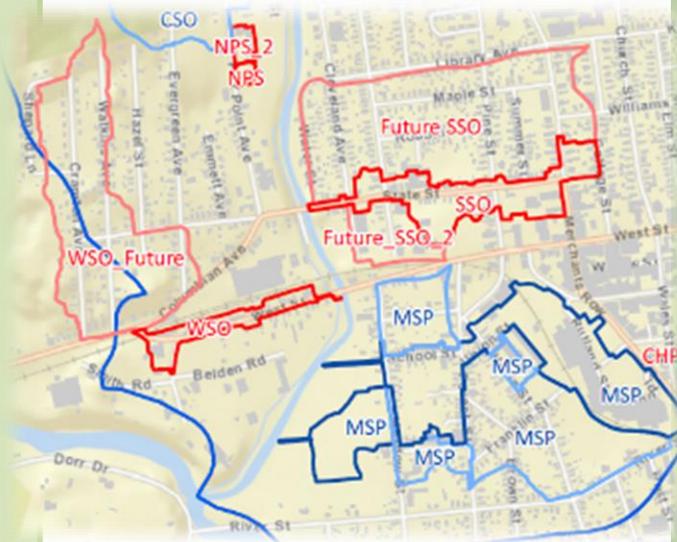




TENNEY BROOK / EAST CREEK WATERSHED – STORMWATER MASTER PLAN

RUTLAND, VERMONT

FINAL REPORT
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I. Disclaimer

The intent of this report is to present the data collected, evaluations, analysis, designs, and cost estimates for the Tenney Brook – East Creek watershed under a contract between the Rutland Natural Resources Conservation District and Watershed Consulting Associates, LLC. Funding for the project was provided from the Vermont Ecosystem Restoration Program (ERP) under grant contract ERP #2014-ERP-1-02. The plan presented is intended to provide the watershed impervious surface owners (primarily the City of Rutland) a means by which to identify and prioritize future stormwater management efforts in the watershed. This planning study presents one recommended potential collection of Best Management Practices (BMPs) that would address specific concerns voiced by the City of Rutland and the Natural Resources Conservation District. There are certainly other BMP strategies that could be implemented in the watershed – these are the sites and practices that project stakeholders felt would have the greatest impact and the greatest probability of implementation. **These practices do not represent a regulatory obligation of any type, nor is the City of Rutland or any other property owner within the watershed bound to implement them.**

1 Project Overview

In May 2013, the State of Vermont Department of Environmental Conservation (VTDEC) issued a document titled Vermont Stormwater Master Planning Guidelines. This document is designed to provide communities in Vermont with a standardized guideline and series of templates to assist them in planning for future stormwater management practices and programs. Vermont has had stormwater regulations in place since 1978, with updates concerning unified sizing criteria in 2002. Currently, the State is re-writing the stormwater manual to reflect new priorities. The State recognizes that managing stormwater can be a costly endeavor – the guidelines are written to help identify the appropriate practices for each watershed, community, and site in order to maximize the use of funds.

The guidelines encourage each stormwater master plan (SWMP) to follow the same procedures. They are:

- Problem Definition
- Collection of Existing Data
- Development of New Data



- Existing and Proposed Program, Procedure, or Practice Evaluation
- Summary and Recommendations

In keeping with these guidelines, we have prepared the following report which will detail the methods regarding problem definition, the collection of existing data, the development of new data, the development of proposed practices and procedures, and the final summary and recommendations for the stakeholders concerned.

2 Background

2.1 Problem Definition

Tenney Brook and East Creek, in Rutland Town and Rutland City are watersheds that are subject to a multitude of development-related stressors including non-point urban runoff which have degraded water quality, to the extent that East Creek is listed as impaired for E.coli contamination. Moon Brook, however, adjacent to the project watershed has been listed as stormwater-impaired by the VTDEC and is now subject to a costly and complicated Flow Restoration Planning process.

Impervious cover within the watershed is high due to the mixed residential, commercial, and industrial uses that occur there. The East Creek watershed is split between the City and Town of Rutland. The portion within the Town of Rutland is more rural, with fewer contiguous blocks of residential or commercial development.

In an effort to more efficiently address the stormwater management issues facing the watershed, and to most wisely allocate potential future project budgets, this stormwater master plan focuses on the watershed within the City of Rutland. By using this strategy, the hope is that current condition of the streams within the watershed can be maintained and potentially significantly improved to keep them off the impaired waters list.

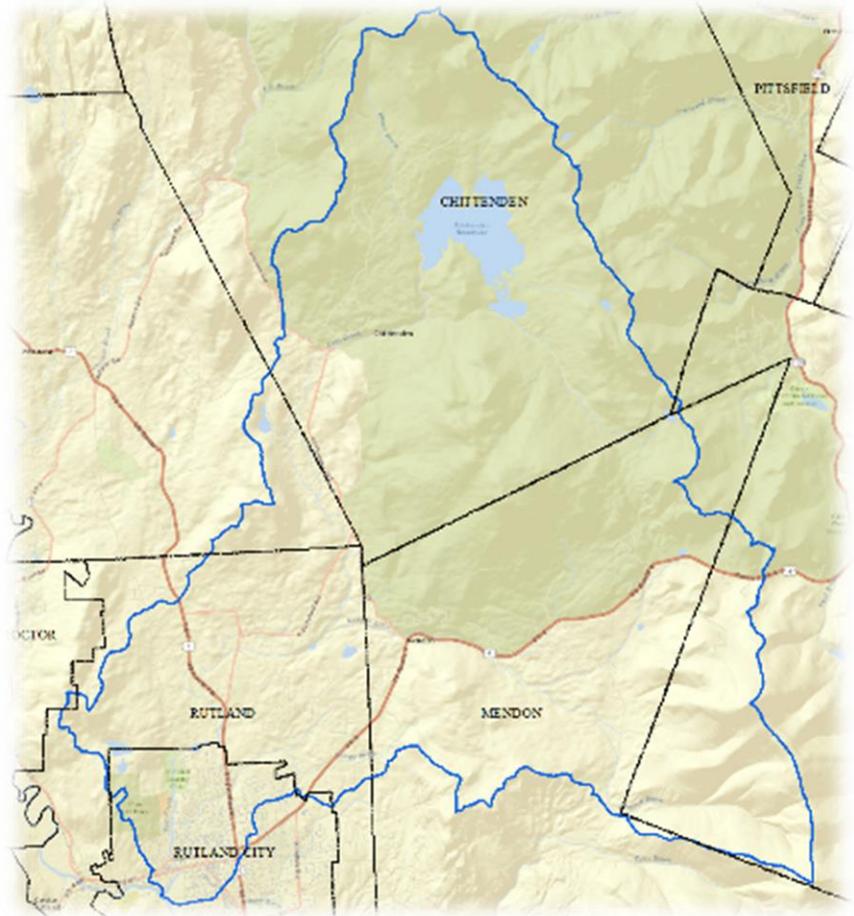
To accomplish this, potential projects rely on a mix of Green Stormwater Infrastructural development where possible, and more traditional end-of-pipe stormwater Best Management Practices where applicable in order to use the most effective tools possible.

2.2 East Creek and Tenney Brook – Existing Conditions

East Creek originates in the town of Mendon and flows northwesterly into the Chittenden Reservoir, which is dam-controlled and used for the generation of hydroelectric power. East Creek flows through the towns of Mendon, Chittenden, and Pittsford before reaching Rutland Town and City. Tenney Brook is a tributary to East Creek, originating in the northeast corner of Rutland Town and joining East Creek in Rutland City.



The watershed as a whole has approximately 1,244 acres of impervious cover (based on the impervious cover data layer 'Land_IMPERVLCB2011' generated by the Spatial Analysis Lab using high-resolution aerial imagery). Impervious cover accounts for approximately 3% of landuse within the watershed. The distribution of impervious cover is markedly different for the towns concerns – in East Creek's upper reaches in Mendon, Chittenden, and Pittsford, the impervious cover percentage is only 1% of the total land area. Rutland Town possesses more at 5% of the total watershed while Rutland City increases substantially to 25%.



Land use in the upper reaches is primarily rural residential and agricultural, with some upland forests while Rutland Town and City are primarily semi-urban residential areas with industrial and commercial uses intermixed, especially within Rutland City.

The East Creek watershed – much of the land in the upper reaches of Chittenden and Mendon are largely forested and undeveloped, while development increases in Rutland Town and City.



Town	Impervious Cover (ac)	Watershed within Bounds (ac)	% Impervious
Watershed Total	1,244	39,242	3%
Rutland City	541	2,114	26%
Rutland Town	326	5,987	5%
Other Towns	374	31,123	1%

East Creek watershed acreage totals and impervious coverage broken down by municipal boundary.

2.2.1 Stressors on the Watershed:

The dam control and periodic release does result in low dissolved oxygen in certain reaches of the East Creek near the Reservoir as water released through the dam is generally drawn from lower in the water column. This condition is primarily associated with the area below the dam up to four miles downstream. This condition has resulted in the listing of East Creek on the State’s List of Impaired Waters.

East Creek is also stressed by moderately high levels of phosphorous, associated with both fertilizer from lawns and gardens, as well as discharges from combined sewer overflows. These stressors were observed to be worst in the lowest reaches of the East Creek in Rutland City. Combined sewer overflows also contribute to possible E. coli contamination within the Creek, which has led to its listing on the State’s List of Impaired Waters as well. There is some evidence that the stream’s ecosystem is affected by temperature stressors associated with its passage through the urban environment, as well as iron pollution in a small tributary from unknown sources.

Tenney Brook, as a primarily urban stream, is stressed in its lowest mile by sediment inputs from stormwater runoff, as well as temperature effects associated with the urban environment. It has been listed by the State a priority water in need of further assessment. Existing assessments of its ecosystem indicate that macro-invertebrate health within the stream is generally good while fish populations are fair.



3 Data Collection

3.1 Existing Data Collection – Data Library Development

The data library developed for the watershed consists of four primary categories:

- Stormwater Permits
- GIS Data
- TMDL Development Documents
- Watershed Reports

3.1.1 Stormwater Permits:

Under the Stormwater Permits category, all stormwater permits within both the watershed and within the administrative boundaries of the City and Town of Rutland were pulled from the VTDEC database and should be considered current as May, 2014.

Permits were divided into Town, City, and Public Property permit categories (though it should be noted that no permits were found on publicly-owned parcels within the Town of Rutland). As this watershed is not currently under an MS4 jurisdiction, there will likely be no regulatory onus to retrofit or re-develop stormwater management features on private property, therefore publicly owned stormwater permits were examined to determine whether or not they could play a more significant role in the SWMP for this watershed.

Of the four found within the City of Rutland, none were determined to be of high priority for future projects. One permit covers the City’s landfill and presents little opportunity for retrofit, while one permit covers the State-owned Marble Valley Correctional Facility, which has little viable land for creating a larger management feature. The remaining two permits cover stormwater discharge from a small public housing development on Pine Street and a residential development in the north-east corner of the City on Wendy Lane near the Home Depot. The housing at Pine Street presents too many space constraints to plan any larger retrofits, while the residential development on Wendy Lane is isolated in terms of routing drainage to it.

Summary information for all permits and primary documents for the four publicly owned permits can be found in Folder A-1 – Stormwater Permits.

Please note that there is an Excel-based spreadsheet document titled ‘East_Creek_SW_Permits_Rutland_Town_and_City.xlsx’ with specific information for each permit, divided by City, Town, or Public Land. In this document are links to PDF documents hosted by the Vermont Agency of Natural Resources describing the permit. It was decided to organize and present the permit data in this manner to not duplicate existing efforts and to reduce data storage space for the finished library.



3.1.2 GIS Data:

GIS data was drawn from a variety of public resources including the Agency of Natural Resources's Atlas, Vermont Center for Geographic Information, UVM's Spatial Analysis Lab, and the City and Town of Rutland's Public Works Departments. Select processing of the data was performed (noted in Table A-1: Data Library Table) to ensure that it is relevant and responsive to the needs of this particular SWMP. Individual ArcGIS shapefiles were then combined into a geodatabase file structure for ease of use and data migration from platform to platform. These data represent the most current available, however GIS data within the State of Vermont is very dynamic – these data should not be regarded as the 'final' version. Download or access dates were noted for all data to indicate vintage.

These data layers serve as the starting basis for the development of new GIS data. All new or developed data are collected in a separate geodatabase file.

Existing GIS data can be found in Folder A-2 – Existing GIS Data. Descriptions of each layer can be found in Table A-1: Data Library Table.

3.1.3 Total Maximum Daily Load (TMDL) Development Documents:

TMDL Development documentation is included primarily because the TMDL development for Moon Brook used the East Creek watershed as an 'attainment stream' and therefore contains pertinent information on the hydrology within the East Creek watershed. There is currently no specific TMDL requirement for the East Creek watershed. Descriptions of the two reports obtained are outlined in Table A-1: Data Library Table.

These documents can be found in Folder A-3 – TMDL Development Documents.

3.1.4 Reports:

The Reports folder contains all available reports pertaining to the East Creek watershed that WCA was able to find after speaking with various State agencies and officials, UVM personnel, and City and Town officials. These reports include the Rutland Regional Planning Commission's geomorphic assessment for the East Creek watershed (and beyond in the Otter Creek watershed), UVM's Vermont stormwater flow monitoring study detailing the methodology used to obtain target reductions for stormwater-impaired waterways, the Otter Creek Basin Management Plan prepared by the VT ANR, the Otter Creek Basin Stormwater Mapping Project outlining all stormwater conveyances, the VT DEC's aquatic species monitoring data and report, as the Town of Rutland's Storm Water Management Plan submitted to the VT DEC.

Descriptions of these reports, as well as the completeness and quality of each, can be found in Appendix 1: Data Library Table. The source documents can be found in Folder A-4 – Reports.



Please note that there is an Excel-based spreadsheet in this folder containing source data for Biomonitoring and Aquatic Species Data.

3.2 New Data Development

In order to more accurately prioritize potential stormwater management projects in the watershed, a variety of data had to be either refined or developed. The primary data development undertaken for this SWMP was the creation of specific GIS-based data layers to aid in the streamlining, and in some cases automation, of hydrologic, hydraulic, and water quality modeling for the design, sizing, evaluation, and prioritization of projects.

Additionally, once priority sites had been identified through desktop surveying and stakeholder input, several of them were surveyed for more accurate topography and infrastructure placement.

New data developed for this project includes:

- Land use layers
- HydroCAD models for each of the Tier 2 Project Sites
- WinSLAMM models for each of the Tier 2 Project Sites

Land Use Data:

Accurate land use data is of primary importance in modeling application for stormwater management and is often the most constraining bottle-neck in the modeling workflow. Developing data is time-consuming and resource intensive. For this SWMP, a layer was produced using a mix of existing layers (impervious cover developed for the Lake Champlain basin in 2011 and building footprints provided by the City of Rutland) as well as layers developed using heads-up digitizing of pertinent features too small to be capture on either of these layers (sidewalks, driveway, etc.), and finally layers derived using geoprocessing of the aforementioned layers to obtain a layer describing expanses of open space and forested lands.

The categorization of the land usage for these properties lends itself well the use of HydroCAD hydrologic and hydraulic modeling software, critical for the design of BMPs with respect to runoff retention volume and timing. These categories are also useful in the use of WinSLAMM, an urban runoff water quality modeling program that can assist with the prediction of pollutant loading for particular drainage areas and the potential pollutant reduction associated with certain management practices.

Developing this land use data and using these two models in conjunction can allow the more accurate prediction of peak discharge rates, volumes retained and infiltrated, and pollutant loads reduced. These data are important for the prioritization methods used in this SWMP to rank projects.



HydroCAD Models:

In order to properly size and design BMPs for the project sites, each site was modeled using HydroCAD Build 13 Version 10. This generated runoff discharge rates and volumes. Additionally each project site was modeled for the water quality volume (WQv) using a modified curve number method as typical curve number methods embedded within HydroCAD don't always accurately portray the volumes and discharge rates associated with smaller WQv storms. The model data for both of these model runs can be found in Appendices 10a and 10b.

WinSLAMM Models:

While HydroCAD will accurately model runoff volume and peak discharge rate, it does not model pollutant washoff. WinSLAMM is a specialized modeling program developed primarily for use in urban and semi-urban environments to model pollutant loading associated with a drainage area and its land use. Using WinSLAMM and modeled BMPs, pollutant load reductions were derived for each Tier 2 Project Site in order to assist with ranking. All WinSLAMM models are presented in Folder A-6 in their entirety.

Data refined for this project includes:

- Stormwater Subwatersheds
- Proposed Future Stormwater Subwatersheds

Also critical in the modeling process is the use of accurate drainage area delineations. The VT DEC has, over the years, developed stormwater-specific subwatersheds for many areas in the State. While these subwatersheds are generally accurate, it's often necessary to verify the boundaries using a combination of high resolution topography information and field verification.

The City of Rutland has also developed their own stormwater subwatersheds based around the infrastructure that is slated for separation from the combined sewer. In many locations these subwatersheds are in agreement with those developed by the State, while in others they are not.

Once the final priority sites had been selected, the drainage area delineations from the VT DEC and the City of Rutland were combined. Any overlaps between the delineations were examined and eliminated where necessary. The delineations were overlaid with 2' LiDAR derived contours and aerial photos to determine any more necessary changes based on topography or building infrastructure. Once these delineations had been created, field visits were conducted along borders that were deemed to be inconclusive based on topography or building infrastructure and corrected if necessary.

Please note that it was beyond the scope of this project to verify, for the purposes of creating some of the 'concept-level' designs, to individually verify stormwater infrastructure, either the existing separate stormwater sewer as mapped by the VT DEC or the potential future stormwater sewer to be separated from the combined sewer. Certain projects, such as the Giorgetti Arena Parking lot and Preville Street Extension, as well as the Lincoln Avenue Right-of-Way, required greater detail for both the topography and the infrastructure. These sites were surveyed and the infrastructure confirmed.



Data collected after the initial GIS-based data library was assembled includes:

- 2' contour LiDAR data for the City of Rutland
- Building Footprints for the City of Rutland
- Proposed Future Stormwater Sewer Disconnections
- Proposed Future Stormwater Subwatersheds

These data were provided by the City of Rutland and were used and are presented 'as-is', with the exception of the Proposed Future Subwatersheds (see description of data revisions above).

All of these data are collected in a single GIS geodatabase and are located in Folder A-5.

4 Proposed Best Management Practices

4.1 Tier 1 – Initial Potential BMP Site Evaluation

The process of BMP identification consisted of first assessing existing stormwater permit to determine if there were any publicly-owned properties with existing BMPs that could be either expanded or upgraded. After finding that none of the four were particularly suitable, an examination of public parcels with existing separate stormwater sewer outfalls, or public parcels in proximity to stormwater sewer lines was conducted. See sub-section 4.1.1 – Publicly Owned Potential Project Sites.

Additionally, any existing separate stormwater sewer system outfalls were evaluated for possible suitability for stormwater BMPs. These sites were compiled into an initial list as the 'Tier 1' Project Sites. A full list of these sites, including descriptions of the stormwater subwatershed size and impervious cover, as well as the potential BMP for it, are listed in Appendix 2 – Tier 1 Project Sites (full report). This document also includes a large-scale map showing the potential project sites and subwatersheds.

4.1.1 Publicly Owned Potential Project Sites:

In all, several sites were identified that met this criteria including

- CHP – City Hall Parking lot
- WSO - West Street Outfall
- GAP – Giorgetti Arena Parking lot
- RPO – Rotary Park Outfall
- MSP – Meadow Street Park

Additionally several other projects were identified that were partially or completely within the transportation corridor right-of-way including



- PSE – Preville Street Extension
- OSO – Oak Street Outfall
- R7R – Route 7 Right-of-Way
- CGO – Crescent and Grove Right-of-Way
- LAR – Lincoln Avenue Right-of-Way

Note that not all of these projects were selected by the project stakeholders for final priority site analysis and ranking but are mentioned here as they are potential projects in the future.



4.2 Tier 2 – Potential BMP Priority Site Evaluation

After reviewing all Tier 1 projects with the City of Rutland and the Rutland NRCD staff, a final list of ten project sites was selected based on the City’s priorities, potential feasibility, and overall water quality impact. Tier 2 subwatersheds were then modeled for hydrologic, hydraulic, and water quality concerns to provide inputs for the ranking matrix used to prioritize them.

ID	Site ID	BMP Type	Retrofit Description	Total Score	Rank
WSO	West Street Outfall	Underground Recharge Gallery w/Offline Hydrodynamic Separator	An underground stone-filled infiltration gallery will be installed to filter and infiltrate runoff.	32	1
RPO	Rotary Park Outfall	Underground Storage Chambers	Underground stormwater storage chambers to infiltrate runoff.	31	2
FAO	Field Avenue Outfall	Gravel Wetland	Gravel wetland with allowance for ponding with controlled outlets	29	3
GAP	Giorgetti Arena Parking Lot	Bioretention	Bioretention practice and vegetated filter strip conveyances will be created to manage SW runoff from parking lot and part of adjacent roadway.	29	3
LAR	Lincoln Avenue Right-of-Way	Bioretention	Bioretention practices to be installed in right-of-way to promote SW infiltration and provide traffic-calming.	26	4
NPS 2	Northwest Primary School Pipe Outfalls	Splash Pads and Infiltration	Stone splash pads and stone swale will reduce erosion associated with piped runoff outfalls	25	5
NPS	Northwest Primary School Parking Lot	Stone Diaphragm	Rip-rap stone diaphragm will disperse force of runoff from main parking lot and encourage infiltration.	25	5
BSS	Baxter Street Swale	Regenerative Stormwater Conveyance	At the outfall of an existing SW outfall, a series of step-pools will reduce erosion and promote infiltration	24	6
SSO	State Street Outfall	Bioretention w/Offline Hydrodynamic Separator	Bioretention with offline hydrodynamic swirl separator for pre-treatment	23	7
ASO	Adams Street Outfall	Offline Hydrodynamic Separator	Underground offline hydrodynamic swirl separator to remove some sediment and other pollutants	23	7
CHP	City Hall Parking Lot	Underground Storage Chamber	Underground concrete chamber with controlled outlet to collect and slowly release SW runoff	21	8
PSE	Preville Street Extension	Green Gutter' Bio-infiltration strips	Vegetated bio-infiltration 'gutter' will border roadway travel lane and proposed bike path	19	9

This table is a summary of the overall Tier 2 Project Site ranking matrix. This matrix, in its entirety, can be found in Appendix 3 – Tier 2 Projects – Full Ranking Matrix.



5 Proposed Best Management Practices (BMPs)

The final list of ten BMPs includes seven infiltration-based practices, three filtration-based practices, and one stand-alone offline hydrodynamic separator for water quality treatment. Eight of these practices will fully treat the water quality volume (WQv) from their respective subwatersheds, one will treat 50% of the WQv, while three of them are expected to treat greater than 80% of the 1-year channel protection volume (CPv) storm. Of the ten, two of the practices are considered to be 'green streets' practices, while seven of the practices use some form of green stormwater infrastructure.

If all projects are implemented a total of 103.8 acres of impervious cover would be managed within the City of Rutland. The potential annual total suspended solids (TSS) load reduction would be approximately 89,910 lbs. while the potential annual total phosphorous (TP) load reduction would be approximately 81 lbs.

In addition to these water quantity and quality benefits, a number of these BMPs have auxiliary benefits such as recreational or educational benefits, erosion control, or habitat creation or protection. While these benefits are less quantifiable than pollutant reduction, they still have demonstrable value to the community.



5.1 Proposed BMPs – Project Prioritization Matrix

5.1.1 Primary Scoring Criteria for Proposed BMPs:

Criteria	Quality	Score
Impervious Acres Managed (ac)	> 20 acres	5
	10-20 ac	4
	2-10 acres	3
	1-2 acres	2
	< 1 acre	1
Channel Protection Volume Mitigated	>80%	2
	<80%	0
Relative Project Cost	<\$10K	6
	\$10-20K	5
	\$20-50K	4
	\$50-100K	3
	\$100-500K	2
	\$500K+	1
Volume Treated (ac-ft)	<1 ac-ft	1
	1-2 ac-ft	2
	2-5 ac-ft	3
	5-10 ac-ft	4
	10+ ac-ft	5
Annual TSS Load Mitigation (pounds)	<100 lbs	1
	100 - 1,000 lbs	2
	1,000 - 5,000 lbs	3
	5,000 - 10,000 lbs	4
	10,000 - 20,000 lbs	5
	20,000+ lbs	6
Annual TP Load Mitigation (pounds)	0-0.5 lbs	1
	0.5 - 1.0 lbs	2
	1 - 5 lbs	3
	5 - 10 lbs	4
	10 - 20 lbs	5
	20+ lbs	6

Primary Scoring Criteria for Proposed BMPs.



The Primary Scoring Criteria for Proposed BMPs is based on impervious acreage managed, water quantity and quality treatment, relative project cost. After evaluating each modeled outcome in WinSLAMM and HydroCAD, natural break groupings were determined from the outcomes.

5.1.2 Secondary Scoring Criteria for Proposed BMPs:

Criteria	Quality	Score
Permitability	Minimal Issues/Concerns or no permits	2
	Complex issues/Potential permit denial	0
Land Availability	City owned	4
	Non City owned regulated (expire permit)	3
	Non City owned/Participatory Owner	2
	Unknown	0
	Not City owned/Non participatory owner	-2
Other Project Benefits	Infrastructure Improvement (e.g. Culvert Replacement)	1
	Provides treatment for site covered under expired permit	1
	Educational/Functional Benefit	1
	Recreational	1
	Natural Habitat Creation/Protection	1
	Outfall Erosion Control	1
Ease of O/M	Underground Storage/ Swirl Separator	2
	Bioretention/Rain Gardens/Tree Box Filters	1
	Ponds/Constructed Wetlands	0

Secondary scoring criteria were also used in the ranking matrix to ascertain the potential less-quantifiable benefits of each project with respect to its aesthetic, educational, recreational, or habitat benefits, as well as its feasibility and maintenance burden.



5.1.3 Cost Summary:

The table below represents the estimated cost for each project in the SWMP. The reasoning for this is presented in Section 5.1.4 Cost Estimation. A detailed explanation of specific cost breakdown with all the factors is presented in Section 5.1.4 Cost Estimation is found in Appendix 6 – BMP Cost Summary Matrix.

BMP ID	Total Implementation Cost Estimate
CHP - City Hall Parking Lot	\$ 9,826.64
GAP - Giorgetti Arena Parking (Infiltration Strip)	\$ 14,061.05
NPS - Stone Diaphragm	\$ 22,303.55
NPS - Splash Pads and Infiltration	\$ 27,879.44
PSE - Preville Street Extension	\$ 42,183.14
BSS - Baxter Street Swale	\$ 44,995.35
ASO - Adams Street Outfall	\$ 45,000.00
LAR - Lincoln Avenue Right-of-Way	\$ 53,119.00
GAP - Giorgetti Arena Parking (Bioretention)	\$ 78,116.93
SSO - State Street Outfall	\$ 643,039.86
FAO - Field Avenue Outfall	\$ 643,421.35
RPO - Rotary Park Outfall	\$ 849,500.00
WSO - West Street Outfall	\$ 683,665.84

5.1.4 Cost Estimation:

For each Tier 2 project, a rough cost estimate was developed that takes into account

- Base cost (based on a cost estimate for each cubic foot of BMP, where applicable)
- Labor cost (which is calculated but not added to the final project cost)
- Planting cost
- Final Design and Permitting cost
- Implementation cost
- Urban Contingency cost

❖ Base Cost Estimation:

This amount is derived from the following calculation:

$$BMP \text{ volume (ft}^3\text{)} \times \$5.30/\text{ft}^3 \text{ (2006 EPA Estimate)} \times 3\% \text{ annual inflation (2006-2014)}$$



❖ Labor Cost Estimation:

This amount is split out from the Base Cost and represents roughly 75% of the Base Cost total. This is presented to show estimated cost of labor, a source of potential savings for some projects where labor will be performed by municipal crews as ‘in-kind’ labor donation.

$$\text{Base Cost} \times 1.75$$

❖ Planting Cost Estimation:

This amount is based on a real-world project implemented in Waitsfield, VT during the summer of 2012 and reflects prices of locally-sourced ornamental perennials suited for Bioretention practices in a high-sediment, high-chloride environment such as those found in urban stormwater runoff applications.

$$\text{BMP ft}^2 \times \$3.09/\text{ft}^2$$

❖ Final Design and Permitting Cost Estimation:

This cost is based largely on the Base and Planting Costs, as these are the aspect of a project most likely to change as the project moves toward implementation.

$$(\text{Base Cost} + \text{Planting Cost}) \times 30\%$$

❖ Implementation Cost Estimation:

This represents the basic, no-contingency cost to put the BMP in the ground. It’s simply the sum of Base, Planting, and Design and Permitting Costs.

❖ Urban Contingency Cost Estimation:

This represents 10% of the total Implementation Cost and is reflective of the potential for cost overruns while working in an urban to semi-urban environment such the City of Rutland. Reasons for using the Urban Contingency can consist of utility conflicts, traffic management and interference, weather delays, etc.



5.2 Proposed BMPs – Concept Descriptions

Please refer to Appendix 4 – Concept Design Layouts for maps and illustrations of each Tier 2 Project Site, along with additional information for each. Appendix 5 – Proposed BMPs – One Page Summaries includes a detail sheet for each project site with a BMP description, model outcome data, and proposed BMP specifications, as well as a site photo for each.

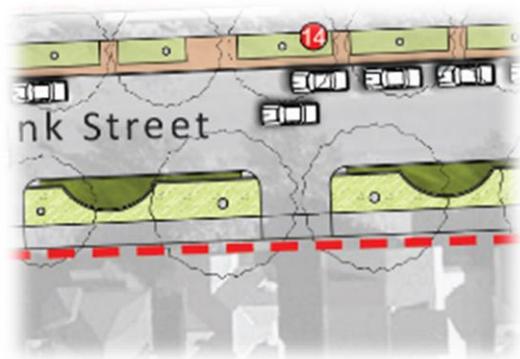
(PSE) – Preville Street Extension – Green Gutters

The proposed retrofit along Preville Street Extension will take the form of ‘green gutters’ at the edge of the road corridor. ‘Green gutters’ are essentially vegetated swales allowing runoff to enter, filter through the vegetation, and infiltrate back into the ground. In this case the ‘green gutters’ could also be simple stone cobble-topped areas with massed plantings at regular intervals.

The City of Rutland is currently planning to turn Preville Street Extension, which leads to the publicly-owned Giorgetti Arena, into a one-way street with a recreational path running alongside. The path’s terminus will be at the Giorgetti Arena parking lot. The creation of this path will allow the ‘green gutters’ to serve an education purpose as well as managing stormwater runoff. The inclusion of green space between the road corridor and the recreational path will also serve to keep users of the road and path separated, leading to fewer automobile/pedestrian or biker conflicts. Additionally the narrowing of the road and the visual cues provided by the ‘gutter’ will have a traffic calming effect.



Concept illustration of in-street green gutters to capture and infiltrate stormwater runoff.



The creation of a ‘green gutter’ along Preville Street Extension is estimated to remove 268 lbs. of sediment and 0.40 lbs. of phosphorous annually from runoff, as well as eliminating several points of erosion currently degrading the banks of the East Creek along this section of road.

The City of Rutland has expressed their desire to see this project implemented for its functional, recreational, and educational values.



(GAP) - Giorgetti Arena Parking Lot - Bioretention

Several different options are viable for the parking lot area of Giorgetti Arena. Currently, runoff from the parking lot is either sheet flowing to a grassy area and running over a steep bank down to the East Creek, or it flowing to Preville Street Extension out the entrance to the parking lot, entering a shallow paved channel and running over the bank to the East Creek. This runoff has carved an eroded channel over time.



The primary option for Giorgetti Arena is a Bioretention practice located where the entry way grassy area and 'Oculus' monument are currently. This practice is designed to handle the full water quality volume (WQv) coming off the parking lot, as well as part of Preville Street Extension, removing nearly 1,000 lbs. of sediment and 0.8 lbs. of phosphorous annually, as well as eliminating a highly eroded outfall to East Creek. As the terminus of the Rutland recreational path will be in the Giorgetti Arena parking lot, the Bioretention practice design can integrate the path, melding stormwater management and recreational activities to create an educational opportunity.



Concept illustration of an infiltration swale located next to a parking lot.

Secondary options at Giorgetti Arena include the creation of a vegetated swale in the grassy margin between the parking lot and Oak Street Extension, or the integration of green islands within the parking lot itself to capture runoff, provide some filtration and infiltration, and increasing the overall length of the treatment train for runoff on the lot. The inclusion of trees within these green islands would also increase rainfall interception, increase evapotranspiration, and provide shading and aesthetic benefits for the parking lot and its patrons. These features could be incorporated with a minimum loss of parking spaces.

Additionally a roughly 5' wide stone-topped infiltration trench could be built along the access road leading to the baseball field and overflow parking for the arena. The trench would capture runoff from the road and part of the arena roof, filtering and infiltrating it before it could run over the back to the East Creek. This practice would remove 199 lbs. of sediment and 0.17 lbs. of phosphorous annually.

(BSS) – Baxter Street Swale – Regenerative Stormwater Conveyance

The existing outfall located behind two residences on Baxter Street is eroded and is transporting not only sediment and nutrient-laden stormwater runoff to East Creek but is also creating riparian erosion and transporting river bank sediment into the Creek. Protecting this outfall, as well as providing a means for runoff to infiltrate, was the key design concern for this site.



Concept illustration of a RSC (Illustration Credit: UMCES.edu)



Existing conditions at the Baxter Street outfall. Erosion worsens beyond the wood edge.

In creating what is known as a regenerative stormwater conveyance, or more commonly known as a ‘losing stream’, stormwater runoff will enter a series of four trench pools excavated perpendicular to the land slope. As the soil here has an adequate to good capacity for infiltration, runoff would spread over the surface of each trench pool in succession and infiltrate into groundwater. 100% of the WQv could be infiltrated using this practice, resulting in an annual sediment reduction of 2,850 lbs. and an annual phosphorous reduction of 2.42 lbs. Additionally this practice would eliminate erosion currently present on the site.

The City of Rutland currently has a ‘handshake’ agreement for access to the stormwater outfall in this residential area. It is anticipated that an agreement would need to be reached with the landowners as far as compensation for property.



(WSO) – West Street Outfall - Infiltration

The proposed retrofit is located on a City-owned parcel of land on the banks of East Creek. The existing outfall is a separate stormwater sewer system, but the overall future watershed will be up to 51.30 acres, 17 acres of which is impervious cover. This existing separated drainage system is largely industrial and the associated streets see high traffic, making this a potential hot spot for pollutants. The future drainage area to be connected is largely residential and extends up a hill, potentially resulting in a significant amount of stormwater runoff.



View into the West Street Outfall publicly owned parcel.

By creating an approximately 9,000 square foot underground stone infiltration gallery, 100% of the WQv could be treated, resulting in an annual reduction of 33,274 lbs. of sediment and 24.21 lbs. of phosphorus. Combining this practice with a hydrodynamic swirl separator would extend the life span of the gallery by allowing for easy sediment removal from the separator. Please see Appendix 7 – Hydrodynamic Separator Specification Sheets for more information on this device. A flow splitter would ensure that only the WQv enters the practice - overflow would be directed to East Creek.

This nature of this practice is such that overall aesthetic of the parcel could remain largely unchanged. The opportunity to create a pocket park or similar open, public space along the banks of the Creek would still exist, all while managing stormwater runoff.

(LAR) – Lincoln Avenue Right-of-Way – Bioretention / Green Streets

The proposed project in the Lincoln Avenue Right-of-Way is unique in that it presents the City of Rutland with the opportunity to re-create a vision of an aesthetic, tree-lined boulevard that City planners initially envisioned in the 1890s but never realized. Now, however, it could come with a modern twist in that it would manage stormwater runoff, preventing it from reaching the City's combined sanitary sewer and contributing to combined sewer overflows and the E. coli impairment in East Creek.



Infiltration practices could incorporate level spreaders constructed from re-purposed railway rails, in a nod to Rutland's position as Vermont's 'Rail City'.



Within the 50' ROW that the City of Rutland owns, there are numerous potential scenarios. The City of Rutland has expressed a desire to return the avenue to its original intended configuration where the travel lanes would be divided down the middle by a large green median. The bioretention practice in the media could either be shallow (6-12") or deeper (~3'). The depth of the median bioretention would affect the runoff routing. If deep, piped connections are possible to route runoff from adjacent side streets to the median. If shallow, runoff pathways would be overland over crosswalks and the road travel lane. The road surface would have to be sloped to direct runoff to this central feature. Within this median, filtration and infiltration practices could be designed that would alleviate pressure on the City's combined sewer system. Modeling indicates that approximately 2.37 acre-feet of runoff would infiltrate annually, removing 3,818 lbs. of sediment and 3.04 lbs. of phosphorous.



Stormwater planters, incorporated into the street, could also be an aspect of the Lincoln Avenue Right-of-Way design.

This configuration would also have a traffic-calming effect on the avenue, which is often used as a north-south bypass to Route 7 through the City.

There is also the opportunity to create subsurface infiltration practices on either side of the existing road footprint that would take drainage from the road and sidewalk. These subsurface galleries, in order to receive street drainage, would have to be integrated with the sidewalk surface and allow for passage of runoff underneath them, much like a boardwalk. These 'boardwalks' could be constructed of materials other than wood, if desired, to maximize longevity and increase ease of maintenance. The road surface would have to be sloped to direct runoff to these features.

(FAO) - Field Avenue Outfall – Gravel Wetland

The proposed project at Field Avenue, near the northern border of the City of Rutland, is unique among the Tier 2 projects in that it represents the opportunity to design a treatment system for future separate stormwater sewer. Currently the area proposed for the future outfall is served by a combined sewer. The City plans to separate it and discharge runoff to East Creek.



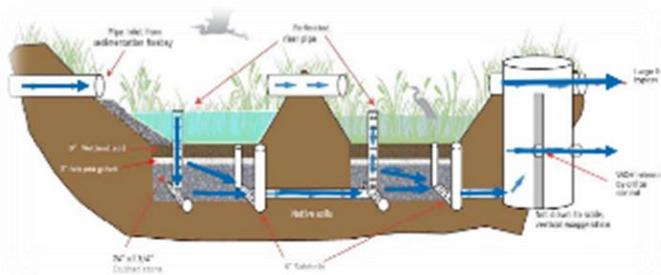
The proposed future separate stormwater system would run parallel to this access road.

The proposed retrofit is a gravel treatment wetland that would treat 100% of the WQV, and has the potential to treat over 80% of the channel protection volume (CPv). A total of 19,951 lbs. of sediment would

be prevented from entering East Creek annually from 9.64 acre-feet of runoff, while over 21 lbs. of phosphorous could be removed.

The property the retrofit would be located on is currently privately held. The City would have to pursue land acquisition. Additionally the outfall would be in close proximity to an existing Class II wetland but could potentially be configured in such a way as to bypass the wetland and discharge treated runoff below the wetland’s outlet or pipe treated effluent directly into the dam-controlled Patch Pond. Accommodating the system footprint to avoid wetland and buffer impacts

is a key consideration in the design feasibility of this project. As greater than 80% of the CPv would be controlled, it is anticipated that the impacts to local hydrology would be minimal.



Typical gravel wetland cross-section (Illustration Credit: UNH Stormwater Center).

(ASO) – Adams Street Outfall – Offline Hydrodynamic Separator

The Adams Street Outfall was identified by the City of Rutland as a particular concern as there is currently a large separate stormwater sewer outfall pipe discharging runoff to Tenney Brook. The drainage area is relatively small currently at 6.8 acres, but will have an additional 29 acres added to it in the future. As Tenney Brook is a relatively small stream at this point, the discharge of sediment associated with this drainage area could have potential negative impacts on the in-stream ecosystem.



The hydrodynamic separator would be located under the pavement before the bridge.

The primary challenge with the Adams Street Outfall is that the location of the outfall is highly constrained. The surrounding residential neighborhood has very little open space, poor soils for infiltration, and the riparian area is narrow. Developing a management practice with a large footprint is not feasible. The most feasible solution in a constrained outfall like this is two-fold.

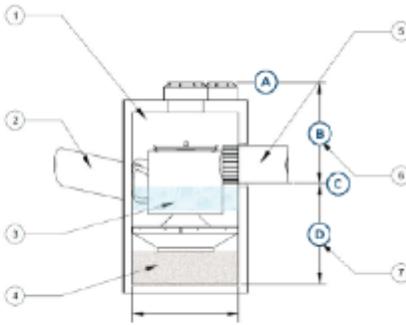
The first step is to attempt to control sediment discharges to the stream via an offline hydrodynamic separator. The proposed retrofit is a 10’ Hydro International Downstream



Defender. Please see Appendix 7 Hydrodynamic Separator Specification Sheets for more detail. Located offline, and therefore having more control over the influent rate, the separator should be able to remove 2,261 lbs. of sediment annually as modeled using WinSLAMM. This amount represents only ~8% of the potential total washoff



1 Vortex Chamber Diameter	10 ft
2 Maximum Inlet Pipe Diameter	30"
3 Oil Storage Capacity	1050 gal
4 Sediment Storage Capacity	8.7 yd ³
5 Outlet Pipe Diameter	30"
6 Minimum Stormdrain Depth	5 ft
7 Standard Depth	9.4 ft



Specifications for the Hydro International Downstream Defender to be used at the Adams Street Outfall.

from the drainage. However the manufacturer claims that sediment removal rates reach nearly 80% for this particular model. The difference in removal percentages is likely due to the use of a generic configuration for the separator in WinSLAMM, which does not take into account the specific measures used by the Downstream Defender. Based on these rates, sediment removal could increase to approximately 20,000 lbs. annually. Modeled removal for phosphorous results in 4.0 lbs. annual removal, however if a larger percentage of sediment does indeed take place, this amount could be much higher.

The second measure for this particular drainage would be to institute a neighborhood-specific program of runoff control. The development of this sort of plan would hinge largely on small, dispersed management practices such as residential rain gardens, in-street Bioretention bumpouts, catchbasin-connected dry wells, and other small-scale practices. This has the potential to reduce the overall runoff being collected and treated by the separator, as well as reducing the ‘flashy’ nature of the outfall. The opportunities and suggestions presented for the State Street Outfall – GSI Overlay would be pertinent here (see below).

(SSO) – State Street Outfall – Bioretention (with Underdrain) and Hydrodynamic Separator

A combined system of a hydrodynamic separator (see Appendix 7) and bioretention with underdrain is proposed for the State Street Outfall, to be placed between Green Mountain Power’s solar panel installation and State Street. An infiltration-based practice is not possible at this location because of the site’s status as a contaminated brownfield from past industrial use involving coal gasification. Review of soil test boreholes shows the majority of the contamination issues related to polyaromatic hydrocarbons (PAHs) and polychlorinated biphenyl (PCBs) to be located on areas of the site farthest from the road. Excavation near the road should pose fewer containment and mitigation challenges.

The team has discussed potentially utilizing the northern portion of the site with Gerold Noyes, Vermont Department of Environmental Conservation project manager. He explained that the



project could be permitted providing underdrainage systems were utilized to prevent any additional volume inputs to groundwater. We also discussed the potential project with Beth Eliason, Environmental Engineer at Green Mountain Power. She did not see any immediate impediments to the project but intended to internally discuss the proposal to confirm this tentative impression. If the project is to move forward additional discussions will be necessary with the Green Mountain Power to confirm the feasibility of citing the project on their land.

The drainage area contributing to this outfall is highly impervious as it is largely old industrial sites with large buildings and associated parking and materials storage areas. Additionally the City has plans to connect two other future separate stormwater sewer systems to this outfall. Though these future drainages are a mix of residential, commercial, and light industrial, the resulting final drainage area is nearly 80 acres, with over 48 acres of impervious surfaces within. With a relatively constrained site and such a large drainage area, treating the full WQv was not entirely feasible. Modeling suggests that 50% of the WQv could be treated on site in a filtration-based practice.

Treating this volume of runoff would lead to an overall reduction of 9,749 lbs. of sediment and 14.06 lbs. of phosphorous annually. There is the possibility that these amounts are low based on the generic configuration used for the hydrodynamic separator (see discussion under ASO – Adams Street Outfall). However, as the overall treatment area is large, with a high percentage of impervious cover, it is advisable that the City look at designating this particular stormwater subwatershed as a high-priority Green Stormwater Infrastructure (GSI) Overlay.

5.2.1 SSO GSI Overlay – Runoff Management Opportunities:

In an area like the State Street Outfall subwatershed with little opportunity near existing outfalls to create a large-scale, end-of-pipe management practice, a favorable option is to pursue small-scale, distributed GSI practices. Within this subwatershed, the soils are generally favorable – most areas are underlain by Hydrologic Soil Group ‘A’ or ‘B’ soils, with two isolated pockets of ‘C’ soils. These soils, which generally drain well, are suitable for the creation of infiltration practices.

Additionally, the topography of the SSO subwatershed is well-suited for the creation of GSI practices. The area is generally gently-graded, with few steep hills which can create challenges for smaller management practices through generation of high-volume fast flowing runoff.

The opportunities for GSI implementation are laid out on the sheet titled ‘State Street Outfall – Green Stormwater Infrastructure Opportunities’ in Appendix 4. A brief description of each of the practices is found below. Please note that these opportunities are presented for planning purposes only and would need to be individually sited and designed prior to implementation.



Bioretention

Also commonly known as a ‘rain garden’, these practices promote the filtration of runoff by vegetation, as well as the infiltration of runoff into soil media and then into groundwater or an underdrain. When used as a full infiltration practice, runoff is reduced. When used with an underdrain in areas where interference with building basements, etc. is a possible concern, runoff is cleaned prior to entering the stormwater system. Bioretention practices can provide a number of street-level and site-level aesthetic benefits.



Bioretention Bump-out

These practices are essentially in-street bioretention practices they protrude into the street corridor where possible. Using curb-protected edging to prevent traffic from running into them, they rely on curb-cut inlets to allow runoff to enter. In many cases in the SSO subwatershed, they can be easily integrated along the margins of roads between the sidewalk and street. In addition to treating runoff, they also provide traffic-calming through road width reduction. They do require the removal of parking spaces or part of the travel lane.



Stormwater Planter

Similar to Bioretention Bump-outs, Stormwater Planters can be implemented between the street corridor and the sidewalk, typically without taking up any of the travel lane or parking spaces. With such a small, low-impact footprint, planters can be an ideal solution for managing runoff from small drainages without taking up parking or travel space.





Cistern



The use of cisterns to capture rooftop drainage can be beneficial in many ways. By removing runoff that would otherwise have entered the combined or separate stormwater sewer systems, overall volume and flow can be reduced. Additionally, rooftop runoff is typically cleaner than road or other impervious surface runoff. Rooftop runoff can usually be re-used for landscaping irrigation with little concern for water quality. Cisterns can be installed either on the surface or sub-surface, depending on space constraints.

Pervious Pavement or similar

The SSO subwatershed is a relatively high-traffic area with the need to maintain travel ways wherever possible. Using a pervious pavement (or similar practice) solution can maintain travel corridors or parking areas, while allow for runoff reduction from existing surfaces. While there are many types of pervious pavement, one that has been used



with some success in the Northeast is the Pave Drain. Pave Drain is an articulating concrete block with sub-surface archway built into the individual blocks that can maximize storage voids. This is just one of many possible pervious pavements that could be used within the SSO subwatershed.

Underground Recharge Chamber

Underground recharge chambers are another practice that can be used in areas where paved surfaces can't be sacrificed for above-ground management practices. Chambers come in many different varieties and can be used on many different sites such as parking lots, parks or playgrounds, or even as part of stormwater planter to provide additional storage volume.



Vegetated Swale

Vegetated swales are similar to bioretention in that they allow for filtration and infiltration via vegetation and soil media. Typically swales will be used as a conveyance of runoff from a source to a destination, such as an overflow catch basin structure or a bioretention area.





2000 Sq. Ft. Buildings

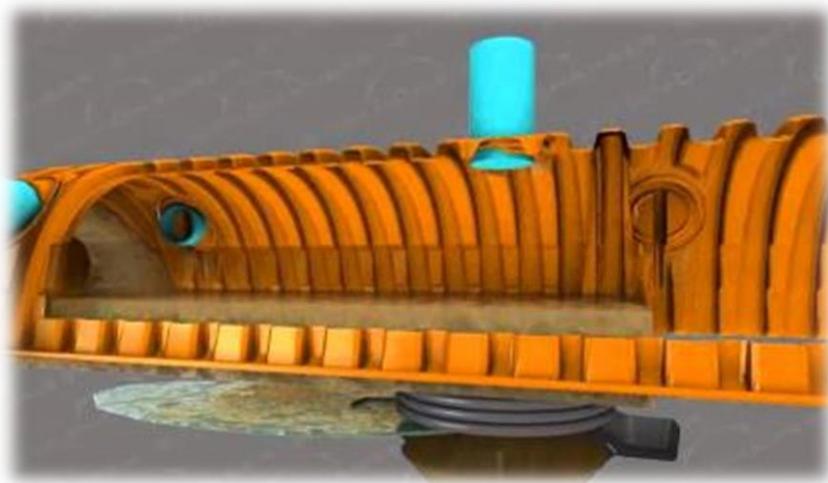
Using the building footprint layer provided by the City of Rutland, buildings within all priority watersheds were selected and analyzed for footprint square footage, as entered into the building database by the City of Rutland. For all priority watersheds, a mean square footage of 1,500 sq. ft. was found. In order to prioritize larger buildings which may generate more runoff than smaller residential buildings, a threshold of 2,000 square feet was chosen to select priority buildings which could potentially be eligible for some sort of downspout disconnection, whether via residential rain barrels of larger rain cisterns, or via rain gardens or downspout stormwater planters. All buildings greater than or equal to 2,000 sq. ft. within the State Street Outfall GSI Overlay were compiled into an



Excel-based spreadsheet, with address information where available, and ranked according to size. See Appendix 8 – SSO Overlay – 2,000 Sq. Ft. Buildings for a full list of buildings within the drainage area that meet this criteria. This spreadsheet could serve as the first step in an outreach program to encourage building owners to adopt on-site stormwater management practices.

(RPO) – Rotary Park Outfall – Underground Recharge Chambers

An underground storage chamber and infiltration recharge gallery is the preferred option for the Rotary Park Outfall. The City has planned a major renovation of the parking to re-level the playing field, tear down an old building on-site, and re-do the parking area. By connecting the existing separate stormwater sewer drainage outfalls to StormTech underground chambers, 100% of the WQv will be managed, as well as over 80%



A StormTech chamber is shown here. Runoff enters via a manifold and spreads along the base of the chamber, infiltrating (or being filtered by the stone sub-base before entering an underdrain).

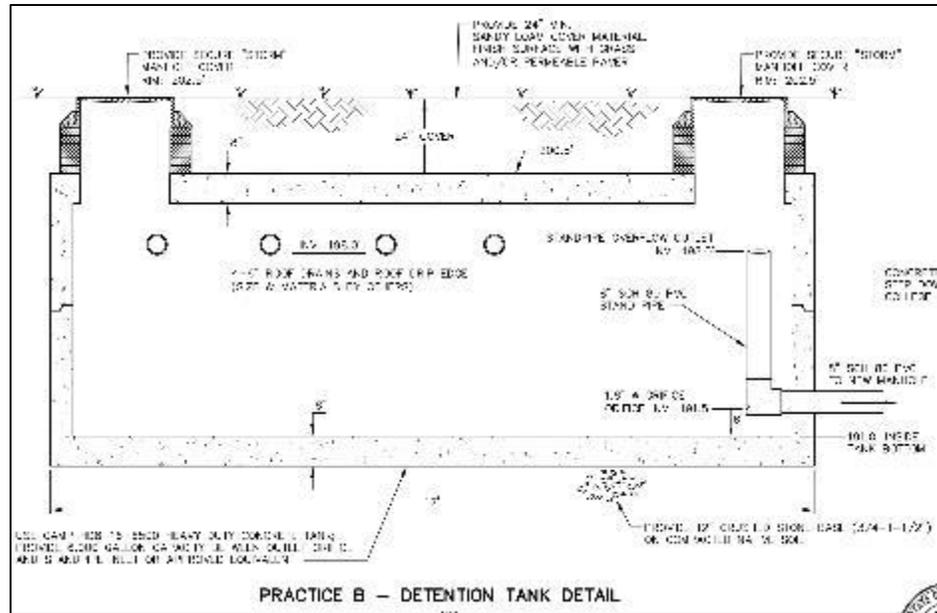
of the CPv. This is important in this location as the discharge would otherwise be to Tenney Brook, which is more sensitive than East Creek to high flows.



Additionally, by installing an approximately 300 foot pipe, a future separate stormwater sewer can be connected to these chambers. The current plan for the future drainage area is to connect to existing pipes underneath Route 7, leading to a direct outfall to Tenney Brook. By installing this new pipe, this drainage could be treated instead of directly discharged. Negotiations would have to take place between the City and the landowners in the corridor between Route 7 and Rotary Park for this pipe to be installed.

(CHP) – City Hall Parking Lot – Underground Detention Chamber

The proposed retrofit for Rutland City Hall parking lot is an underground storage chamber with a controlled outlet. This project presents an opportunity to showcase the type of small-scale project that can be done in highly-impervious, densely-built urban centers to provide runoff detention in order to mitigate combined sewer overflows.



Currently the parking lot and part of the roof of City Hall drain to a single catchbasin that discharges to the City’s combined sewer. By installing a simple concrete underground storage tank in this relatively little-used corner of the lot, the entire 1-year storm event can be detained and slowly bled off into the combined sewer using a low-flow orifice control. By using a simple baffle wall within the chamber, some sediment and nutrient removal will take place. By incorporating a bioretention area at the surface, runoff could be managed in the bioretention prior to discharging into the chamber system below. This would allow for some aesthetic benefit and also reduce overall volume of flow to the combined sewer by evapotranspiration.



(NPS + NPS 2) - Northwest Primary School – Erosion Control and Infiltration

The City of Rutland and the Rutland NRCD identified the Northwest Primary School parking lot and yard/roof drain pipe outfalls as a project site of concern for them. Currently the parking lot drains to its center and onto a grass bank where some erosion is occurring. By creating a stone diaphragm along the downhill edge of the lot and establishing a thick



vegetated buffer downslope of the level spreader, the runoff force can be dispersed, while also encouraging infiltration on-site. This will prevent the parking lot runoff from reaching East Creek as concentrated flow and potentially eroding the conveyance.

The second project on the site consists of armoring the pipes that convey roof and yard drainage from the school building and vehicle pull-through area. These outfalls are currently poorly armored with some angular stone. The proposed retrofit would increase the depth of the stone at the outfall and enlarge the overall footprint of the outfall channel in order to slow down the piped runoff and encourage on-site infiltration. This will prevent this runoff from creating an eroded channel to East Creek.

These projects will also have educational value for the school and the greater school community. The use of educational signage, particularly on the parking lot retrofit, would be highly encouraged.



6 Summary and Recommendations:

During the development of this SWMP an examination was made of the character of the East Creek watershed, with special attention paid to the particular stressors faced by the water bodies within the overall watershed. While overall East Creek and Tenney Brook are not overly degraded, they do face stressors such as E. coli contamination from combined sewer overflow and moderate nutrient pollution that could, over time, lead to a greater degree of degradation.

In order to assist future planners cope with existing and potential future problems, all available pertinent data was collected on the watershed and evaluated for completeness and quality. Summaries of this data were created to increase ease of use. Existing GIS data was collected from a variety of sources and new GIS data was generated that will assist with future stormwater management project modeling and design.

The initial Tier 1 analysis of the watershed shows that there are nearly 18 viable project sites within the watershed encompassing both existing and future separate stormwater sewer systems. This selection was accomplished primarily using stormwater utility data provided by the State and the City to identify outfalls from larger subwatersheds with adjacent open space that could potentially be used. Public space was given precedence wherever possible. Many of the Tier 1 project sites were not chosen for subsequent analysis in the Tier 2 phase of the plan – this does not mean that they are not worth pursuing in the future. Indeed many of the sites have the potential to manage a large portion of the City of Rutland’s stormwater runoff. The largest and potentially most important of those sites are:

- MSP – Meadow Street Park
- CGO – Crescent and Grove Streets Outfall
- NSO – North Street Outfall

These sites certainly bear further analysis in the future if certain projects in the Tier 2 list prove unfeasible.

Under Tier 2 analysis 10 sites were chosen for further analysis and concept-level design. The selection of these sites was a collaborative process between the City of Rutland and the Rutland NRCDC where sites were chosen based not only on their potential overall impact on water quality within the watershed, but also their potential feasibility and their potential auxiliary benefits to the community in the form of education or recreation. Some were chosen as priorities as they represent the opportunity to build synergy between current projects, such as the renovation of Preville Street Extension and Giorgetti Arena parking lot for the new recreational path.

Implementing all of these projects, particularly the projects with large future separate stormwater sewer systems, is highly encouraged. East Creek and Tenney Brook, while currently generally healthy, won’t remain that way if large drainage areas are routed directly into them without any form of treatment prior to discharge. Increasing runoff into these water bodies could



result in the need for Flow Restoration Planning for this watershed. Getting in front of the issue now would potentially eliminate the need to undergo the costly FRP process.

Finally, the distributed green stormwater infrastructure projects envisioned for the Giorgetti Arena parking lot, Preville Street Extension, and Lincoln Avenue right-of-way will provide on-the-ground examples of how GSI could be implemented within Rutland. Additionally, the opportunities and recommendations presented for the State Street Outfall (SSO) drainage area represent the potential nucleus of a City-wide system of distributed GSI management practices. By focusing on this drainage for future GSI implementation, greater water quality benefits can be realized as there is little-to-no room at the outfall for a large-scale end-of-pipe practice. Pursuing implementation in this area will provide valuable lessons for future projects.

Precedents for management practices like this exist in Vermont. The City of South Burlington initially adopted an overlay district known as the Bartlett Brook Overlay to manage stormwater runoff in that watershed. Years later, the practices and regulations developed for that watershed are being adopted City-wide. This same process is encouraged for the City of Rutland.