of high flows;
- Retrofits to sites with expired state-issued stormwater permits;
- New stormwater management practices for sites currently without stormwater controls; and,
- Neighborhood-scale disconnection/green stormwater infrastructure (GSI) retrofit practices to reduce the effective impervious area in specific subwatersheds.

Field forms were prepared for each of the potential BMPs and retrofit projects and presented to the City of Burlington. Retrofits to existing stormwater management practices in the watershed were generally found to be cost-efficient and therefore were prioritized for implementation. These projects, combined with retrofits to sites with expired state-issued permits and a single new, centralized treatment practice on Flynn Avenue adjacent to the planned Champlain Parkway, were assessed with VTBMPDSS and determined to be sufficient to meet the high-flow target. A conceptual engineering design and planning level cost estimate has been prepared for each of these practices. Although the flow reduction possible via additional, new stormwater management practices and neighborhood-scale disconnection were evaluated, planning level cost estimates were not developed. It is anticipated that, as part of the City’s on-going integrated permitting project, neighborhood-scale initiatives may receive further consideration and may ultimately be reprioritized.

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## 1. BACKGROUND

The Englesby Brook watershed is located in Chittenden County, primarily in the City of Burlington with a small portion in the City of South Burlington. Englesby Brook drains an area of approximately 605 acres in the Burlington Bay watershed, flowing from east to west into Lake Champlain. (Figure 1). The entire stream and its tributaries are Class B waters designated as cold water fish habitat pursuant to the Vermont Water Quality Standards (WQS). Land use in the Englesby Brook watershed is 96% developed land and 4% forested.

Englesby Brook was designated as a stormwater-impaired watershed on the 2006 Vermont 303(d) list due to multiple impacts associated with excess stormwater runoff throughout the watershed. The Vermont Department of Environmental Conservation (VT DEC) developed a total maximum daily load (TMDL) for Englesby Brook that was approved by the U.S. Environmental Protection Agency in 2007. The TMDL identifies changes in watershed hydrology – a reduction in stormwater high flows and an increase in baseflow – that are needed to restore water quality.

The TMDL establishes a high flow reduction target (Q0.3) of 34.4% and a low flow augmentation target (Q95) of 11.2% measured at the mouth during the one-year storm event. There is an underlying assumption that a sufficient number of BMPs (and associated storage volumes) can be identified and sited in the watershed to achieve the required flow restoration targets and subsequent aquatic life benefits. VT DEC relies on the VTBMPPDSS model to quantify flows and to evaluate if flow restoration targets are achieved. The flow targets are the basis for development of the flow restoration plan (FRP).

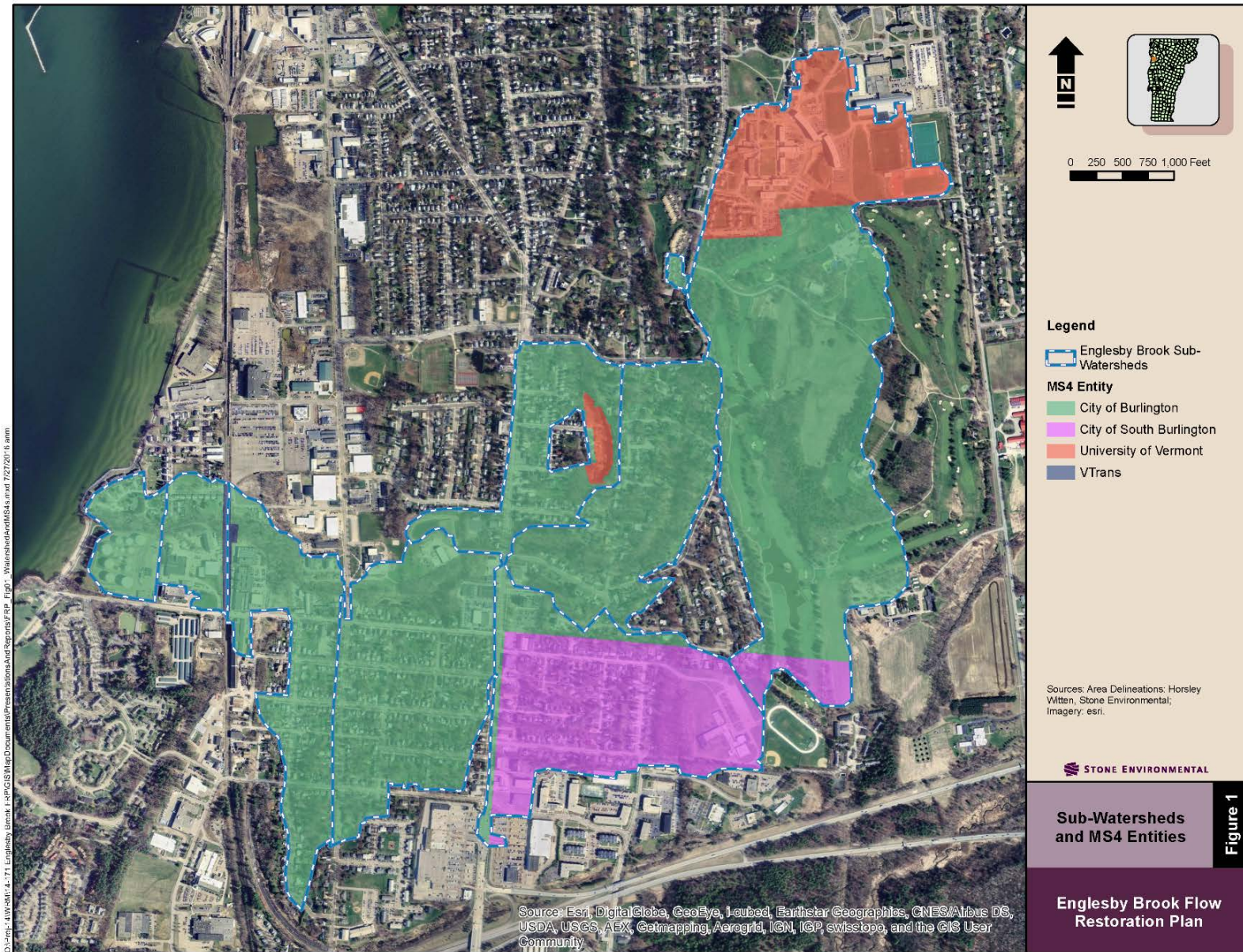
The FRP identifies the scope and scale of the best management practice (BMP) retrofits of existing impervious surface that, when implemented, are projected to meet the flow targets established in the TMDL and ultimately, to attain compliance with the Class B WQS. In addition, the Municipal Separate Storm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

There are four MS4s with impervious cover contributing to stormwater high flows in Englesby Brook – the City of Burlington, the City of South Burlington, the University of Vermont (UVM), and the Vermont Agency of Transportation (VTrans). The relative share of impervious cover in each MS4's portion of the watershed, based on 2003 QuickBird high-resolution satellite imagery, is presented in Table 1, below.

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

Jurisdiction	Total Area (ac)	Impervious Area (ac)	Fraction of Watershed Impervious Area (%)
City of Burlington	431.2	101.6	67.5%
City of South Burlington	83.5	24.8	16.5%
University of Vermont	56.6	22.9	15.2%
VTrans	2.6	1.3	0.8%
<b>TOTAL</b>	<b>573.9</b>	<b>150.6</b>	<b>100.0%</b>

Figure 1. Englesby Brook Watershed Boundaries and MS4 Landholdings



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## 1.1. TMDL Flow Targets

In developing the TMDLs for waters that were determined to be impaired by stormwater runoff, VT DEC chose to use flow as a surrogate. Flow was used as a surrogate because the impacts on streams of increased stormwater flows resulting from urbanization are cumulative and include multiple stressors. Using flow was thought to integrate the effects of multiple stressors, which are all related to stormwater runoff. In general, the basis for the TMDL flow targets was a comparison of modeled flow duration curves (FDCs) between the impaired watershed and attainment watersheds with similar hydrologic characteristics where the WQS are currently met. In the case of Englesby Brook, there are seven attainment streams with similar hydrologic characteristics.

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

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

Flow Target	High Flow ( $Q_{0.3\%}$ ) Reduction Target (%) <sup>1</sup>	Low Flow ( $Q_{95\%}$ ) Increase Target (%) <sup>2</sup>
TMDL Targets	-25.5%	11.2%
TMDL Targets with 20 acres of non-jurisdictional future growth	-34.4%	11.2%

<sup>1</sup> The high flow reduction target is negative (-), indicating there needs to be a reduction in high flow from the baseline condition.

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

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

## 1.2. Future Growth

VT DEC added a future growth allocation to the TMDL flow targets to account for non-jurisdictional (e.g., not subject to state regulation and therefore unlikely to be managed by a BMP) impervious area that could reasonably be estimated to be constructed in the Englesby Brook watershed during the next 10-15 years while the TMDL is implemented. New, non-jurisdictional impervious surfaces are typically created as a part of smaller projects – such as the construction of a single family home – that are not part of a common plan of development and therefore do not rise to the state regulatory threshold of one acre of post-construction impervious cover. The future growth allocation in the TMDL assumes that no local zoning or land use regulations would be in place that require stormwater management for smaller projects. The Englesby Brook TMDL assumes that 20 acres of non-jurisdictional impervious surface will be created.

In order to incorporate the future growth estimate into the flow restoration target, 20 acres was added to the watershed's existing impervious cover to simulate projected watershed conditions when the TMDL is fully implemented. With the projected non-jurisdictional growth of 20 acres of impervious surface, the high flow target reduction was changed by -8.9% and the low flow target was unchanged (Table 2).



As a result, the reduction in peak flows required to account for future growth amounted to more than 25% of the total high flow reduction required. Given this outcome, and existing land use and development patterns in the Englesby Brook watershed, a careful re-examination of the allocation was completed. Each parcel in the watershed was categorized in one of four categories based on the most recent impervious surface data developed by each jurisdiction<sup>1</sup> and stormwater permit information available through the State of Vermont's Environmental Research Tool<sup>2</sup>:

- Parcels less than one acre in area;
- Parcels that are greater than one acre but currently contain less than one acre of impervious surface;
- Parcels that are greater than one acre, currently contain more than one acre of impervious surface, and currently have a state stormwater permit; and
- Parcels that are greater than one acre, currently have more than one acre of impervious surface, but do not have a state stormwater permit.

Roads were not be included in this analysis, consistent with the impervious cover analysis conducted by CCRPC during the development of the TMDL. Parcels covered by an existing state-issued Stormwater Permit were excluded from this analysis, as it was assumed there could be no additional subjurisdictional development on these parcels. A summary of impervious cover by parcel type and by municipality in the Englesby Brook watershed is presented in Table 3, below.

The maximum amount of additional, subjurisdictional impervious area than can be created in the Englesby watershed, given current state regulatory thresholds and current lot coverage maximums contained in local land development regulations, is slightly more than 30 acres. It is highly unlikely that this amount of impervious surface will ever be developed, as it would require every landowner within the watershed to maximize their lot coverage to the limits allowed by zoning. Both the ultimate increase in subjurisdictional impervious cover and the increase predicted during the next 10-15 years would ideally be extrapolated based on the change in the amount of impervious cover in the watershed between 2003 – which served as the base condition when the TMDL was developed – and the 2010/2012 data.

Unfortunately, the impervious cover dataset from 2003 (often referred to as the QuickBird high-resolution satellite imagery), is of such poor quality that it is virtually impossible to make an accurate comparison between the datasets. Therefore, we selected a reasonable annual growth rate using a recent paper from the U.S. Forest Service, which assessed changes in impervious cover over time in 20 cities. In this work, Nowak et al.<sup>3</sup> found that the overall average rate of increase in impervious cover was 0.31% per year. We applied this impervious area growth rate to impervious areas within the Englesby Brook watershed to determine the acreage of non-jurisdictional impervious growth potential using the following equation:

$$\begin{aligned} \text{Non-jurisdictional impervious acres} &= 2010/2012 \text{ impervious acres} * ((1 + \% \text{ change per year})^{\# \text{ years}}) \\ &= 102.79 \text{ acres} * (1 + 0.31)^{15} = 107.67 \text{ acres or } \underline{4.88 \text{ acres increase between 2012 and 2027}} \end{aligned}$$

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<sup>1</sup> Burlington impervious cover dataset produced in 2012; So. Burlington impervious cover dataset produced in 2010

<sup>2</sup> <https://anrweb.vt.gov/DEC/ERT/StormWater.aspx>

<sup>3</sup> Nowak, D.J., and E.J. Greenfield. 2012. Tree and impervious cover change in U.S. cities. Urban For. Urban Green. 11:21-30.

Table 3: Summary of Impervious Cover by Parcel Type in the Englesby Brook Watershed

	Parcel Type	Parcel Count	Current IA (ac)	Maximum Subjurisdictional IA (ac)
Burlington	Less than 1ac	662	50.80	15.54
	>1ac with <1ac IA	23	8.01	5.48
	>1ac with >1ac IA and no SW permit	17	25.58	0.72
	<i>SUBTOTAL</i>	<i>702</i>	<i>84.39</i>	<i>21.74</i>
South Burlington	Less than 1ac	172	8.30	5.57
	>1ac with <1ac IA	8	2.71	2.45
	>1ac with >1ac IA and no SW permit	7	7.40	0.38
	<i>SUBTOTAL</i>	<i>187</i>	<i>18.41</i>	<i>8.40</i>
<b>Watershed-wide TOTAL</b>		<b>889</b>	<b>102.79</b>	<b>30.36</b>

This estimate is conservative because it does not consider whether each parcel could actually add more impervious area given site and/or setback constraints (e.g., only lot coverage was considered). Even with these conservative assumptions, it was estimated that a net increase of 4.88 acres of non-jurisdictional impervious cover could reasonably be expected to be constructed between 2012 and 2027. Reducing the estimated future growth in non-jurisdictional impervious surface to 4.88 acres has a significant impact on the high flow target reduction (see Section 2.3).

In the unlikely event that the 20-acre future growth allocation assigned by VT DEC in the TMDL to account for non-jurisdictional impervious area estimated to be constructed in the Englesby Brook watershed during the next 10-15 years is actually constructed, an estimated additional 28 acres of impervious surface would need to be treated to meet the full high flow target. At five-year intervals during the implementation of this FRP (beginning in 2020 and depending upon the availability of high-quality aerial imagery and/or impervious cover datasets), VT DEC and the MS4s will assess changes in actual non-jurisdictional impervious cover within the Englesby Brook watershed, to determine whether the 4.88-acre projection remains appropriate. If more non-jurisdictional growth is found to be occurring than was projected, additional BMPs may be required to be developed and implemented to meet the high flow target in future years of the design and construction schedule (see Section 3 and Section 4).

The City of Burlington's stormwater ordinance enacted in December 2008 (Chapter 26) provides for comprehensive review of projects in the City at much lower jurisdictional thresholds than required under Vermont's state stormwater regulations. All projects disturbing more than 400 ft<sup>2</sup> of earth require review from the Stormwater Program. Single Family or duplex projects that are disturbing more than 400 ft<sup>2</sup> and where the total amount of impervious is greater than 2500 ft<sup>2</sup> (the average amount of impervious) must manage increased stormwater runoff from any increase in impervious surface to the maximum extent practicable by applying a series of primarily disconnection-based practices and principles. Projects on commercial properties (including triplexes) disturbing more than 400 ft<sup>2</sup> are required to submit both an Erosion Prevention and Sediment Control Plan and Stormwater Management Plan, depending on the size of the project. Commercial projects where impervious cover is being added or redeveloped are required to meet stormwater management requirements for runoff reduction, water quality treatment, and/or water quantity management; with management principles

determined by the watershed the project is located in. Since the City currently regulates site disturbance and impervious cover change at thresholds well below those required by the state, whether through the MS4 permit or through operational stormwater management permitting, the actual increase in non-jurisdictional impervious cover in the Englesby Brook watershed is expected to remain well below even the 4.88-acre revised projection.

## 2. VTBMPDSS MODEL ASSESSMENT

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

### 2.1. Baseline Conditions

The Base Scenario establishes watershed conditions and flows against which the 2007 Englesby Brook TMDL flow restoration targets are applied. The original Base Scenario includes five existing stormwater BMPs (all stormwater ponds) designed prior to the 2002 Vermont Stormwater Management Manual, when only large storms (i.e. 10-year storm events) required flow reduction. In coordination with VT DEC, a revised Base Scenario was created to address the following:

- Minor errors in the VTBMPDSS setup;
- Updated impervious cover datasets. The updated impervious cover layer for the Credit model (see below) was used as a starting point, and then the 2003 QuickBird high-resolution satellite imagery was used to subtract new areas of impervious cover; and
- Slight changes in subwatershed boundaries resulting from new development and refinement of CSO boundaries.

### 2.2. Current (Credit) Conditions

The Credit Scenario represents current conditions and includes changes in the watershed that have occurred since the time of the base scenario's creation. For the original Credit Scenario, VT DEC added one new BMP, the O8 Pond, which was a large storage retrofit that was a priority project identified in the *Englesby Brook Watershed Restoration Project Final Report* (CWP, 2001). In addition, several of the existing ponds in the north east corner of the watershed – owned and operated by the University of Vermont and the Burlington Country Club – had been retrofitted since baseline conditions were established. VT DEC also increased impervious cover in the watershed by 4.2 acres and changed subwatershed boundaries from the Base Scenario.

In coordination with VT DEC, a revised Credit Scenario was created to account for the following:

- Minor errors in the VTBMPDSS setup;

- Updated impervious cover datasets. The latest impervious cover layer from Burlington and South Burlington was used as a starting point, and then the 2013 (circa) imagery was used to add missing areas of impervious cover;
- Removal of the O8 Pond regulator #1;
- Corrected subwatershed boundaries (described above);
- Addition of three BMPs (M7/M8/M9) to represent the forebay and two west ponds for the SM06 retrofit from the Watershed Plan, which provided water quality treatment but little flow reduction capacity; and
- Addition of three newly constructed BMPs, brought on-line as part of new development or redevelopment projects.

Under the Credit Scenario there are ten BMPs used to manage stormwater within the Englesby Brook watershed; these BMPs are discussed in more detail in Section 3 of this report. Not all of these BMPs, however, are able to meet current (2002) stormwater standards for controlling high flows and thus provide the same level of support in terms of achieving the goals of the FRP. Assuming responsibility for the high flow allocation should be apportioned based on impervious area, it is possible to estimate the current amount of high flow treatment credit toward to the TMDL that should be assigned to each MS4 based on the amount of impervious area in each MS4 being treated by BMPs which provide high flow treatment. The high flow treatment credit is the MS4’s high flow allocation multiplied by the proportion of the MS4’s impervious area currently receiving high flow treatment (impervious acres within the MS4 treated by the BMP / MS4 impervious acres), and is summarized in Table 4 below.

Table 4: Remaining Untreated High Flow Allocation, by MS4

MS4 Entity	Allocation (%)	High Flow Treatment Credit (%)	High Flow Allocation Remaining Untreated (%)
Burlington	18.7	-4.5	14.2
South Burlington	4.6	-4.1	0.5
UVM	4.2	-7.5	-
VTrans	0.3	-	0.3
<b>TOTAL</b>	<b>27.7</b>	<b>-15.7</b>	<b>14.7</b>

It should be noted that UVM’s facilities currently generate more high flow treatment credit (-7.5%) than their allocation (-4.2%) requires. This excess treatment credit has NOT been assigned to another MS4 for the purpose of this summary.

### 2.3. Future (Restoration) Condition

The Flow Restoration Scenario represents the retrofits needed to sufficiently manage high flows in order to achieve the flow restoration target in the TMDL. In addition, as discussed in Section 1.2, the future growth allocation was revisited and a more reasonable assumption about potential growth in non-jurisdictional impervious surfaces was established. In preparing this FRP, a number of restoration scenarios were modeled to evaluate the efficacy of 28 stormwater retrofit opportunities that were identified in the field, as well as a number of neighborhood-scale impervious disconnection options. These retrofit opportunities are discussed

## Identification of Required Controls / 3

further in Section 3, and field forms for each opportunity are included as Appendix A of this report. After an initial evaluation of BMP performance and discussions with the City of Burlington on BMP implementation feasibility, a preferred flow restoration scenario was selected that meets the revised TMDL high flow reduction target. The restoration scenario includes an upgrade to the existing O8 Pond, a retrofit in the vicinity of the proposed Champlain Parkway, and three retrofits at sites where the current stormwater permits have expired. Taken together these adjustments to the VTBMPSDSS base scenario resulted in updated flow restoration targets and the flow restoration scenario results presented in Table 5, below. VTBMPSDSS model files for the Flow Restoration Scenario were provided to VT DEC for review and comment; the summary presented below incorporates feedback from VT DEC on the modeling of the BMPs.

Table 5: Summary of Modeling Scenarios.

	Model Scenario	Purpose	High Flow (Q <sub>0.3%</sub> ) Target		Conclusion
			(cfs)	% reduction	
Original Base Scenario	Five pre-2002 BMPs	These flows are the baseline from which restoration/treatment is measured	20.9	-	Successfully replicated VT DEC's model.
Revised Base Scenario	Original Base with corrections and updated IA	Allow for more accurate comparison with restoration scenarios.	25.6	-	New baseline to measure achieved flow reductions.
Original Credit Scenario	Original Base + new O8-Pond; updated IA and subwatersheds	What is the change in baseline flow given current conditions?	19.2	8.0	Successfully replicated VT DEC's model.
Revised Credit Scenario	Original Credit with corrections + SM6 retrofit + new BMPs; revised IA and subwatersheds	Update to today's existing conditions.	21.6	15.7	Corrections result in higher flow reductions than VT DEC's original prediction.
Flow Restoration Scenario	Revised Credit + retrofit of O8-Pond + Champlain Pkwy retrofit + retrofit of 4 BMPs in need of permit renewal	What is the max. flow reduction achievable with implementation of most feasible retrofits?	18.5	27.7	Meets the revised TMDL target, assuming 4.88 acres of future growth. Some BMPs have greater than 12-hr detention times.

### 3. IDENTIFICATION OF REQUIRED CONTROLS

In 2015, field studies were performed throughout the Englesby Brook watershed to identify and assess existing BMPs that were candidates for retrofits, view newly constructed BMPs that needed to be included in the Credit Scenario, and evaluate potential locations for new BMPs. A comprehensive list of all of the BMPs considered in developing the Englesby Brook FRP is presented in Table 6 and Figure 2. The table lists the candidate BMP sites, provides general information about each BMP, and highlights practices that were ultimately included as part of the Flow Restoration Scenario. Because the ultimate goal of the Englesby Brook FRP is flow control, all new BMPs were modeled as dry basins in order to maximize the amount of storage that could be achieved within a given footprint. More detailed information for each BMP site is provided in Appendix A.

## Identification of Required Controls / 3

Table 6: Summary of BMPs Considered in Developing Englesby Brook FRP.

Model ID	Permit ID	Model Run	Location / Description	Address	Practice
M1		Base	BCC Lower Pond		Wet basin
M2		Base	BCC Upper Pond 2		Wet basin
M3		Base	BCC Upper Pond 1		Wet basin
M4	3753-INDS	Base	Catamount Lower Pond	UVM	Wet basin
M5	3753-INDS	Base	Catamount Upper Pond	UVM	Wet basin
M6		Credit	O8 Pond	Champlain School	Wet basin
M7, M8, M9		Credit	SM6		Treatment wetland
M10		FRP	O8 Pond retrofit		Retrofit existing wet basin
M11			SM6 retrofit		Retrofit existing wetland w/ underground storage
M12	6298-9030		Harbor Watch retrofit		Dry basin
M13	3-1239 (w/w)	Base	Tank Farm	38 Flynn Ave	Dry basin
M14	6308-9030		Switchback et al	160 Flynn Ave	Underground storage
M15	6290-9030 & 6315-9030		208 Flynn Ave, west edge of parcel	208 Flynn Ave	Swale
M16	6290-9030 & 6315-9030		208 Flynn Ave, north end of parking lot	208 Flynn Ave	Underground storage
M17		FRP	Green space between CP alignment and parking lot	288 Flynn Ave	Dry basin
M18	1-1087	FRP	Flynn Ave Co-Op retrofit	288 Flynn Ave	Dry basin
M19	1-0337	FRP	Pine Street Counseling Center retrofit	300 Flynn Ave	Dry basin
M20			Pine Street Deli	316 Flynn Ave	Wet basin
M21			Burlington Subaru		Underground storage
M22			Rice High School		Dry basin
M23			Harrison Ave	Harrison Ave, near Central Ave	Detention basin + swale
M24			Sears Lane	Sears Lane	unsuitable
M25	2-0789	FRP	Overlake Condos retrofit		Dry basin
M26			Champlain Parkway – Englesby Brook	208 Flynn Ave	Gravel wetland
M27	6145-INDS	Credit	Hickok & Boardman (H&B)	346 Shelburne Rd	Swale/wet pond /infiltration chamber
M28			Walgreens	514 Farrell St	Underground storage
M29		FRP	Champlain Co-op	810 Pine St	Underground storage
M30		Credit	Pizzigalli Properties	462 Shelburne Rd	Permeable pavement
M31		Credit	847 Pine St. redevelopment	847 Pine St.	Bioretention

### Identification of Required Controls / 3

Model ID	Permit ID	Model Run	Location / Description	Address	Practice
M32	6756-INDS		Route 7 roundabout	Rte 7-S. Willard St.	Underground storage
M33	2-0999		Champlain Apartments	817 Pine St	Underground storage, combined with M29
M34	2-1052		Crescent Terrace		unsuitable

Each site was reviewed to determine its ability to site a BMP capable of meeting the  $CP_v$  criteria of the 2002 Vermont Stormwater Management Manual. The  $CP_v$  criteria was utilized as part of the FRP evaluation, since the 1-year, 24-hour storm event is a close approximation to the storm event associated with the  $Q_{0.3\%}$  flow. The  $CP_v$  criteria requires 12 hours of detention for cold water fish habitats, such as Englesby Brook. Several sites were constrained such that they were found to be unsuitable for meeting this criterion, and were therefore not considered further.

The suite of BMPs ultimately included in the Flow Restoration Scenario is summarized in Table 7, including an estimated drainage area and impervious area managed through each practice, as well as the modeled impact the practice has on attainment of the high flow target. A visual summary of the areas in the watershed receiving treatment is offered in Figure 3, with grey indicating the portion of the watershed draining to a flow BMP. While some field work was performed as part of identifying these candidate sites, no detailed hydrologic analysis, property research, engineering, or other studies were performed, and thus unidentified constraints may exist that prevent certain sites from being utilized in the FRP.

In addition to the site-specific controls identified in developing the FRP, neighborhood-scale disconnection efforts were also considered. In general, it was assumed that 50% of the currently directly connected impervious areas could be disconnected. The disconnection efforts were found to have varying degrees of impact on high flow conditions at the watershed outlet and will likely be considered further at part of the City of Burlington's on-going integrated planning project.

Figure 2. Locations and Drainage Areas of BMPs Considered in Developing Englesby Brook FRP

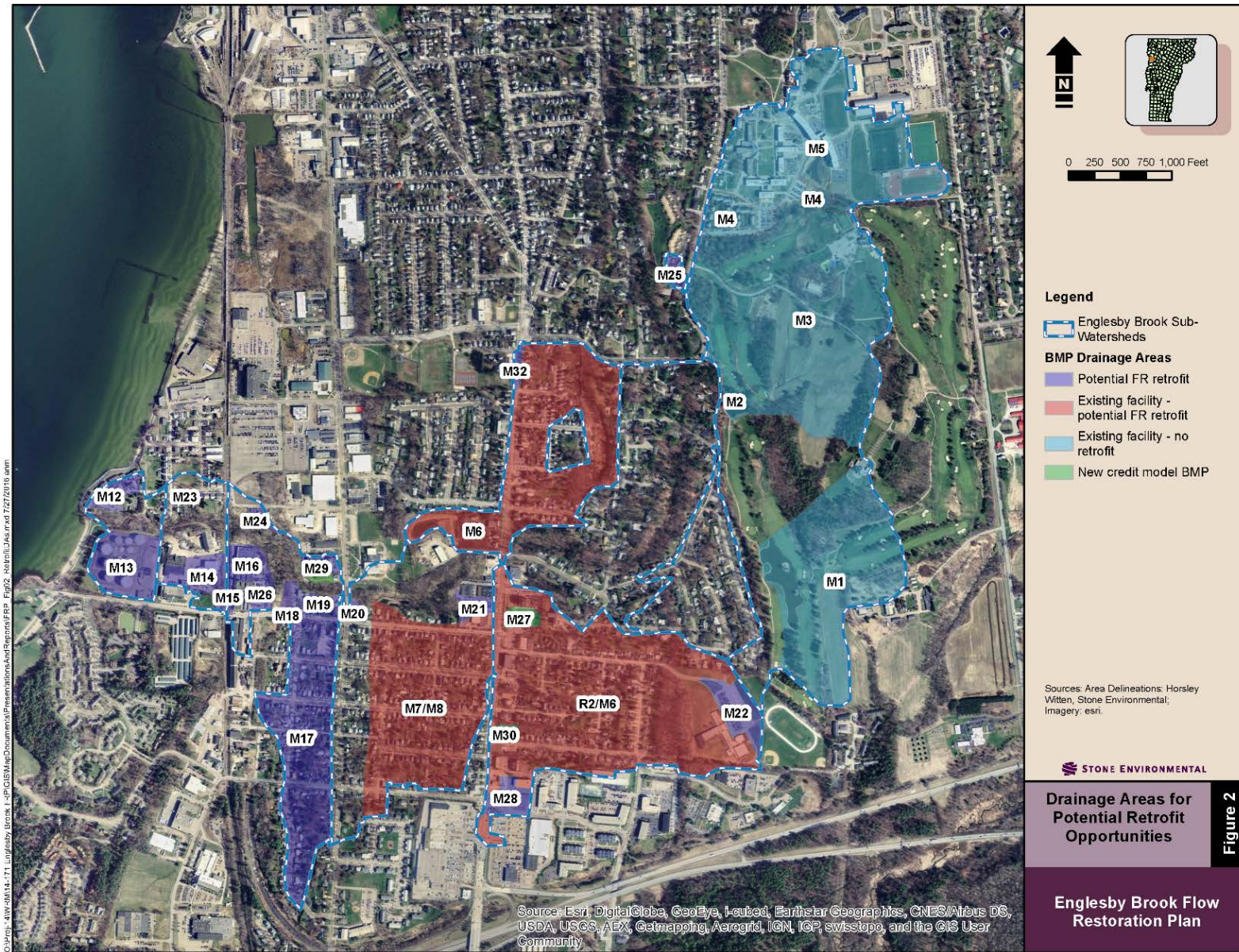




Table 7: Summary of BMPs Included in Englesby Brook Flow Restoration Scenario.

Site ID	Site Name	BMP Type	Model Scenario	DA (ac)	IA (ac)	% Difference in Q03 <sup>1</sup>		Detention Time <sup>4</sup> (min)
						BMP <sup>2</sup>	Water-shed <sup>3</sup>	
M1	BCC Lower Pond	Wet Basin	Base/ Credit	43.40	1.28	-6.7	-3.0	997
M2	BCC Upper Pond 2	Wet Basin	Base/ Credit	9.34	0.54	-0.2	0.7	33
M3	BCC Upper Pond 1	Wet Basin	Base/ Credit	67.94	5.60	-0.1	0.0	17
M4	Catamount Lower Pond	Wet Basin	Base/ Credit	7.46	3.36	-37.5	-1.6	517
M5	Catamount Upper Pond	Wet Basin	Base/ Credit	45.23	20.61	-46.3	-8.5	843
M6B (M10)	Englesby 08 Pond Retrofit	Wet Basin	Credit/FRP	129.76	48.55	-63.4	-36.9	721
M7/M8/M9	Englesby SM6 Ponds	Forebay/ 2 Wet Basins	Credit	44.09	19.52	3.5	0.05	47
M17	288 Flynn Ave/ Champlain Pkwy	Dry Basin	FRP	30.77	13.07	-49.4	-5.1	763
M18	208 Flynn Ave Coop	Dry Basin	FRP	0.42	0.30	-66.7	0.0	758
M19	Pine St. Counseling Ctr.	Dry Basin	FRP	0.80	0.48	-50.0	-0.1	704
M25	Overlake Condos	Dry Basin	FRP	1.19	0.73	-62.5	-0.8	647
V27/M27A/ M27B	Hickok & Boardman	Swale/Wet Pond/Infil. Chamber	Credit	1.29	0.92	-100.0	-0.9	55
M29	Champlain Co-op	Dry Basin	FRP	1.59	1.09	-57.1	-0.6	847
M30	Pizzagalli Properties	Permeable Pavement	Credit	0.64	0.58	-100.0	-0.3	360
M31	847 Pine St.	Dry Basin	Credit	0.45	0.23	-100.0	-0.1	101

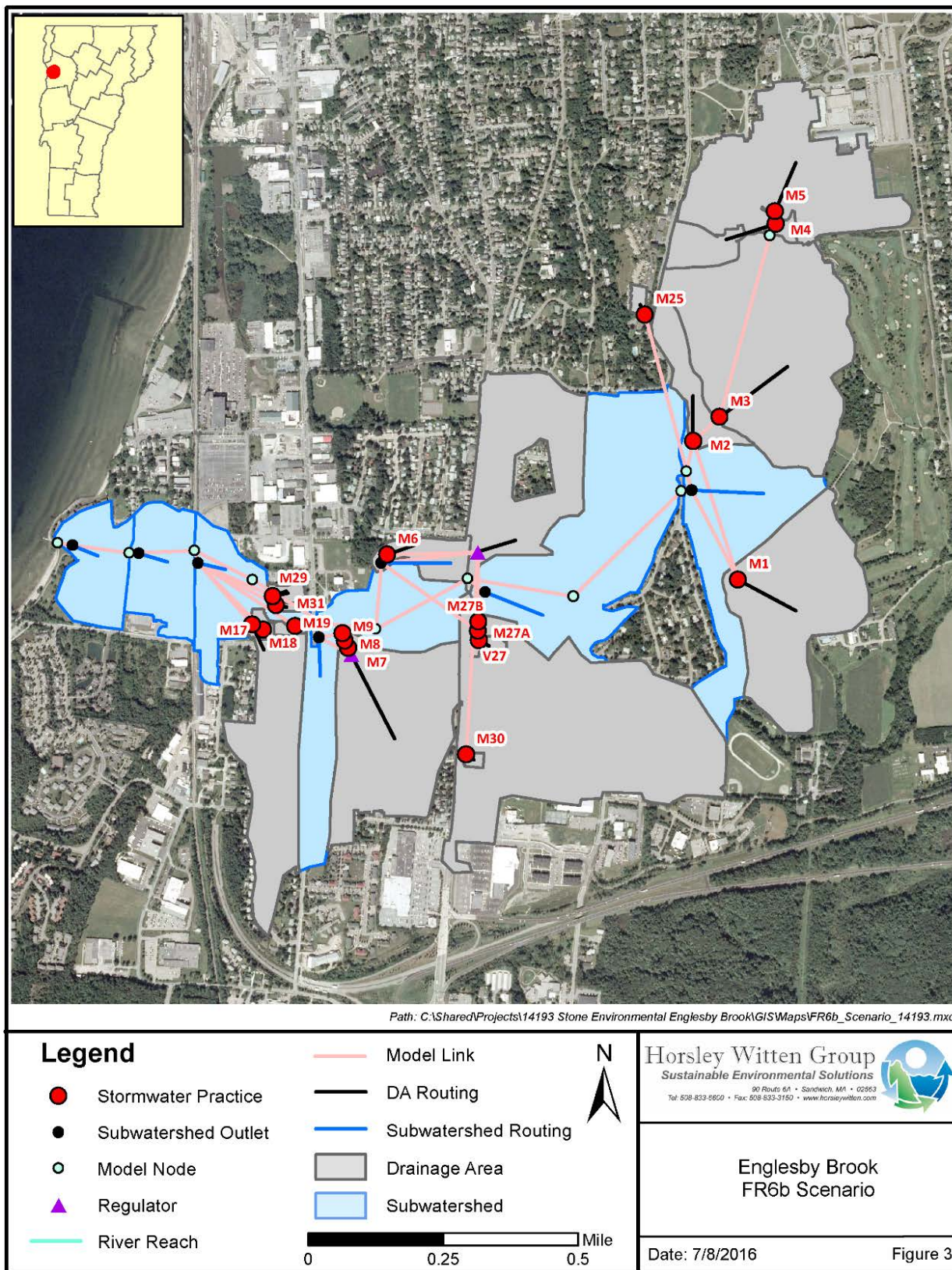
<sup>1</sup> Percent difference in high flows is negative when showing a reduction. The model was run with all BMPs turned on and then with individual BMPs turned off, one at a time, to quantify differences in flow and relative performance.

<sup>2</sup> Differences at each BMP were determined by comparing the inflows and outflows in the BMP. 100% represents no surface discharge; BMPs with less than 50% at the BMP outlet could be opportunities to enhance performance.

<sup>3</sup> Differences in flow at the watershed outlet are intended as a relative comparison of BMP effectiveness, but are not absolute or additive. Individual BMP values do not add up to corresponding total watershed reductions due to other losses in the system.

<sup>4</sup> Detention times are restricted to ~12 hrs (720 mins) per cold water fisheries requirements.

Figure 3: Englesby Brook Watershed Areas Receiving Treatment in the Flow Restoration Scenario



## 4. DESIGN AND CONSTRUCTION SCHEDULE

The 2012 MS4 permit requires that this FRP include a design and construction schedule for the stormwater BMPs that have “been identified by the permittee[s] as necessary to achieve the flow restoration targets.” The schedule must provide for implementation of the BMPs as soon as possible, but no later than 20 years from the effective date of MS4 permit, which is December 5, 2012—meaning that the BMPs must be implemented by the end of 2032 (Appendix E). The BMPs included in this FRP will, at a minimum, require permitting and design work prior to construction, and will have varying costs. In addition, and as discussed in more detail in Section 6, an undetermined level of effort will be required to support expired permit holders in implementing necessary upgrades to their systems and obtaining current permit coverage.

Implementation of the BMPs included in the Flow Restoration Scenario will fall largely to the City of Burlington. Flow restoration efforts are one of several Clean Water Act obligations, including the Lake Champlain Phosphorus TMDL, similar Flow Restoration efforts in Centennial and Potash Brooks, the Englesby Brook Bacteria TMDL, and improvements to the City’s combined sewer system.

The City is actively engaged in developing an integrated plan, and anticipates this plan will have broad implications for the prioritization and timing of flow restoration projects in the context of the full suite of the City’s Clean Water Act obligations. As such, it is anticipated that implementation of the Flow Restoration Scenario BMPs will be initiated within three years from receipt of approval of this FRP from VT DEC. Development of the full design and construction will, by necessity, follow completion of the integrated plan in 2018.

## 5. FINANCIAL PLAN

The 2012 MS4 permit also requires that this FRP include a financing plan that estimates the costs for implementing the FRP and describes a strategy for financing the FRP. A conceptual design, showing the location and layout for each BMP included in the Flow Restoration Scenario is included in Appendix C. Itemized cost estimates were developed for the top two priority projects, as discussed in Section 5.1 below. For the other BMPs included in the Flow Restoration Scenario – retrofits for sites with expired permits – a modified spreadsheet method was used to develop cost estimates, as detailed in Section 5.2.

### 5.1. Itemized Cost Estimates

An engineer’s opinion of probable cost estimate was developed for the two highest priority projects – the retrofit of the O8 Pond (M10) and the centralized treatment area bordered by Flynn Ave, 288 Flynn Ave, and the future location of the Champlain Parkway (M17). The cost estimate includes an itemized list of materials as well as final design and construction engineering costs in 2016 dollars. The cost estimates are summarized in Table 8, below, and presented in full in Appendix D.

Table 8: Proposed Priority BMP Cost Estimates.

BMP ID	Site Name	Storage Volume (cf)	Total Cost (\$)	Impervious Area (ac)	Cost per Impervious Acre
M10	O8 Pond retrofit <sup>1</sup>	136,061	\$360,850	48.55	\$7,433
M17	288 Flynn Ave/ Champlain Pkwy	74,201	\$385,500	13.07	\$29,495
<b>TOTAL</b>			<b>\$746,350</b>	<b>61.62</b>	

<sup>1</sup> This is an expansion of an existing practice which increases available storage and optimizes detention; costs reflect only the incremental cost of the retrofit.

## 5.2. Spreadsheet Cost Estimates

Estimating costs for implementing BMP retrofits for sites with expired permits utilized a somewhat less robust approach. Cost estimates were calculated as a base construction cost plus a 30% contingency factor for final design and permitting. The base cost was estimated on a unit cost basis, using a specified design volume (cu. ft.) multiplied by a unit cost (\$/cu. ft.). Unit costs were calculated based on the memorandum from Tetra Tech, Inc. dated October 30, 2007. These rates use a 2000 base year and have been updated to account for inflation to the year 2016, using a 2.5% inflation rate. The costs are calculated based on the following equation:

$$\text{total cost} = \text{installation cost (I)} + \text{land cost (L)} + \text{fixed cost (F)}$$

Where:

I = \$6/cf of infiltration, inflated at 2.5% to year 2016 = \$8.70/cf

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

F = design/permitting costs (30% of I)

The anticipated costs associated with implementing the expired permit BMP retrofits, as identified in Table 7 as part of the Flow Restoration Scenario, are presented below in Table 9. Although all of these projects would be located on private land, no cost has been assigned for land acquisition.

Table 9: Proposed Expired Permit BMP Retrofit Cost Estimates.

BMP ID	Site Name	Treatment Volume (cf)	I (\$)	F (\$)	Total Cost (\$)	Impervious Area (ac)	Cost per Impervious Acre
M18	208 Flynn Ave Coop	1,370	\$11,919	\$3,576	\$15,495	0.30	\$51,649
M19	Pine St Counseling Ctr	2,349	\$20,436	\$6,131	\$26,567	0.48	\$55,348
M25	Overlake Condos	3,537	\$30,772	\$9,232	\$40,004	0.73	\$54,799
M29	Champlain Co-op <sup>1</sup>	5,089	\$55,343	\$16,603	\$71,946	1.09	\$66,005
<b>TOTAL</b>					<b>\$154,011</b>	<b>2.60</b>	

<sup>1</sup> Any BMP at this location will likely need to be subsurface, and therefore the assumed unit cost per cf treated was increased by 25%.

## 6. REGULATORY ANALYSIS

As part of this plan, retrofits are being proposed on sites tied to expired State operational stormwater permits. A field assessment of each of the five systems in the Englesby Brook watershed with expired stormwater permits has been completed, and is included as Appendix B; all five systems are located within the City of Burlington. The expired permits were written broadly with few enforceable items and typically focus on curb-and-gutter system elements, including catch basins. Ultimately, the permit holders will either have to have their permit adopted under the MS4 permit, or to request coverage under a Residual Designation Authority (RDA) permit from the State. The decision as to how the responsibility for the proposed retrofit projects on private land are covered in the future will be subject to discussion and agreement with the private landowners and the City of Burlington.

Table 5 indicates that only BMPs on properties with expired permits and two other retrofits (the retrofit of O8 and the retrofit related to the Champlain Parkway) are required to meet the flow targets (with the revised future growth analysis). The M29 (Champlain Co-op) BMP listed in Table 6 as being part of the FR model run appears to be in conflict with this statement. This retrofit was originally conceived as a dry basin in combination with underground storage at M33 (Champlain Apartments), which does have an expired operational permit. Responsibility for implementation for M29/M33 will be shared between the private landowner and the City of Burlington—or, if only M29 is ultimately implemented, that responsibility will fall to the City.

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## APPENDICES

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## APPENDIX A: CONSIDERED FLOW REDUCTION BMPS

**ID#: M10**

**Name:** O8 Pond retrofit

**Concept Description:**  
Expand the existing pond to the east toward the forebay and raise permanent pool to create additional storage volume and extend detention.

**Notes/Feasibility:**  
Existing pond is lined, so it will be slightly more complicated than simply digging



GENERAL SITE INFORMATION	RETROFIT DETAILS
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<b>Site Contact Info:</b>	<b>Project Candidate:</b> 1 <sup>st</sup> tier
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<b>Ownership:</b>	<b>Retrofit of new or existing BMP:</b> retrofit
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<b>Land Use Type:</b>	<b>Proposed Retrofit Practice 1:</b> expand existing facility
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<b>Land Use Detail:</b>	<b>Proposed Retrofit Practice 2:</b>
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<b>Existing BMP on Site?</b> Y	<b>Non-Structural Controls:</b>
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<b>Is site a hotspot?</b> N	<b>Non-Structural Other:</b>
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<b>Sources/pollutants:</b>	<b>Maintenance Burden:</b> moderate, but existing
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<b>Soils:</b>	<b>Benefits:</b>	<b>Conflicts:</b>
	Storage: Y	Soils:
	Water Quality: Y	Access:
	Recharge: N	Land Use:
	Demonstration: N	Utilities:
	Repair: Y	Polluted:
	Reuse: N	High WT:
		Wetlands:
		<b>Other:</b>

**SIZING INFORMATION**

<b>Drainage Area (ac):</b>	131.50
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<b>Impervious Area (ac):</b>	49.97
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<b>Practice Area Available (ft<sup>2</sup>):</b>	
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<b>Existing Head Available?</b> Y	
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**ID#: M11**

**Name:** SM6 retrofit

**Concept Description:**  
 Modify existing treatment wetland system to provide detention storage in addition to water quality functions.

**Notes/Feasibility:**  
 Limited available space for additional storage without relocating stream channel; concept would result in some loss of WQ function.



GENERAL SITE INFORMATION	RETROFIT DETAILS
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<b>Site Contact Info:</b>	<b>Project Candidate:</b> N
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<b>Ownership:</b>	<b>Retrofit of new or existing BMP:</b>
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<b>Land Use Type:</b>	<b>Proposed Retrofit Practice 1:</b>
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<b>Land Use Detail:</b>	<b>Proposed Retrofit Practice 2:</b>
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<b>Existing BMP on Site?</b>	<b>Non-Structural Controls:</b>
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<b>Is site a hotspot?</b>	<b>Non-Structural Other:</b>
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<b>Sources/pollutants:</b>	<b>Maintenance Burden:</b>
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<b>Soils:</b>	<b>Benefits:</b> Storage: Water Quality: Recharge: Demonstration: Repair: Reuse:	<b>Conflicts:</b> Soils: Access: Land Use: Utilities: Polluted: High WT: Wetlands:
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SIZING INFORMATION		
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<b>Drainage Area (ac):</b>	<b>Other:</b>	<b>Other:</b>
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<b>Impervious Area (ac):</b>		
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<b>Practice Area Available (ft<sup>2</sup>):</b>		
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<b>Existing Head Available?</b>		
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**Date:**

**Assessed by:**

ID#: M12																			
<b>Name:</b> Harbor Watch																			
<b>Concept Description:</b> Following EFA, runoff from a portion of the parking lot is diverted using speed bump to existing green space where it flows overland to the storm sewer system. Detention area could be constructed in green space to control peak flows; additional impervious areas (roofs and parking) could be redirected to improved stormwater practice.																			
<b>Notes/Feasibility:</b> Existing practice has limited effectiveness.																			
<b>GENERAL SITE INFORMATION</b>	<b>RETROFIT DETAILS</b>																		
<b>Site Contact Info:</b>	<b>Project Candidate:</b> 2 <sup>nd</sup> tier																		
<b>Ownership:</b>	<b>Retrofit of new or existing BMP:</b> Retrofit																		
<b>Land Use Type:</b>	<b>Proposed Retrofit Practice 1:</b> Bioretention																		
<b>Land Use Detail:</b>	<b>Proposed Retrofit Practice 2:</b> Dry basin																		
<b>Existing BMP on Site?</b>	<b>Non-Structural Controls:</b>																		
<b>Is site a hotspot?</b>	<b>Non-Structural Other:</b>																		
<b>Sources/pollutants:</b>	<b>Maintenance Burden:</b> Moderate																		
<b>Soils:</b>	<table border="0" style="width: 100%;"> <tr> <td style="width: 50%;"><b>Benefits:</b></td> <td style="width: 50%;"><b>Conflicts:</b></td> </tr> <tr> <td>Storage: Y</td> <td>Soils:</td> </tr> <tr> <td>Water Quality: Y</td> <td>Access:</td> </tr> <tr> <td>Recharge: Y</td> <td>Land Use:</td> </tr> <tr> <td>Demonstration: N</td> <td>Utilities:</td> </tr> <tr> <td>Repair: N</td> <td>Polluted:</td> </tr> <tr> <td>Reuse: N</td> <td>High WT:</td> </tr> <tr> <td></td> <td>Wetlands:</td> </tr> <tr> <td><b>Other:</b></td> <td><b>Other:</b></td> </tr> </table>	<b>Benefits:</b>	<b>Conflicts:</b>	Storage: Y	Soils:	Water Quality: Y	Access:	Recharge: Y	Land Use:	Demonstration: N	Utilities:	Repair: N	Polluted:	Reuse: N	High WT:		Wetlands:	<b>Other:</b>	<b>Other:</b>
<b>Benefits:</b>	<b>Conflicts:</b>																		
Storage: Y	Soils:																		
Water Quality: Y	Access:																		
Recharge: Y	Land Use:																		
Demonstration: N	Utilities:																		
Repair: N	Polluted:																		
Reuse: N	High WT:																		
	Wetlands:																		
<b>Other:</b>	<b>Other:</b>																		
<b>Use in Retrofit DA:</b> N																			
<b>SIZING INFORMATION</b>																			
<b>Drainage Area (ac):</b> 2.30																			
<b>Impervious Area (ac):</b> 1.70																			
<b>Practice Area Available (ft<sup>2</sup>):</b> 6,970																			
<b>Existing Head Available?</b> Y																			

Date: 04/10/15

Assessed by: JSM

**ID#: M13**

**Name:** Tank Farm

**Concept Description:**  
None.

**Notes/Feasibility:**  
Existing w/w permit (3-1239) requires that storm flows are controlled such that "it does not exceed 100 gallons per minute". VTBMPPSS was modified to reflect this level of control.



GENERAL SITE INFORMATION	RETROFIT DETAILS
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**Site Contact Info:**

**Project Candidate:** N

**Ownership:**

**Retrofit of new or existing BMP:**

**Land Use Type:**

**Proposed Retrofit Practice 1:**

**Land Use Detail:**

**Proposed Retrofit Practice 2:**

**Existing BMP on Site?**

**Non-Structural Controls:**

**Is site a hotspot?**

**Non-Structural Other:**

**Sources/pollutants:**

**Maintenance Burden:**

**Soils:**

<b>Benefits:</b>	<b>Conflicts:</b>
Storage: Y	Soils:
Water Quality: N	Access:
Recharge: N	Land Use:
Demonstration: N	Utilities:
Repair: N	Polluted:
Reuse: N	High WT:
	Wetlands:
<b>Other:</b>	<b>Other:</b>

**Use in Retrofit DA:** Added to base model

**SIZING INFORMATION**

**Drainage Area (ac):** 8.76

**Impervious Area (ac):** 8.67

**Practice Area Available (ft²):** 10,890

**Existing Head Available?** Y

<b>ID#: M14</b>																			
<b>Name:</b> 160 Flynn Ave																			
<b>Concept Description:</b> Infrastructure maps shows two outfalls at the northwest corner of the property draining. The one slightly to the east receives stormwater from the back parking lot (shown in photo) and roof drains from the building currently occupied by Booska Movers, approximately 6.1 acres of impervious. Outfall was NOT located during initial field work.  Concept includes constructing underground storage in the parking lot. It may be possible to also capture stormwater being carried in 12" VCP line immediately to the west.																			
<b>Notes/Feasibility:</b> Feasible, but constraints including actual use of area by existing owner/tenant need to be more fully understood																			
<b>GENERAL SITE INFORMATION</b>		<b>RETROFIT DETAILS</b>																	
<b>Site Contact Info:</b>	<b>Project Candidate:</b> Y																		
<b>Ownership:</b> private	<b>Retrofit of new or existing BMP:</b> New BMP																		
<b>Land Use Type:</b> Commercial/industrial	<b>Proposed Retrofit Practice 1:</b> Underground storage																		
<b>Land Use Detail:</b>	<b>Proposed Retrofit Practice 2:</b> Dry pond																		
<b>Existing BMP on Site?</b> no	<b>Non-Structural Controls:</b> none																		
<b>Is site a hotspot?</b> no	<b>Non-Structural Other:</b> none																		
<b>Sources/pollutants:</b>	<b>Maintenance Burden:</b>																		
<b>Soils:</b> Silt loam, poorly drained	<table border="0"> <tr> <td><b>Benefits:</b></td> <td><b>Conflicts:</b></td> </tr> <tr> <td>Storage: Yes</td> <td>Soils: No</td> </tr> <tr> <td>Water Quality: Yes</td> <td>Access: Maybe</td> </tr> <tr> <td>Recharge: ?</td> <td>Land Use: Maybe</td> </tr> <tr> <td>Demonstration: No</td> <td>Utilities: No</td> </tr> <tr> <td>Repair: Yes</td> <td>Polluted: Maybe</td> </tr> <tr> <td>Reuse: No</td> <td>High WT: No</td> </tr> <tr> <td></td> <td>Wetlands: No</td> </tr> <tr> <td><b>Other:</b></td> <td><b>Other:</b></td> </tr> </table>	<b>Benefits:</b>	<b>Conflicts:</b>	Storage: Yes	Soils: No	Water Quality: Yes	Access: Maybe	Recharge: ?	Land Use: Maybe	Demonstration: No	Utilities: No	Repair: Yes	Polluted: Maybe	Reuse: No	High WT: No		Wetlands: No	<b>Other:</b>	<b>Other:</b>
<b>Benefits:</b>	<b>Conflicts:</b>																		
Storage: Yes	Soils: No																		
Water Quality: Yes	Access: Maybe																		
Recharge: ?	Land Use: Maybe																		
Demonstration: No	Utilities: No																		
Repair: Yes	Polluted: Maybe																		
Reuse: No	High WT: No																		
	Wetlands: No																		
<b>Other:</b>	<b>Other:</b>																		
<b>Use in Retrofit DA:</b>																			
<b>SIZING INFORMATION</b>																			
<b>Drainage Area (ac):</b> 6.1																			
<b>Impervious Area (ac):</b> 4.21																			
<b>Practice Area Available (ft<sup>2</sup>):</b> 13,000																			
<b>Existing Head Available?</b> Y																			

Date: 04/10/15

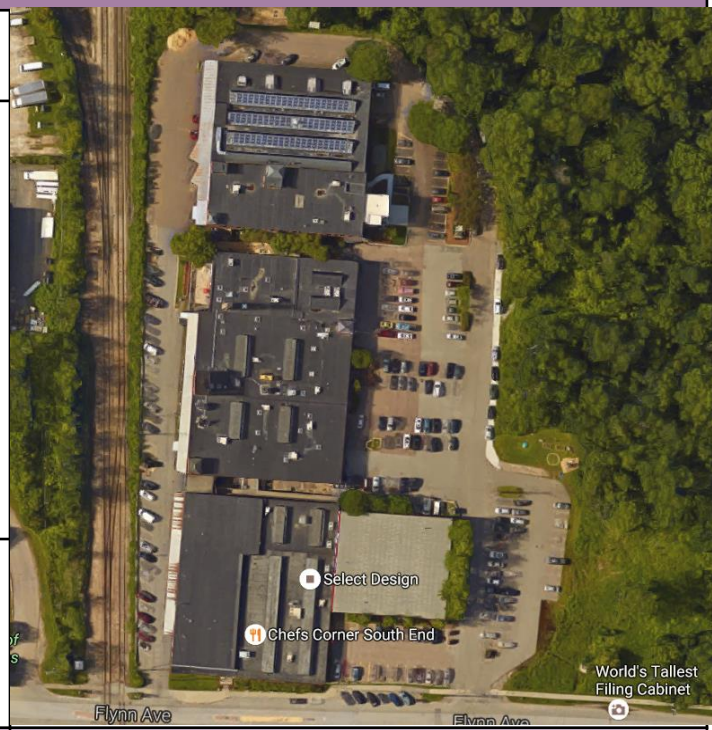
Assessed by: JSM

**ID#: M15**

**Name:** 208 Flynn Ave, west edge of parcel (along railroad)

**Concept Description:**  
Runoff from paved areas and canopy roofs on the west side of 208 Flynn drain west and north toward green space between the lot and railroad. A bioswale (or other linear treatment practice) could potentially be installed in the green space; there is also a limited amount of room at the northwest corner of the parking lot that could potentially be used for detention storage.

**Notes/Feasibility:**  
Daycare facility has outdoor play yard at the north end of the parcel; it would be important to ensure any practice did not interfere with their use of this area. It may be challenging to work within the railroad ROW.



<b>GENERAL SITE INFORMATION</b>	<b>RETROFIT DETAILS</b>
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<b>Site Contact Info:</b>	<b>Project Candidate:</b> 2 <sup>nd</sup> tier
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<b>Ownership:</b>	<b>Retrofit of new or existing BMP:</b> new
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<b>Land Use Type:</b>	<b>Proposed Retrofit Practice 1:</b> Bioswale
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<b>Land Use Detail:</b>	<b>Proposed Retrofit Practice 2:</b> Dry basin
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<b>Existing BMP on Site?</b>	<b>Non-Structural Controls:</b>
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<b>Is site a hotspot?</b>	<b>Non-Structural Other:</b>
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<b>Sources/pollutants:</b>	<b>Maintenance Burden:</b>
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<b>Soils:</b>	<b>Benefits:</b> Storage: Y Water Quality: Y Recharge: Y Demonstration: N Repair: N Reuse: N	<b>Conflicts:</b> Soils: Access: Land Use: Utilities: Polluted: High WT: Wetlands:	<b>Other:</b>
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**SIZING INFORMATION**

<b>Drainage Area (ac):</b> 2.60	
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<b>Impervious Area (ac):</b> 2.50	
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<b>Practice Area Available (ft<sup>2</sup>):</b> 3,000	
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<b>Existing Head Available?</b> Y	
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**ID#: M16**

**Name:** 208 Flynn Ave, north end of parking lot

**Concept Description:**  
 Currently stormwater runoff from parking is being diverted to rock-lined swale and conveyed to Englesby Brook. Evidence of erosion in stone-lined channel. Underground storage could be constructed at the northeast corner of the lot. Some runoff from parking lot will be captured and treated in stormwater facility planned for Champlain Parkway.

**Notes/Feasibility:**  
 Field inspection found that it would be extremely challenging to convey sufficient runoff volume to the proposed facility.



<b>GENERAL SITE INFORMATION</b>	<b>RETROFIT DETAILS</b>
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<b>Site Contact Info:</b>	<b>Project Candidate:</b> N
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<b>Ownership:</b>	<b>Retrofit of new or existing BMP:</b>
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<b>Land Use Type:</b>	<b>Proposed Retrofit Practice 1:</b>
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<b>Land Use Detail:</b>	<b>Proposed Retrofit Practice 2:</b>
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<b>Existing BMP on Site?</b>	<b>Non-Structural Controls:</b>
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<b>Is site a hotspot?</b>	<b>Non-Structural Other:</b>
---------------------------	------------------------------

<b>Sources/pollutants:</b>	<b>Maintenance Burden:</b>
----------------------------	----------------------------

<b>Soils:</b>	<b>Benefits:</b> Storage: Water Quality: Recharge: Demonstration: Repair: Reuse:	<b>Conflicts:</b> Soils: Access: Land Use: Utilities: Polluted: High WT: Wetlands: <b>Other:</b>
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<b>SIZING INFORMATION</b>	
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<b>Drainage Area (ac):</b>	
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<b>Impervious Area (ac):</b>	
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<b>Practice Area Available (ft²):</b>	
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<b>Existing Head Available?</b>	
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**ID#: M17**

**Name:** 288 Flynn Ave/Champlain Pkwy


**Concept Description:**  
 Planned Champlain Parkway alignment leaves a modest amount of green space between the roadway and the parking lot for 288 Flynn Ave. Stormwater flows from Pine St can be diverted down Flynn Ave and to this facility, allowing for treatment of a significant volume at this site

**Notes/Feasibility:**  
 Concept design maximizes use of available space; unlikely the residents of 288 Flynn Ave would support this level of exposure to the planned Champlain Parkway



GENERAL SITE INFORMATION	RETROFIT DETAILS
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<b>Site Contact Info:</b>	<b>Project Candidate:</b> 1 <sup>st</sup> tier	
<b>Ownership:</b>	<b>Retrofit of new or existing BMP:</b> new	
<b>Land Use Type:</b>	<b>Proposed Retrofit Practice 1:</b> Dry basin	
<b>Land Use Detail:</b>	<b>Proposed Retrofit Practice 2:</b> Bioretention	
<b>Existing BMP on Site?</b>	<b>Non-Structural Controls:</b>	
<b>Is site a hotspot?</b>	<b>Non-Structural Other:</b>	
<b>Sources/pollutants:</b>	<b>Maintenance Burden:</b>	
<b>Soils:</b>	<b>Benefits:</b>	<b>Conflicts:</b>
<b>Use in Retrofit DA:</b>	Storage: Y	Soils:
<b>SIZING INFORMATION</b>	Water Quality: Y	Access:
<b>Drainage Area (ac):</b> 31.70	Recharge: Y	Land Use:
<b>Impervious Area (ac):</b> 13.63	Demonstration: N	Utilities:
<b>Practice Area Available (ft<sup>2</sup>):</b> 30,500	Repair: N	Polluted:
<b>Existing Head Available?</b> Y	Reuse: N	High WT:
	<b>Other:</b>	Wetlands:
		<b>Other:</b>

ID#: M18	
<b>Name:</b> Flynn Ave Co-op Parking Lot	
<b>Concept Description:</b> An underground storage facility could be constructed in the parking lot to attenuate flows from the parking lot and building roofs draining to the west side of the site.	
<b>Notes/Feasibility:</b> Expired permit 1-1087. Area could also potentially be made to flow to M17.	

GENERAL SITE INFORMATION	RETROFIT DETAILS	
<b>Site Contact Info:</b>	<b>Project Candidate:</b>	1 <sup>st</sup> tier
<b>Ownership:</b>	<b>Retrofit of new or existing BMP:</b> new	
<b>Land Use Type:</b>	<b>Proposed Retrofit Practice 1:</b>	Underground storage
<b>Land Use Detail:</b>	<b>Proposed Retrofit Practice 2:</b>	
<b>Existing BMP on Site?</b>	<b>Non-Structural Controls:</b>	
<b>Is site a hotspot?</b>	<b>Non-Structural Other:</b>	
<b>Sources/pollutants:</b>	<b>Maintenance Burden:</b>	High
<b>Soils:</b>	<b>Benefits:</b>	<b>Conflicts:</b>
<b>Use in Retrofit DA:</b>	Storage: Y	Soils:
<b>SIZING INFORMATION</b>	Water Quality: N	Access:
	Recharge: N	Land Use:
	Demonstration: N	Utilities:
	Repair: N	Polluted:
<b>Drainage Area (ac):</b> 0.42	Reuse: N	High WT:
<b>Impervious Area (ac):</b> 0.30	<b>Other:</b>	Wetlands:
<b>Practice Area Available (ft<sup>2</sup>):</b> 3,000		<b>Other:</b>
<b>Existing Head Available?</b> Y		



**ID#: M19**

**Name:** Pine Street Counseling Center

**Concept Description:**  
Install dry basin or possibly bioretention area in north central area of lot to capture flows from roof and parking areas.


**Notes/Feasibility:**  
Expired permit 1-0337



GENERAL SITE INFORMATION	RETROFIT DETAILS
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<b>Site Contact Info:</b>	<b>Project Candidate:</b> 1 <sup>st</sup> tier	
<b>Ownership:</b>	<b>Retrofit of new or existing BMP:</b> New	
<b>Land Use Type:</b>	<b>Proposed Retrofit Practice 1:</b> Dry basin	
<b>Land Use Detail:</b>	<b>Proposed Retrofit Practice 2:</b> Bioretention	
<b>Existing BMP on Site?</b>	<b>Non-Structural Controls:</b>	
<b>Is site a hotspot?</b>	<b>Non-Structural Other:</b>	
<b>Sources/pollutants:</b>	<b>Maintenance Burden:</b> moderate	
<b>Soils:</b>	<b>Benefits:</b>	<b>Conflicts:</b>
<b>Use in Retrofit DA:</b>	Storage: Y	Soils:
<b>SIZING INFORMATION</b>	Water Quality: Y	Access:
	Recharge: M	Land Use:
	Demonstration: N	Utilities:
	Repair: N	Polluted:
	Reuse: N	High WT:
<b>Drainage Area (ac):</b> 0.80	<b>Other:</b>	<b>Other:</b>
<b>Impervious Area (ac):</b> 0.48		
<b>Practice Area Available (ft<sup>2</sup>):</b> 1750		
<b>Existing Head Available?</b> Y		

**ID#: M20**

<b>Name:</b> Pine Street Deli	
<b>Concept Description:</b> As part of planned renovation of Pine Street Deli, City is requiring improved stormwater management. CAD files were provided by owner's engineer.	
<b>Notes/Feasibility:</b> Although modeled, proposed BMP resulted in 0% change in high flows at watershed outlet and therefore was not included in the Flow Restoration Scenario	

<b>GENERAL SITE INFORMATION</b>	<b>RETROFIT DETAILS</b>
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<b>Site Contact Info:</b>	<b>Project Candidate:</b> Proposed	
<b>Ownership:</b>	<b>Retrofit of new or existing BMP:</b>	
<b>Land Use Type:</b>	<b>Proposed Retrofit Practice 1:</b>	
<b>Land Use Detail:</b>	<b>Proposed Retrofit Practice 2:</b>	
<b>Existing BMP on Site?</b>	<b>Non-Structural Controls:</b>	
<b>Is site a hotspot?</b>	<b>Non-Structural Other:</b>	
<b>Sources/pollutants:</b>	<b>Maintenance Burden:</b>	
<b>Soils:</b>	<b>Benefits:</b>	<b>Conflicts:</b>
<b>Use in Retrofit DA:</b>	Storage:	Soils:
	Water Quality:	Access:
	Recharge:	Land Use:
	Demonstration:	Utilities:
	Repair:	Polluted:
	Reuse:	High WT:
	<b>Other:</b>	Wetlands:
		<b>Other:</b>
<b>SIZING INFORMATION</b>		
<b>Drainage Area (ac):</b>		
<b>Impervious Area (ac):</b>		
<b>Practice Area Available (ft<sup>2</sup>):</b>		
<b>Existing Head Available?</b>		

**ID#: M21**

**Name:** Burlington Subaru

**Concept Description:**  
Underground storage could be installed along back edge of Burlington Subaru dealership to manage parking lot runoff.

**Notes/Feasibility:**  
As shown in photo, area is currently used for vehicle parking/storage, therefore any practice would need to be underground, increasing the cost



GENERAL SITE INFORMATION	RETROFIT DETAILS
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<b>Site Contact Info:</b>	<b>Project Candidate:</b> 2 <sup>nd</sup> tier
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<b>Ownership:</b>	<b>Retrofit of new or existing BMP:</b> New
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<b>Land Use Type:</b>	<b>Proposed Retrofit Practice 1:</b> Underground storage
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<b>Land Use Detail:</b>	<b>Proposed Retrofit Practice 2:</b>
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<b>Existing BMP on Site?</b>	<b>Non-Structural Controls:</b>
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<b>Is site a hotspot?</b>	<b>Non-Structural Other:</b>
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<b>Sources/pollutants:</b>	<b>Maintenance Burden:</b>
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<b>Soils:</b>	<b>Benefits:</b> Storage: Y Water Quality: Y Recharge: N Demonstration: N Repair: Y Reuse: N	<b>Conflicts:</b> Soils: Access: Land Use: Utilities: Polluted: High WT: Wetlands:
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SIZING INFORMATION	
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<b>Drainage Area (ac):</b> 1.58	<b>Other:</b>
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<b>Impervious Area (ac):</b> 1.56	
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<b>Practice Area Available (ft<sup>2</sup>):</b> 3,920	
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<b>Existing Head Available?</b> Y	
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**ID#: M22**

<p><b>Name:</b> Rice High School</p> <p><b>Concept Description:</b> Runoff from Rice High School currently flows to O8 Pond, but a nested treatment practice could be built on-site at the school to create additional storage capacity in the O8 Pond.</p> <p><b>Notes/Feasibility:</b> Green space available both immediately adjacent to parking lot, as well as along access road.</p>	
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<b>GENERAL SITE INFORMATION</b>	<b>RETROFIT DETAILS</b>
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<b>Site Contact Info:</b>	<b>Project Candidate:</b> 2 <sup>nd</sup> tier	
<b>Ownership:</b>	<b>Retrofit of new or existing BMP:</b> New	
<b>Land Use Type:</b>	<b>Proposed Retrofit Practice 1:</b> Dry basin	
<b>Land Use Detail:</b>	<b>Proposed Retrofit Practice 2:</b>	
<b>Existing BMP on Site?</b>	<b>Non-Structural Controls:</b>	
<b>Is site a hotspot?</b>	<b>Non-Structural Other:</b>	
<b>Sources/pollutants:</b>	<b>Maintenance Burden:</b>	
<b>Soils:</b>	<b>Benefits:</b>	<b>Conflicts:</b>
<b>Use in Retrofit DA:</b>	Storage: Y	Soils:
<b>SIZING INFORMATION</b>	Water Quality: Y	Access:
	Recharge: Y	Land Use:
	Demonstration: N	Utilities:
	Repair: N	Polluted:
<b>Drainage Area (ac):</b> 4.85	Reuse: N	High WT:
<b>Impervious Area (ac):</b> 2.12	<b>Other:</b>	Wetlands:
<b>Practice Area Available (ft<sup>2</sup>):</b> 4,350		<b>Other:</b>
<b>Existing Head Available?</b> Y		

**ID#: M23**

**Name:** Harrison Ave., near Central Ave.

**Concept Description:**  
Install "green street" style practice in green space between road and sidewalk along Harrison Ave.

**Notes/Feasibility:**  
Also considered opportunity to shunt flow to existing green space to north of Harrison Ave, but would not have head to allow gravity flow.



GENERAL SITE INFORMATION	RETROFIT DETAILS
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<b>Site Contact Info:</b>	<b>Project Candidate:</b> 3 <sup>rd</sup> tier
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<b>Ownership:</b>	<b>Retrofit of new or existing BMP:</b>
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<b>Land Use Type:</b>	<b>Proposed Retrofit Practice 1:</b> Swale
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<b>Land Use Detail:</b>	<b>Proposed Retrofit Practice 2:</b> Dry basin
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<b>Existing BMP on Site?</b>	<b>Non-Structural Controls:</b>
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<b>Is site a hotspot?</b>	<b>Non-Structural Other:</b>
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<b>Sources/pollutants:</b>	<b>Maintenance Burden:</b>
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<b>Soils:</b>	<b>Benefits:</b>	<b>Conflicts:</b>
	Storage: Y	Soils:
	Water Quality: Y	Access:
	Recharge: Y	Land Use:
	Demonstration: Y	Utilities:
	Repair: N	Polluted:
	Reuse: N	High WT:
		Wetlands:
	<b>Other:</b>	<b>Other:</b>

**SIZING INFORMATION**

<b>Drainage Area (ac):</b>	0.38	
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<b>Impervious Area (ac):</b>	0.31	
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<b>Practice Area Available (ft<sup>2</sup>):</b>	875	
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<b>Existing Head Available?</b>	Y	
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**ID#: M24**

**Name:** Sears Ln

**Concept Description:**  
 Looked for opportunities to capture runoff from Sears Ln and several adjacent structures; much of the runoff from this area flows north to the Pine St Barge Canal. Area was determined to be inefficient/unsuitable for retrofit based on field inspection.

**Notes/Feasibility:**  
 Estimated drainage area may be generous.



GENERAL SITE INFORMATION	RETROFIT DETAILS
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<b>Site Contact Info:</b>	<b>Project Candidate:</b> N
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<b>Ownership:</b>	<b>Retrofit of new or existing BMP:</b>
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<b>Land Use Type:</b>	<b>Proposed Retrofit Practice 1:</b>
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<b>Land Use Detail:</b>	<b>Proposed Retrofit Practice 2:</b>
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<b>Existing BMP on Site?</b>	<b>Non-Structural Controls:</b>
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<b>Is site a hotspot?</b>	<b>Non-Structural Other:</b>
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<b>Sources/pollutants:</b>	<b>Maintenance Burden:</b>
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<b>Soils:</b>	<b>Benefits:</b> Storage: Water Quality: Recharge: Demonstration: Repair: Reuse:	<b>Conflicts:</b> Soils: Access: Land Use: Utilities: Polluted: High WT: Wetlands: <b>Other:</b>
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SIZING INFORMATION	
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<b>Drainage Area (ac):</b>	0.77
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<b>Impervious Area (ac):</b>	0.34
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<b>Practice Area Available (ft²):</b>	1,300
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<b>Existing Head Available?</b>	
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**ID#: M25**

**Name:** Overlake Condos

**Concept Description:**  
 Opportunity to capture the front (eastern half of the roofs of most residential building, as well as garages and parking area in a centralized facility at the southern end of the complex. May require elimination of 2 parking spot to have sufficient area for the treatment practice.

**Notes/Feasibility:**  
 Expired permit 2-0789. Northern portion of complex appears to drain overland to Prospect St where it likely enters the combined sewer system



GENERAL SITE INFORMATION	RETROFIT DETAILS
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<b>Site Contact Info:</b>	<b>Project Candidate:</b> 1 <sup>st</sup> tier	
<b>Ownership:</b>	<b>Retrofit of new or existing BMP:</b> New	
<b>Land Use Type:</b>	<b>Proposed Retrofit Practice 1:</b> Dry basin	
<b>Land Use Detail:</b>	<b>Proposed Retrofit Practice 2:</b> Bioretention	
<b>Existing BMP on Site?</b>	<b>Non-Structural Controls:</b>	
<b>Is site a hotspot?</b>	<b>Non-Structural Other:</b>	
<b>Sources/pollutants:</b>	<b>Maintenance Burden:</b>	
<b>Soils:</b>	<b>Benefits:</b>	<b>Conflicts:</b>
<b>Use in Retrofit DA:</b>	Storage: Y	Soils:
<b>SIZING INFORMATION</b>	Water Quality: Y	Access:
<b>Drainage Area (ac):</b> 1.19	Recharge: M	Land Use:
<b>Impervious Area (ac):</b> 0.73	Demonstration: N	Utilities:
<b>Practice Area Available (ft<sup>2</sup>):</b> 2,200	Repair: N	Polluted:
<b>Existing Head Available?</b>	Reuse: N	High WT:
	<b>Other:</b>	Wetlands:
		<b>Other:</b>

**ID#: M26**

**Name:** Champlain Parkway

**Concept Description:**  
 Stormwater management will be provided as part of the Champlain Parkway. Based on current plans for the roadway, a gravel wetland will be constructed to the west of the alignment in this area and will also provide treatment for a portion of the parking lot at 208 Flynn Ave. The timeline for the Champlain Pkwy is outside the purview of this project and therefore it has not been included as part of the FRP.

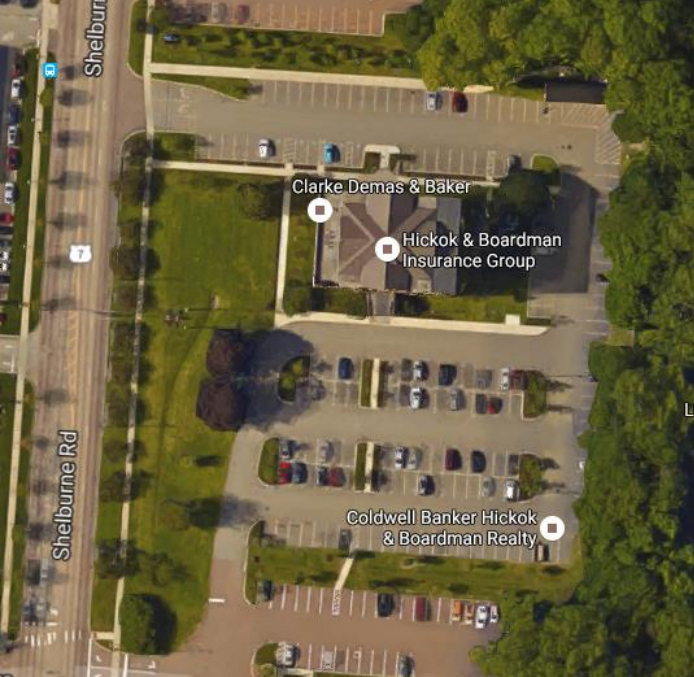
**Notes/Feasibility:**  
 Were the Champlain Pkwy project to be abandoned there is an opportunity for a large, centralized facility on this site that could be expanded to include M17.



GENERAL SITE INFORMATION	RETROFIT DETAILS
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<b>Site Contact Info:</b>	<b>Project Candidate:</b> Proposed	
<b>Ownership:</b>	<b>Retrofit of new or existing BMP:</b> New	
<b>Land Use Type:</b>	<b>Proposed Retrofit Practice 1:</b> Gravel wetland	
<b>Land Use Detail:</b>	<b>Proposed Retrofit Practice 2:</b>	
<b>Existing BMP on Site?</b>	<b>Non-Structural Controls:</b>	
<b>Is site a hotspot?</b>	<b>Non-Structural Other:</b>	
<b>Sources/pollutants:</b>	<b>Maintenance Burden:</b>	
<b>Soils:</b>	<b>Benefits:</b>	<b>Conflicts:</b>
<b>Use in Retrofit DA:</b>	Storage: Y	Soils:
<b>SIZING INFORMATION</b>	Water Quality: Y	Access:
	Recharge: N	Land Use:
	Demonstration: Y	Utilities:
	Repair: N	Polluted:
	Reuse: N	High WT:
<b>Drainage Area (ac):</b> 1.67	<b>Other:</b>	<b>Other:</b>
<b>Impervious Area (ac):</b> 1.23		
<b>Practice Area Available (ft²):</b> 3,500		
<b>Existing Head Available?</b> Y		



<b>ID#: M27</b>	
<b>Name:</b> Hickock & Boardman	
<b>Concept Description:</b> Retrofit of this property was completed as part of redevelopment and includes a suite of green stormwater infrastructure practices: grass swales, disconnection, infiltration/Stormtech.	
<b>Notes/Feasibility:</b> Permit 6145-INDS. No changes considered.	

GENERAL SITE INFORMATION	RETROFIT DETAILS	
<b>Site Contact Info:</b>	<b>Project Candidate:</b>	Constructed
<b>Ownership:</b>	<b>Retrofit of new or existing BMP:</b> Existing	
<b>Land Use Type:</b>	<b>Proposed Retrofit Practice 1:</b>	
<b>Land Use Detail:</b>	<b>Proposed Retrofit Practice 2:</b>	
<b>Existing BMP on Site?</b>	<b>Non-Structural Controls:</b>	
<b>Is site a hotspot?</b>	<b>Non-Structural Other:</b>	
<b>Sources/pollutants:</b>	<b>Maintenance Burden:</b>	
<b>Soils:</b>	<b>Benefits:</b>	<b>Conflicts:</b>
<b>Use in Retrofit DA:</b>	Storage: Y	Soils:
<b>SIZING INFORMATION</b>	Water Quality: Y	Access:
<b>Drainage Area (ac):</b> 1.29	Recharge: Y	Land Use:
<b>Impervious Area (ac):</b> 0.92	Demonstration: N	Utilities:
<b>Practice Area Available (ft<sup>2</sup>):</b> 1,300	Repair: N	Polluted:
<b>Existing Head Available?</b> Y	Reuse: N	High WT:
	<b>Other:</b>	Wetlands:
		<b>Other:</b>

**ID#: M28**

**Name:** Walgreens

**Concept Description:**  
 Stormwater runoff from existing parking lot at Walgreens and travel lane that connects through to Bacon St is unmanaged. The concept design for this site would involve underground storage to manage parking lot runoff.

**Notes/Feasibility:**  
 Travel lane is unpaved and there was evidence of significant sediment transport to Bacon St. Runoff from this area ultimately ends up in the O8 Pond



GENERAL SITE INFORMATION		RETROFIT DETAILS	
Site Contact Info:		Project Candidate:	3 <sup>rd</sup> tier
Ownership:		Retrofit of new or existing BMP:	New
Land Use Type:		Proposed Retrofit Practice 1:	Underground storage
Land Use Detail:		Proposed Retrofit Practice 2:	
Existing BMP on Site?		Non-Structural Controls:	
Is site a hotspot?		Non-Structural Other:	
Sources/pollutants:		Maintenance Burden:	
Soils:		Benefits:	Conflicts:
Use in Retrofit DA:		Storage: Y	Soils:
<b>SIZING INFORMATION</b>	Drainage Area (ac):	Water Quality: Y	Access:
	Impervious Area (ac):	Recharge: N	Land Use:
	Practice Area Available (ft <sup>2</sup> ):	Demonstration: N	Utilities:
	Existing Head Available?	Repair: N	Polluted:
		Reuse: N	High WT:
	Other:	Wetlands:	Other:

**ID#: M29**

**Name:** Champlain Co-op, 810 Pine St.

**Concept Description:**  
 Concept would include underground storage due to surface site constraints; practice would be used to manage runoff from roofs and parking areas.

**Notes/Feasibility:**  
 City infrastructure mapping suggests significant underground utility constrains are also likely present on this site.



GENERAL SITE INFORMATION	RETROFIT DETAILS
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<b>Site Contact Info:</b>	<b>Project Candidate:</b> 3 <sup>rd</sup> tier																		
<b>Ownership:</b>	<b>Retrofit of new or existing BMP:</b> New																		
<b>Land Use Type:</b>	<b>Proposed Retrofit Practice 1:</b> Underground storage																		
<b>Land Use Detail:</b>	<b>Proposed Retrofit Practice 2:</b>																		
<b>Existing BMP on Site?</b>	<b>Non-Structural Controls:</b>																		
<b>Is site a hotspot?</b>	<b>Non-Structural Other:</b>																		
<b>Sources/pollutants:</b>	<b>Maintenance Burden:</b>																		
<b>Soils:</b>	<table style="width:100%; border-collapse: collapse;"> <tr> <td style="width:50%;"><b>Benefits:</b></td> <td style="width:50%;"><b>Conflicts:</b></td> </tr> <tr> <td>Storage: Y</td> <td>Soils:</td> </tr> <tr> <td>Water Quality: Y</td> <td>Access:</td> </tr> <tr> <td>Recharge: N</td> <td>Land Use:</td> </tr> <tr> <td>Demonstration: N</td> <td>Utilities:</td> </tr> <tr> <td>Repair: N</td> <td>Polluted:</td> </tr> <tr> <td>Reuse: N</td> <td>High WT:</td> </tr> <tr> <td></td> <td>Wetlands:</td> </tr> <tr> <td><b>Other:</b></td> <td><b>Other:</b></td> </tr> </table>	<b>Benefits:</b>	<b>Conflicts:</b>	Storage: Y	Soils:	Water Quality: Y	Access:	Recharge: N	Land Use:	Demonstration: N	Utilities:	Repair: N	Polluted:	Reuse: N	High WT:		Wetlands:	<b>Other:</b>	<b>Other:</b>
<b>Benefits:</b>	<b>Conflicts:</b>																		
Storage: Y	Soils:																		
Water Quality: Y	Access:																		
Recharge: N	Land Use:																		
Demonstration: N	Utilities:																		
Repair: N	Polluted:																		
Reuse: N	High WT:																		
	Wetlands:																		
<b>Other:</b>	<b>Other:</b>																		
<b>Use in Retrofit DA:</b>																			

**SIZING INFORMATION**

<b>Drainage Area (ac):</b>	1.59	
<b>Impervious Area (ac):</b>	1.09	
<b>Practice Area Available (ft<sup>2</sup>):</b>	3,900	
<b>Existing Head Available?</b>	Y	

**ID#: M30**

**Name:** Pizzigalli Properties, 462 Shelburne Rd.

**Concept Description:**  
As part of redevelopment effort, permeable pavement was installed in parking bays in this lot.

**Notes/Feasibility:**  
Permeable paver walk at E. end of S. lot was considered too small to effectively include in VTBMPPSS.



GENERAL SITE INFORMATION	RETROFIT DETAILS
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<b>Site Contact Info:</b>	<b>Project Candidate:</b> Constructed	
<b>Ownership:</b>	<b>Retrofit of new or existing BMP:</b> Existing	
<b>Land Use Type:</b>	<b>Proposed Retrofit Practice 1:</b> Permeable pavement	
<b>Land Use Detail:</b>	<b>Proposed Retrofit Practice 2:</b>	
<b>Existing BMP on Site?</b>	<b>Non-Structural Controls:</b>	
<b>Is site a hotspot?</b>	<b>Non-Structural Other:</b>	
<b>Sources/pollutants:</b>	<b>Maintenance Burden:</b>	
<b>Soils:</b>	<b>Benefits:</b> Storage: Y Water Quality: Y Recharge: Y Demonstration: N Repair: N Reuse: N	<b>Conflicts:</b> Soils: Access: Land Use: Utilities: Polluted: High WT: Wetlands: Other:
<b>Use in Retrofit DA:</b>		
<b>SIZING INFORMATION</b>		
<b>Drainage Area (ac):</b>	0.64	
<b>Impervious Area (ac):</b>	0.58	
<b>Practice Area Available (ft²):</b>	11,800	
<b>Existing Head Available?</b>	Y	

**ID#: M31**

**Name:** 847 Pine St redevelopment

**Concept Description:**  
A rain garden/bioretention facility was constructed at this site as part of a redevelopment effort.

**Notes/Feasibility:**



GENERAL SITE INFORMATION	RETROFIT DETAILS
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<b>Site Contact Info:</b>	<b>Project Candidate:</b> Constructed
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<b>Ownership:</b>	<b>Retrofit of new or existing BMP:</b> Existing
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<b>Land Use Type:</b>	<b>Proposed Retrofit Practice 1:</b> Bioretention
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<b>Land Use Detail:</b>	<b>Proposed Retrofit Practice 2:</b>
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<b>Existing BMP on Site?</b>	<b>Non-Structural Controls:</b>
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<b>Is site a hotspot?</b>	<b>Non-Structural Other:</b>
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<b>Sources/pollutants:</b>	<b>Maintenance Burden:</b>
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<b>Soils:</b>	<b>Benefits:</b>	<b>Conflicts:</b>
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<b>Use in Retrofit DA:</b>	Storage: Y	Soils:
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	Water Quality: Y	Access:
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	Recharge: Y	Land Use:
--	-------------	-----------

	Demonstration: N	Utilities:
--	------------------	------------

	Repair: N	Polluted:
--	-----------	-----------

	Reuse: N	High WT:
--	----------	----------

	<b>Other:</b>	<b>Other:</b>
--	---------------	---------------

<b>SIZING INFORMATION</b>	
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<b>Drainage Area (ac):</b> 0.45	
---------------------------------	--

<b>Impervious Area (ac):</b> 0.23	
-----------------------------------	--

<b>Practice Area Available (ft²):</b> 2,100	
---	--

<b>Existing Head Available?</b>	
---------------------------------	--

**ID#: M32**

**Name:** Route 7/South Willard St roundabout

**Concept Description:**  
 A roundabout is planned for the intersection of Route 7 and So Willard St. As part of the project, underground storage with a sand filter has been proposed. The timeline for this project is outside the purview of the City and therefore is has not been included as part of the FRP.

**Notes/Feasibility:**  
 Permit 6756-INDS. Stormwater runoff from this area ultimately flows to the O8 Pond.



GENERAL SITE INFORMATION	RETROFIT DETAILS
--------------------------	------------------

<b>Site Contact Info:</b>	<b>Project Candidate:</b> Proposed
---------------------------	------------------------------------

<b>Ownership:</b>	<b>Retrofit of new or existing BMP:</b>
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<b>Land Use Type:</b>	<b>Proposed Retrofit Practice 1:</b>
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<b>Land Use Detail:</b>	<b>Proposed Retrofit Practice 2:</b>
-------------------------	--------------------------------------

<b>Existing BMP on Site?</b>	<b>Non-Structural Controls:</b>
------------------------------	---------------------------------

<b>Is site a hotspot?</b>	<b>Non-Structural Other:</b>
---------------------------	------------------------------

<b>Sources/pollutants:</b>	<b>Maintenance Burden:</b>
----------------------------	----------------------------

<b>Soils:</b>	<b>Benefits:</b> Storage: Y Water Quality: Y Recharge: N Demonstration: N Repair: N Reuse: N	<b>Conflicts:</b> Soils: Access: Land Use: Utilities: Polluted: High WT: Wetlands:	<b>Other:</b>
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**SIZING INFORMATION**

<b>Drainage Area (ac):</b>	0.73	
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<b>Impervious Area (ac):</b>	0.60	
------------------------------	------	--

<b>Practice Area Available (ft²):</b>	1,300	
---------------------------------------	-------	--

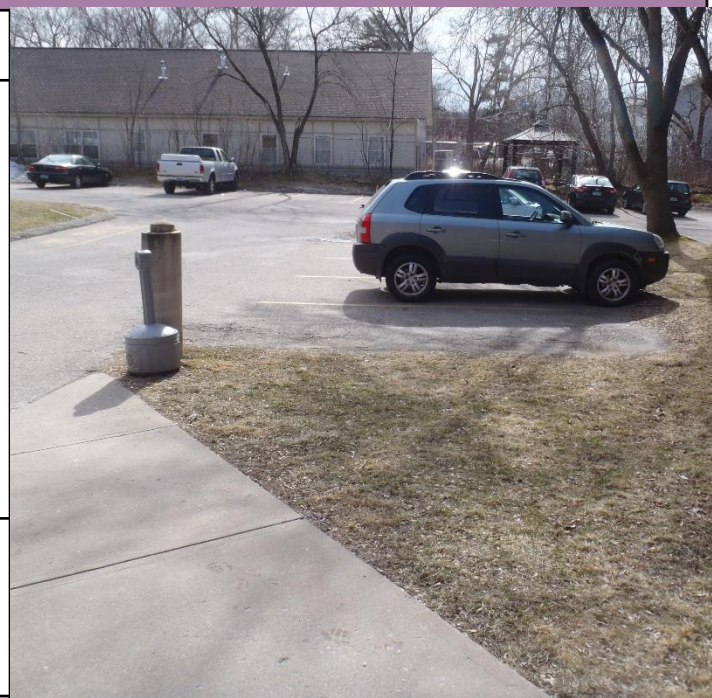
<b>Existing Head Available?</b>	Y	
---------------------------------	---	--

**ID#: M33**

**Name:** Champlain Apartments, 817 Pine St.

**Concept Description:**  
 Concept for this location is a combined underground storage facility that would also serve M29. See that summary sheet for additional detail.

**Notes/Feasibility:**  
 Expired permit 2-0999.



GENERAL SITE INFORMATION	RETROFIT DETAILS
--------------------------	------------------

Site Contact Info:	Project Candidate: N
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Ownership:	Retrofit of new or existing BMP:
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Land Use Type:	Proposed Retrofit Practice 1:
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Land Use Detail:	Proposed Retrofit Practice 2:
------------------	-------------------------------

Existing BMP on Site?	Non-Structural Controls:
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Is site a hotspot?	Non-Structural Other:
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Sources/pollutants:	Maintenance Burden:
---------------------	---------------------

Soils:	Benefits:	Conflicts:
	Storage:	Soils:
	Water Quality:	Access:
	Recharge:	Land Use:
	Demonstration:	Utilities:
	Repair:	Polluted:
	Reuse:	High WT:
		Wetlands:
	<b>Other:</b>	<b>Other:</b>

Use in Retrofit DA:	
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**SIZING INFORMATION**


Drainage Area (ac):	
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Impervious Area (ac):	
-----------------------	--

Practice Area Available (ft²):	
--------------------------------	--

Existing Head Available?	
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**ID#: M34**

<p><b>Name:</b> Crescent Terrace</p>	
<p><b>Concept Description:</b> Given the neighborhood constraints, no location for a single centralized facility was identified. There are opportunities into this area for lot-scale disconnection and small bioretention/rain garden practices.</p>	
<p><b>Notes/Feasibility:</b> Expired permit 2-1052</p>	

GENERAL SITE INFORMATION	RETROFIT DETAILS
--------------------------	------------------

Site Contact Info:	Project Candidate: N	
Ownership:	Retrofit of new or existing BMP:	
Land Use Type:	Proposed Retrofit Practice 1:	
Land Use Detail:	Proposed Retrofit Practice 2:	
Existing BMP on Site?	Non-Structural Controls:	
Is site a hotspot?	Non-Structural Other:	
Sources/pollutants:	Maintenance Burden:	
Soils:	<p><b>Benefits:</b> Storage: Water Quality: Recharge: Demonstration: Repair: Reuse:</p> <p><b>Other:</b></p>	<p><b>Conflicts:</b> Soils: Access: Land Use: Utilities: Polluted: High WT: Wetlands: <b>Other:</b></p>
Use in Retrofit DA:		
SIZING INFORMATION		
Drainage Area (ac):		
Impervious Area (ac):	<p><b>Other:</b></p>	<p><b>Other:</b></p>
Practice Area Available (ft <sup>2</sup> ):		
Existing Head Available?		



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## **APPENDIX B: REVIEW OF EXPIRED STORMWATER PERMITS IN THE ENGLESBY BROOK WATERSHED**

March 29, 2016

To: Megan Moir, CPESC, CPSWQ

From: Julie Moore, PE

Stone Project No. 16-030

Subject: Englesby Watershed Expired Stormwater Permit Review

# MEMO

Stone completed a field assessment of each of the five systems in the Englesby Brook watershed with expired stormwater permits. These systems are identified in Table 1, below.

*Table 1: Expired Stormwater Permits in the Englesby Brook Watershed*

Permit Number	Project Name	Permit Issued
1-0337	Howard Mental Health Services	3/4/1982
1-1087	Flynn Ave Coop Housing	9/15/1992
2-0789	Overlake Condominiums	11/24/1988
2-0999	Champlain Apartments	4/20/1982
2-1052	Crescent Terrace	12/20/1985

In general, the permits are written rather broadly with few enforceable items and typically focus on curb-and-gutter system elements, including catch basins. Further, the site plans available in the permit files tend to lack the specificity and level of detail provided for systems constructed post-2002. A brief summary of our observations is provided below, including recommendations for completing any actions that would be required to bring the facilities into compliance.

### **1-0337, Howard Mental Health Services, 300 Flynn Ave.**

Permit covers the discharge of roof drainage via “stone lined ditch in natural drainage swale” to Englesby Brook; parking lot runoff does not appear to be regulated under the permit. During the site visit we found that the stone lined ditch is not well defined. The majority of flow leaving the site and discharging to Englesby Brook appears to occur via subsurface drain pipes not included in the permit; four outfalls were identified during the site visit that are not included in the City’s stormwater GIS layer, including one of which appears to divert water directly from Pine Street. In order to bring this facility into compliance with its existing permit, the stone lined ditch would need to be improved. In addition, the source of the water draining to each of the subsurface drains should be confirmed. As part of the Englesby Brook Flow

Restoration Plan (FRP), a potential retrofit was identified for managing runoff from parking lots draining to the existing green space behind 300 Flynn Ave.

Photo 1: Presumed Location of Natural Drainage Swale and Unknown Subsurface Drainage Outlet



### **1-1087, Flynn Ave Coop Housing, 288 Flynn Ave**

Permit covers the discharge of stormwater runoff from roofs and paved parking lots following treatment “via grass-lined swales, through rip-rapped areas at the top of bank of Englesby Ravine, and via overland flow across vegetated terrain...” During the site visit we found that there are grass-lined to the north of the apartment complex which appear to convey stormwater runoff to rip-rapped areas that lead down to the ravine. We also noted during our site visit that the parking lot catch basin indicated in the City’s stormwater GIS layer does not exist. This site was generally found to be in compliance with its permit. As part of the Englesby Brook FRP, a significant potential retrofit was identified for in the green space immediately to the west of 288 Flynn Ave. and to the east of the proposed Champlain Parkway alignment.

Photo 2: Rip-rapped Slope Behind 288 Flynn Ave



**2-0789, Overlake Properties, 545 Prospect St**

Permit covers the discharge of stormwater runoff from paved road and parking lots after treatment by “passage through trap catch basins” to a stone bed and “approximately 1000 feet overland flow through wooded area and grassed drainage swale to the stream.” During the site visit we observed that sediment levels in the catch basin were below the invert of the outlet pipe, but that the outlet lacked a trap or hood. In addition, we observed a PVC pipe passing through the basin (not draining into). The stone bed noted in the permit could not be located. A 15” concrete pipe and 6” PVC pipe were both located approximately 100 feet southeast of Prospect St, which discharged into a small wetland area (see Photo 3). We followed the outflow from the wetland area for a considerable distance but could not see where it connected to the stream; a portion of the flow appeared to cross Prospect Pkwy. In order to bring this facility into compliance with its existing permit, a trap or hood would need to be fitted onto the catch basin outlet and a stone bed or other

energy dissipation measures added at the outlet. In addition, it would also be prudent to determine the source of the water passing through the catch basin in the PVC pipe in order to guard against a potential illicit discharge were it to carry something other than stormwater. As part of the Englesby Brook FRP, a potential retrofit was identified for managing runoff in the green space at the southern end of the parcel.

Photo 3: Looking Downstream from the 15" Concrete Pipe Outfall



## 2-0999, Champlain Apartments, 817 Pine St

Permit covers the discharge of stormwater runoff from paved parking areas after “passage through trap catch basins and a 1500 gallon septic tank in series” before being piped directly to the city stormwater system. During our site visit we observed that sediment in all three parking lot catch basins has accumulated above the invert of the outlet pipe. No access manholes (or similar) for the septic tank were observed; the septic tank may be located under the dumpster cage in the south west corner of the parking lot (see Photo 4). The catch basin indicated in the City’s stormwater GIS layer in the green space/courtyard area near the building could not be located. In order to bring this facility into compliance with its existing permit, the catch basins would need to be serviced and a trap or hood would fitted onto each of the outlets. In addition, the septic tank should be formally located and likely serviced. As part of the Englesby Brook FRP, a potential retrofit was identified along/underneath the western edge of the parking lot.

Photo 4: Looking East toward Dumpster Cage and Probable Septic Tank Location



## 2-1052, Crescent Terrace

Permit covers the discharge of stormwater runoff from the paved roads and driveways, roofs and natural terrain, via overland flow across “grassed and/or vegetated terrain to a catch basin and rip-rapped outfall, prior to discharge to an unnamed tributary...” During our site visit we observed that sediment levels in the three catch basins indicated in the City’s stormwater GIS layer were below the invert of the outlet pipes. The vegetated terrain and rip-rapped outfall were observed as described in the permit. This site was generally found to be in compliance with its permit. No specific retrofit for this site is currently contemplated as part of the Englesby Brook FRP, however this is a part of a neighborhood generally being evaluated for targeted disconnection.

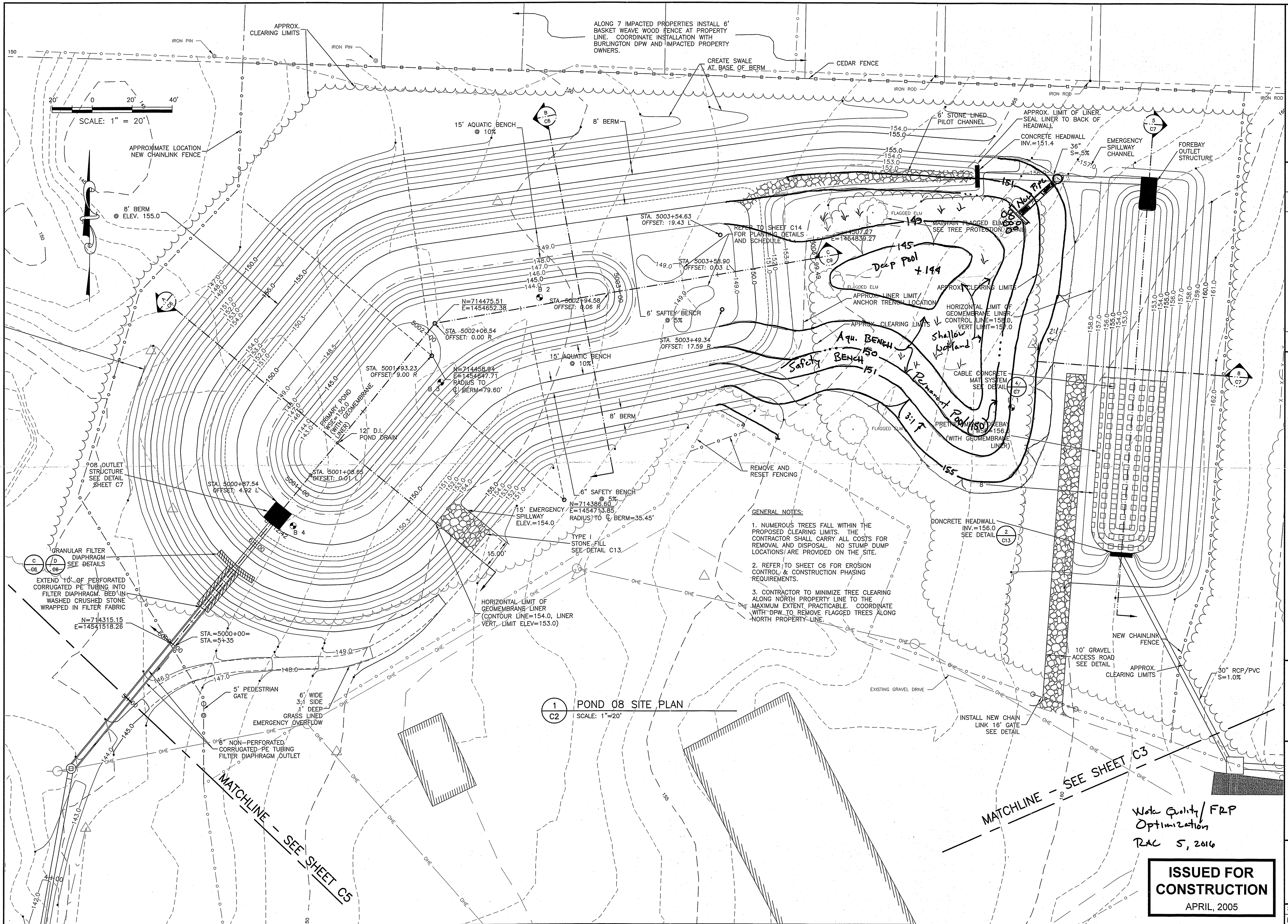
Photo 5: Large Stone Rip-Rap at Outfall



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## APPENDIX C: FLOW RESTORATION BMP CONCEPT DESIGNS





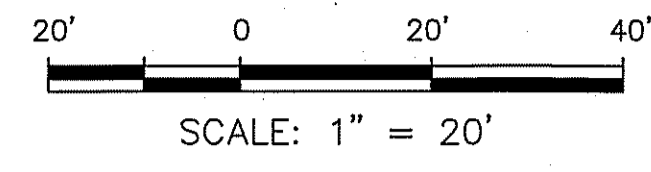
Rev.	Description	By	Date
1	ISSUED FOR REBID	JTM	3/2005

ENGLESBY WATERSHED IMPROVEMENTS  
**POND 08 SITE PLAN**  
 BURLINGTON VERMONT

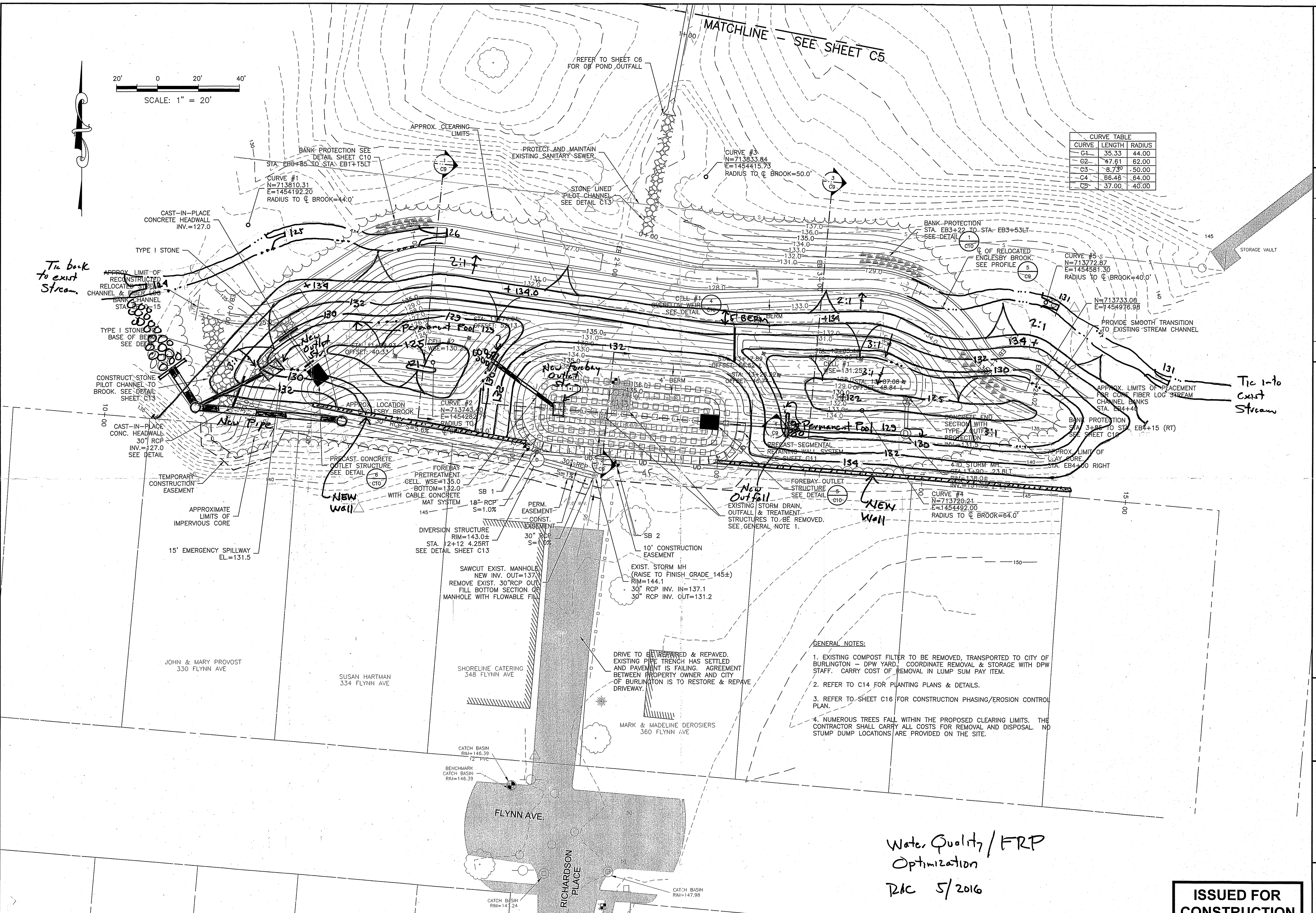
Project No.	6523004
Proj. Manager	JTM
Proj. Designer	JTM
Drawn By	JSK
Checked By	JTM
Scale	1"=20'
Approved	APRIL 2005
Date	

Water Quality/FRP Optimization  
 RAC 5, 2016

**ISSUED FOR CONSTRUCTION**  
 APRIL, 2005



CURVE	LENGTH	RADIUS
C1	35.33	44.00
C2	47.61	62.00
C3	8.73	50.00
C4	86.48	64.00
C5	37.00	40.00



- GENERAL NOTES:**
- EXISTING COMPOST FILTER TO BE REMOVED, TRANSPORTED TO CITY OF BURLINGTON - DPW YARD. COORDINATE REMOVAL & STORAGE WITH DPW STAFF. CARRY COST OF REMOVAL IN LUMP SUM PAY ITEM.
  - REFER TO C14 FOR PLANTING PLANS & DETAILS.
  - REFER TO SHEET C16 FOR CONSTRUCTION PHASING/EROSION CONTROL PLAN.
  - NUMEROUS TREES FALL WITHIN THE PROPOSED CLEARING LIMITS. THE CONTRACTOR SHALL CARRY ALL COSTS FOR REMOVAL AND DISPOSAL. NO STUMP DUMP LOCATIONS ARE PROVIDED ON THE SITE.

*Water Quality / FRP  
 Optimization  
 RBC 5/2016*

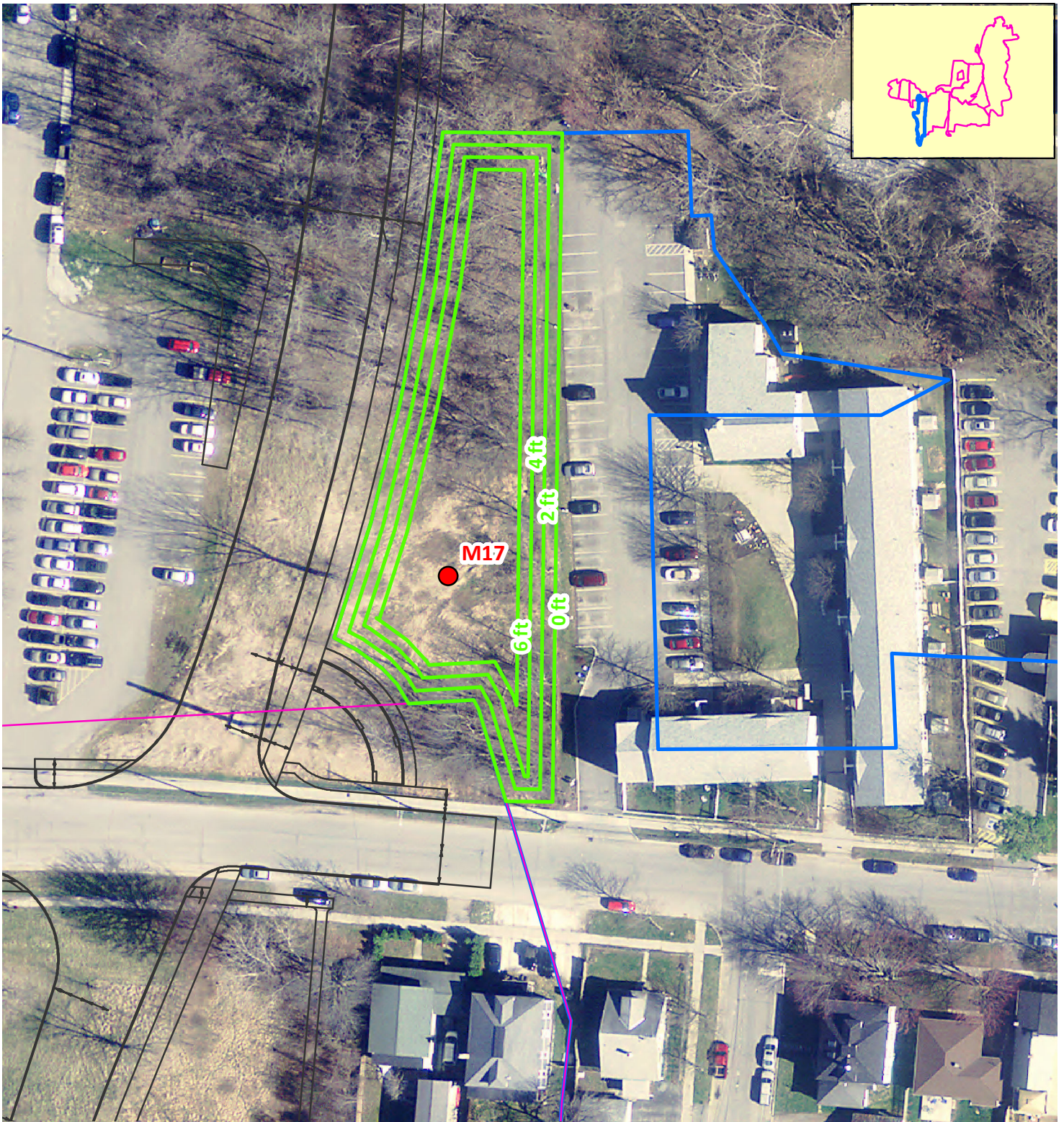
PLAN SM 6 SITE PLAN  
 SCALE: 1"=20'

**ISSUED FOR CONSTRUCTION**  
 APRIL, 2005

Rev.	Description	By	Date
1	ISSUED FOR REBID	JTM	3/2005

ENGLESBY WATERSHED IMPROVEMENTS  
**SM 6 SITE PLAN**  
 BURLINGTON

Project No.	6523004
Proj. Manager	JTM
Proj. Designer	JTM
Drawn By	JSK
Checked By	AS SHOWN
Scale	AS SHOWN
Approved	APRIL 2005
Date	



Path: C:\Shared\Projects\14193 Stone Environmental Englesby Brook\GISMaps\M17\_Concept\_14193.mxd

### Legend

- Proposed M17 BMP
- Proposed M17 Depth Contours
- Proposed M17 Drainage Area
- Proposed Champlain Parkway
- Sub-watersheds



0 25 50 Feet

Horsley Witten Group  
Sustainable Environmental Solutions

90 Route 6A • Sandwich, MA • 02563  
Tel: 508-833-6600 • Fax: 508-833-3150 • www.horsleywitten.com



### M17 Concept Design

Date: 7/22/2016

Figure C.1



Path: \\CIFS1\netdrv-o\Proj-14\WRM\14-171 Englesby Brook FRP\GIS\MapDocuments\PresentationsAndReports\FR\_concepts\Englesby\_Concept\_14193\_M19.mxd

### Legend

- Proposed M19 BMP
- Proposed M19 Depth Contours
- Proposed M19 Drainage Area
- Sub-watersheds



0 25 50 Feet

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Sustainable Environmental Solutions

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M19 Concept Design

Date: 7/29/2016

Figure C.3



Path: O:\Proj-14\WRM\14-171 Englesby Brook FRP\GIS\MapDocuments\PresentationsAndReports\FR\_concepts\Englesby\_Concept\_14193\_M18.mxd

### Legend

- Proposed M18 BMP
- Proposed M18 Depth Contours
- Proposed M18 Drainage Area
- Sub-watersheds



0 25 50 Feet

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Sustainable Environmental Solutions

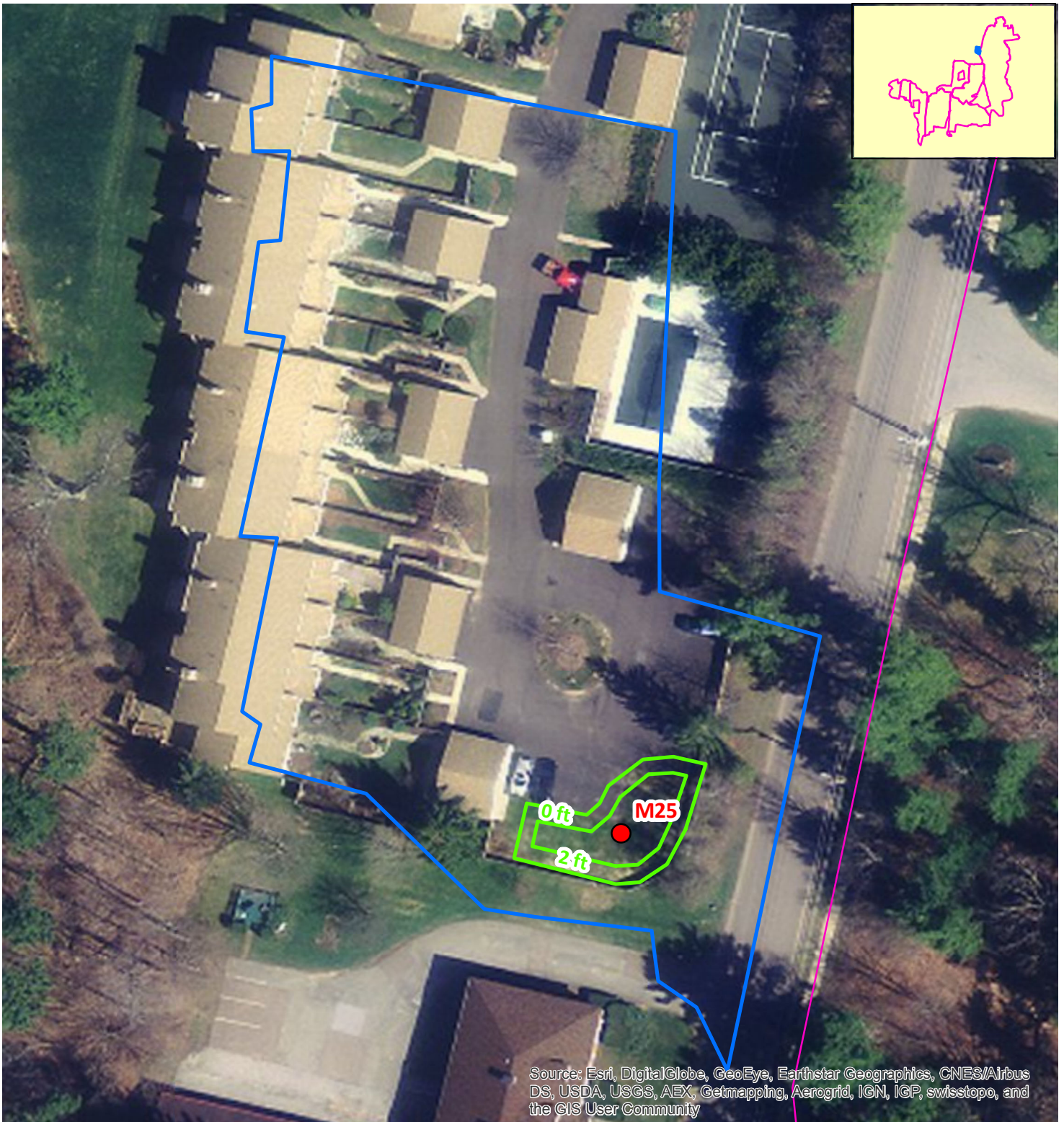
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M18 Concept Design

Date: 8/2/2016

Figure C.4



Path: O:\Proj-14\WRM\14-171 Englesby Brook FRP\GIS\MapDocuments\PpresentationsAndReports\FR\_concepts\Englesby\_Concept\_14193\_M25.mxd

### Legend

- Proposed M25 BMP
- Proposed M25 Depth Contours
- Proposed M25 Drainage Area
- Sub-watersheds



0 25 50 Feet

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### M25 Concept Design

Date: 8/2/2016

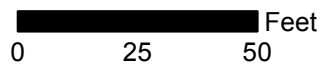
Figure C.6



Path: O:\Proj-14\WRM\14-171 Englesby Brook FRP\GIS\MapDocuments\PpresentationsAndReports\FR\_concepts\Englesby\_Concept\_14193\_M31.mxd

### Legend

- Proposed M31 BMP
- Proposed M31 Depth Contours
- Proposed M31 Drainage Area
- Sub-watersheds



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M31 Concept Design

Date: 8/2/2016

Figure C.7

## APPENDIX D: M10 AND M17 OPINIONS OF PROBABLE COST

Table D.1: M10, O8-Pond Retrofit, Cost Estimate

Item #	Item Description	Unit	Unit Price	Amount	Total Price
1	36" RCP Pipe	LF	\$ 75	30	\$ 2,250
2	6. Dia Manhole	each	\$ 7,500	1	\$ 7,500
3	New Headwall	each	\$ 5,000	1	\$ 5,000
4	Excavation and Material Disposal	CY	\$ 40	3600	\$ 144,000
5	Extend PVC Liner.	SF	\$ 3	18200	\$ 54,600
6	Rip Rap	CY	\$ 70	50	\$ 3,500
7	Access Drive	LS	\$ 5,000		\$ -
8	Sidewalk Replacement	SF	\$ 10		\$ -
9	Concrete Curb Replacement	LF	\$ 30		\$ -
10	Rock and Boulder Excavation	CY	\$ 200	0	\$ -
11	Erosion Control	LS	\$ 10,800	1	\$ 10,800
12	Landscaping	LS	\$ 10,000	1	\$ 10,000
13	Mobilization and Miscellaneous Work (10%)	LS	\$ 23,800	1	\$ 23,800
<b>SUB-TOTAL:</b>					<b>\$ 261,450</b>
	Design and Construction Engineering (20%)	LS	\$52,300	1	\$ 52,300
	Contingency (15%)	LS	\$47,100	1	\$ 47,100
<b>TOTAL:</b>					<b>\$ 360,850</b>

Table D.2: M17, 288 Flynn Ave/Champlain Parkway, Cost Estimate

Item #	Item Description	Unit	Unit Price	Amount	Total Price
1	24" RCP Pipe	LF	\$ 65	300	\$ 19,500
2	4' Dia Catch Basin	each	\$ 3,000	2	\$ 6,000
3	New Drainage Manhole	each	\$ 5,000	1	\$ 5,000
4	6' x 6' Detention Pond Outlet Structure	each	\$ 15,000	1	\$ 15,000
5	Excavation and Material Disposal	CY	\$ 1,100	150	\$ 165,000
6	Rip Rap	CY	\$ 70	50	\$ 3,500
7	Access Drive	LS	\$ 5,000	1	\$ 5,000
8	Sidewalk Replacement	SF	\$ 10	100	\$ 1,000
9	Concrete Curb Replacement	LF	\$ 30	20	\$ 600
10	Rock and Boulder Excavation	CY	\$ 200	0	\$ -
11	Erosion Control	LS	\$ 11,000	1	\$ 11,000
12	Landscaping	LS	\$ 10,000	1	\$ 10,000
13	Mobilization and Miscellaneous Work (10%)	LS	\$ 24,200	1	\$ 24,200
<b>SUB-TOTAL:</b>					<b>\$ 265,800</b>
	Design and Construction Engineering (20%)	LS	\$53,200	1	\$ 53,200
	Contingency (25%)	LS	\$66,500	1	\$ 66,500
<b>TOTAL:</b>					<b>\$ 385,500</b>



## APPENDIX E: DESIGN AND CONSTRUCTION SCHEDULE

