STORMWATER MASTER PLAN FOR THE TOWN OF UNDERHILL, VERMONT

FINAL REPORT

April 30, 2018

Prepared for:

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I. Disclaimer

The intent of this report is to present the data collected, evaluations, analyses, designs, and cost estimates for subwatersheds in Underhill under a contract between the Chittenden County Regional Planning Commission and Watershed Consulting Associates, LLC. Funding for the project was provided by a Vermont Department of Environmental Conservation, Clean Water Fund grant. The plan presented is intended to provide the watershed's stakeholders a means by which to identify and prioritize future stormwater management efforts. This planning study presents a recommended collection of Best Management Practices (BMPs) that would address specific concerns that have been raised for these areas. In particular, there is great need to reduce stormwater impacts including phosphorus and sediment from stormwater runoff to receiving waters within the Town and the greater Lake Champlain Basin in light of future regulation under the Lake Champlain Total Maximum Daily Load requirements. Although there are other BMP strategies that could be implemented in the watershed, these are the sites and practices that project stakeholders believe will have the greatest impact and probability of implementation. These practices do not represent a regulatory obligation, nor is any property owner within the watershed obligated to implement them. This stormwater master plan, and therefore its resultant strategies, will be one of the actions in the Lamoille Tactical Basin Plan. This will put the BMP strategies in queue for state funding for implementation.

II. Glossary of Terms

Best Management Practice (BMP)- BMPs are practices that manage stormwater runoff to improve water quality and reduce stormwater volume and velocity. Examples of BMPs include detention ponds, gravel wetlands, infiltration trenches, and bioretention practices.

Buffers- Protective vegetated areas (variable width) along stream banks that stabilize stream banks, filter sediment, slow stormwater runoff velocity, and shade streams to keep waters cool in the summer months.

Channel Protection Volume (CPv)- The stormwater volume generated from the one-year, 24-hour rainfall event. Management of this event targets preventing stream channel erosion.

Check Dam- A small dam, often constructed in a swale, that decreases the velocity of stormwater and encourages the settling and deposition of sediment. They are often constructed from wood, stone, or earth.

Detention BMP- A BMP that stores stormwater for a defined length of time before it eventually drains to the receiving water body. Stormwater is not retained in the practice. The objective of a detention BMP is to reduce the peak discharge from the basin to reduce channel erosion and settle out pollutants from the stormwater. Some of these practices also include additional water quality benefits. Examples include gravel wetlands, detention ponds, and non-infiltration-dependent bioretention practices.

Drainage Area- The area contributing runoff to a specific point. Generally, this term is used for the area that drains to a BMP or other feature like a stormwater pipe.

Hydrologic Soil Group- A Natural Resource Conservation Service classification system for soils. They are categorized into four groups (A, B, C, and D) with “A” having the highest permeability and D having the lowest.

Infiltration/Infiltration Rate- Stormwater percolating into the ground surface. The rate at which this occurs (infiltration rate) is generally presented as inches per hour.

Infiltration BMP- A BMP that allows for the infiltration of stormwater into the subsurface soil as groundwater, which returns to the stream as baseflow. Mapped soils of Hydrologic Group A or B (sandy well drained soils) are an indicator of infiltration potential. Infiltration reduces the amount of surface storage required. Typical Infiltration BMP practices include infiltration trenches, bioretention practices, subsurface infiltration chambers, infiltration basins, and others.

Outfall- The point where stormwater discharges from a system like a pipe.

Sheet Flow- Stormwater runoff flowing over the ground surface in a thin layer.

Stabilization- Vegetated or structural practices that prevent erosion from occurring.

Stormwater/Stormwater Runoff- Precipitation and snowmelt that runs off the ground surface.

Stormwater Master Plan (SWMP)- A comprehensive plan to identify and prioritize stormwater management opportunities to address current and prevent future stormwater related problems.

Stormwater Permit- A permit issued by the State for the regulated discharge of stormwater.

Swale- An open vegetated channel used to convey runoff and to provide pre-treatment by filtering out pollutants and sediments.

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

Total Phosphorus (TP)- The total phosphorus present in stormwater. This value is the sum of particulate and dissolved phosphorus. It includes both organic and inorganic forms.

Total Suspended Solids (TSS)- The total soil particulate matter suspended in the water column.

Watershed- The area contributing runoff to a specific point. For watersheds like the Browns River, this includes all of the area draining to the point where the river discharges to the Lamoille River.

Water Quality Volume (WQv)- The stormwater volume generated from the first inch of runoff. This runoff is known as the 90th percentile rainfall event and contains the majority of pollutants.

1 Introduction

1.1 The Problem with Stormwater

Stormwater runoff is any precipitation including melting snow and ice that runs off the land. In undeveloped areas, much of the precipitation is soaked into the ground, taken up by plants, or evaporated back into the atmosphere. However, when human development limits or completely prevents this natural sponge-like effect of the land, generally through the introduction of impervious areas such as roads, parking lots, or buildings, the volume of stormwater runoff increases, sometimes dramatically. In addition to the increased volume of stormwater runoff, the runoff is also frequently laden with pollutants such as sediment, nutrients, oils, and pathogens. These stormwater runoff related issues decrease aquatic habitat health, increase flooding and erosion, threaten infrastructure, and prevent use and enjoyment of our water resources. Traditionally, stormwater management techniques have relied heavily upon gray infrastructure, where stormwater is collected and conveyed in a network of catchbasins and pipes, prior to discharging to surface waters (i.e. streams, rivers, ponds, lakes, and coastal waters). Although this approach is effective in removing stormwater from developed areas, it does not eliminate the problem and has proved to worsen negative stormwater effects such as erosion, flooding, and nutrient pollution. It is clear that something has to change. This is where stormwater master planning comes into play. Funding is limited to implement projects that will improve water quality and reduce the negative impacts of uncontrolled stormwater runoff. As such, creating a plan of where and how to best use these funds to provide the greatest benefit to our water resources is key.

1.2 What is Stormwater Master Planning

In the wake of rapid urban development and increasing rainfall intensity, stormwater management that seeks to mimic the undeveloped environment and treat stormwater runoff as close to the source as possible has become the focus of efforts to mitigate urban flooding and maintain the health of our waterways. Given the complexity of current stormwater issues, the development of the Stormwater Master Planning process provides communities with a range of possibilities for stormwater mitigation from small-scale (i.e. individual parcels), to large-scale (i.e. community-wide). Stormwater rarely follows political or parcel boundaries and tackling this problem from a strategic perspective is key to preventing future problems and addressing current sources of water quality degradation. This process was developed because much of the urban area within the state of Vermont predates regulatory requirements for stormwater management, but these distributed and unmanaged areas are contributing to the impairments of our surface waters including Lake Champlain. These unmanaged stormwater discharges can be identified and addressed through this stormwater master planning process. The process allows for assessment and prioritization of the areas most in need of mitigation while acknowledging that, for many areas, these types of stormwater retrofits are voluntary. Public awareness of both stormwater problems and stormwater management practices are critical to the stormwater master planning process. As such, working with municipal officials, project stakeholders, and community members is key to implementation of and support for these plans. Stormwater master planning involves analysis of current and anticipated future conditions, and seeks to prioritize stormwater solutions, maximizing the potential for water quality improvement, flood mitigation, erosion reduction, and pollution prevention using a variety of best management practices (BMPs) and allocating limited funds in a planned and methodical way.

2 Project Overview

In May 2013, the State of Vermont Department of Environmental Conservation (VT DEC) issued a document titled *Vermont Stormwater Master Planning Guidelines*, designed to provide VT communities with a standardized guideline and series of templates. The document assists communities in planning for future stormwater management practices and programs. Our Plan is a combination of Templates 2A: Hybrid site & community retrofit approach with green stormwater infrastructure (GSI) stormwater management, and 3A: Large watershed or regional approach with planned build out analysis and traditional (end of pipe or centralized) stormwater management.

Vermont has had stormwater regulations in place since 1978, with updates concerning unified sizing criteria made in 2002, and again in 2017. Recognizing that stormwater management can be a costly endeavor, the new 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, and include:

- 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.

3 Background

3.1 Problem Definition

The Town of Underhill is located in Chittenden County primarily within the Headwaters Browns River (whose tributaries within the Town include The Creek, Stevensville Brook, Roaring Brook, and Clay Brook), the Seymour River-Lamoille River (tributaries include the Seymour River, Settlement Brook, and Beaver Brook), and the Browns River (tributaries include the Lee River) watersheds. These watersheds are tributaries of the Lamoille River located north of the Town. A small area, within the Mt Mansfield State Forest along the border with the Town of Stowe, falls within the Headwaters Little River and Little River watersheds, both tributaries of the Winooski River (Figure 1).

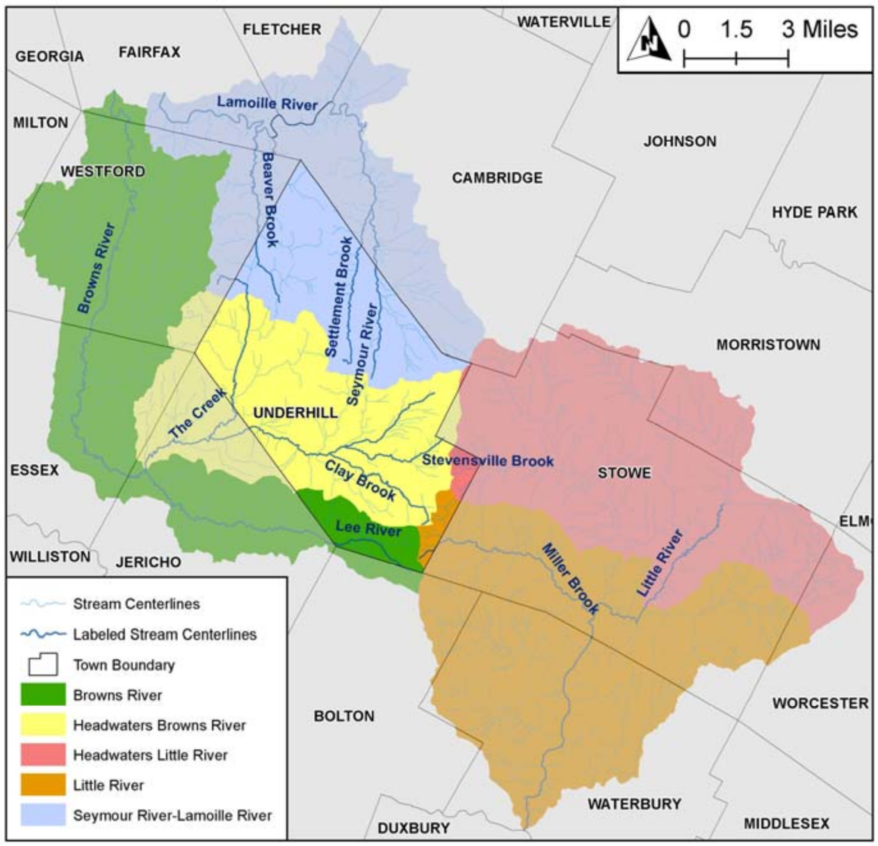

Figure 1. The Town of Underhill is located primarily within the Seymour River-Lamoille River (blue) and Browns River (yellow and green) watersheds, tributaries of the Lamoille river.

Many of Underhill’s surface waters have been negatively affected by human activities. The Browns River has reaches that are adversely impacted by stormwater runoff and development, and a section of the river is on the 2016 stressed waters list due to former large-scale gravel mining and streambank destabilization. Further, a section of the Stevensville Brook, tributary to the Browns River, is on the 2016 stressed waters list due to low pH from acid rain inputs and flood scour as a result of increased flashiness and flooding frequency. The Seymour River also has reaches that are adversely impacted by stormwater runoff and development, and a section of the river is on the 2016 stressed waters list for sediment and nutrients due to bank erosion, agricultural encroachments, and channel instability. These three stressed waterbodies are tributaries of the Lamoille, which has reaches that are adversely impacted by stormwater runoff and development. A section of the river is on the 2016 stressed waters list due to elevated mercury levels.

There are two main areas in the Town of Underhill where development is concentrated. The remainder of the Town is more sparsely developed with scattered rural residential development throughout. Underhill Flats is centered around Route 15 as far as Poker Hill Rd, and Underhill Center encompasses the intersection of River Road and Pleasant Valley Road (Figure 2). Both areas have experienced increased development, with expanding areas of impervious surfaces. The main road between the Flats and the Center parallels the Browns River, with agricultural lands and some development falling in or close to the river corridor. In addition to expanding development along these corridors, Underhill has many steep gravel roads that further contribute sediment and nutrients to surface waters. These roads and associated infrastructure can also constrain smaller tributaries, especially during storm events. One such event occurred after a heavy rain on May 23rd, 2013, where the tributary running parallel to Cilley Hill Road overtopped its banks, destroying the road and the house at the intersection with Route 15.

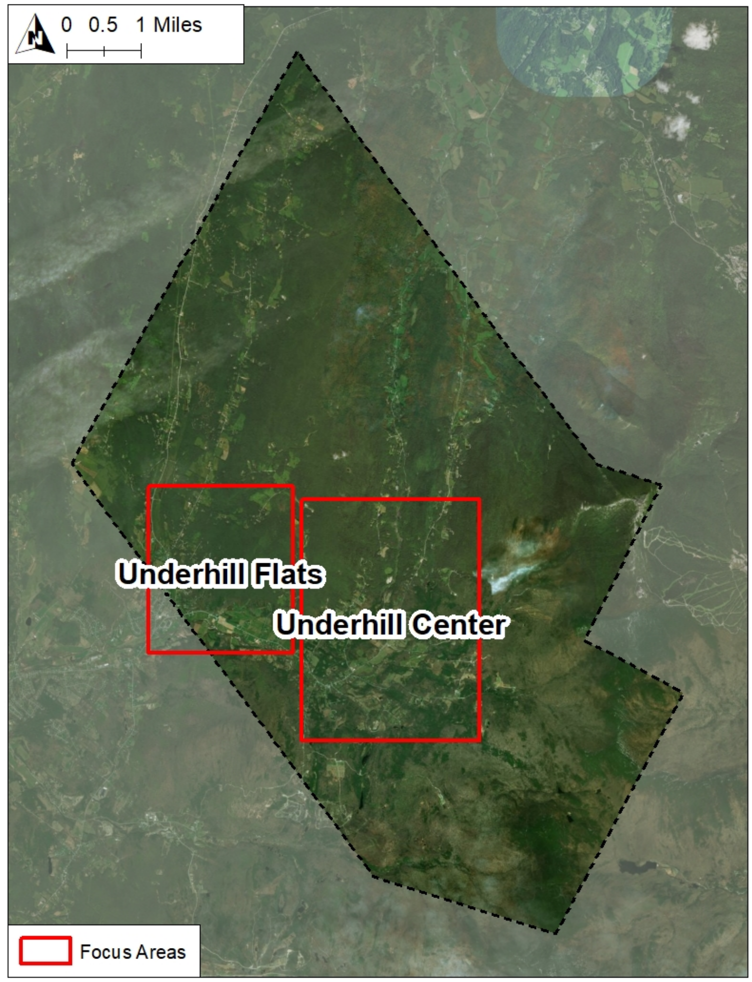

Figure 2. Focus areas for this SWMP include the areas of Underhill Flats and Underhill Center.

The human-influenced stressors in the watershed include commercial development and associated parking areas, construction of roads, residential development, and clearing of previously forested areas. Unmanaged stormwater runoff, particularly from impervious surfaces and landscaped pervious surfaces exacerbate the occurrence of nuisance flooding as well as more extreme flood events. The Lamoille River watershed and its tributaries have experienced extreme flooding in the past, and these flood events are only expected to occur more frequently due to the predicted increased frequency and intensity of extreme weather events associated with climate change. The stormwater management practices investigated seek to protect local river resources as well as the larger Lake Champlain Basin, which currently has a Total Maximum Daily Load (TMDL) in place that requires reductions in phosphorus loading to Lake Champlain via its tributaries though reductions in stormwater and agricultural runoff pollution.

3.2 *Existing Conditions*

The Town of Underhill spans approximately 32,821 acres in Chittenden County, VT and is primarily forested (86%), though 3% of the Town is classified as urban. Of that area, there are 445 acres (1%) of impervious cover. Underhill is located between the more rural towns of Westford, Bolton, and Cambridge, and the fairly urbanized towns of Essex, Jericho, and Stowe (Figure 3). Underhill's development is concentrated in the south-western region adjacent to Jericho, as well as the south-central area paralleling the Browns River.

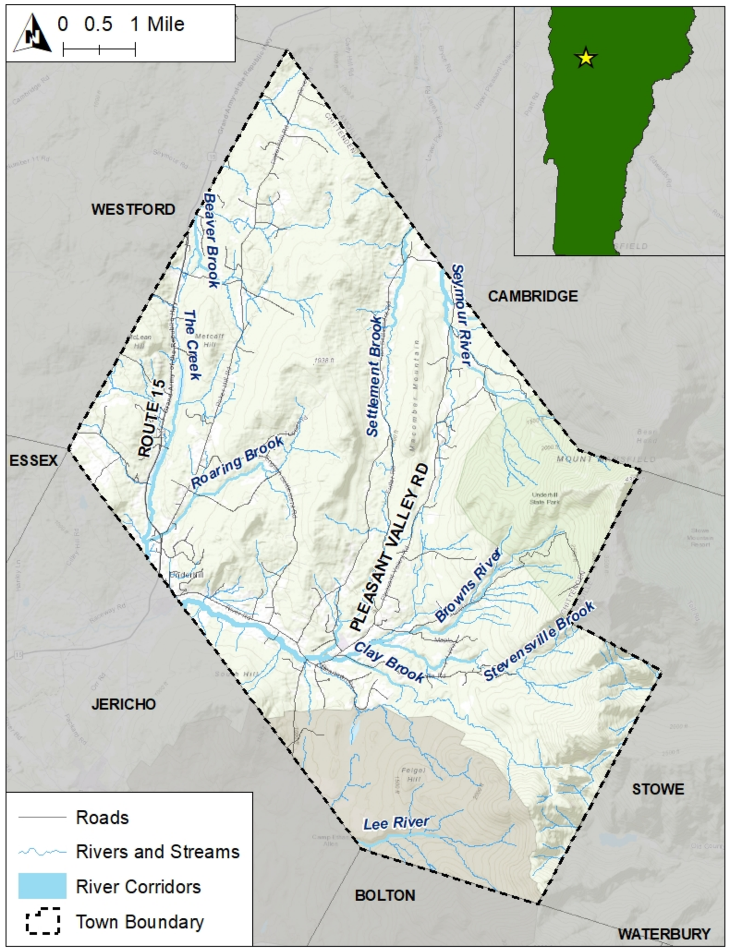

Figure 3. The Town of Underhill is located in Chittenden County, VT.

Soils analyses indicate that of the 32,821 total acres in the Town, 82% are classified as either potentially highly-erodible, or highly-erodible by the latest Natural Resources Conservation Service (NRCS) soil mapping data. Additionally, the majority of the soils in the watershed have very low infiltration potential as indicated by NRCS Hydrologic Soil Group classifications where soils are classified from group A (highest infiltration potential) to group D (lowest infiltration potential). In the Town, the majority of areas belong to either Hydrologic Soil Group C (34%) or D (46%), while only 10% are in group A and 3% are in group B. The remainder is not classified or comprised of water. This combination of steep slopes with limited infiltration capacity and a highly erodible surface make the area particularly susceptible to erosion.

The majority of developments within these areas were constructed with minimal stormwater management features, which has resulted in significant amounts of untreated stormwater draining large portions of developed lands discharging directly to surface waters, particularly to the Browns River along River Road and Pleasant Valley Road. Surrounding the developed lands, rural roads are generally unpaved, with open roadside ditches, and cross culverts. Many of these roads have steep slopes, and traverse large areas. Furthermore, the rural roads access residential driveways which often convey drainage into, and through the Town road drainage system. This is a problem because runoff from private lands is negatively impacting the Town's overall drainage system.

4 Methodology

4.1 *Identification of All Opportunities*

4.1.1 Kickoff Meeting and Initial Data Review:

Relevant prior watershed studies and work previously completed in the Town was reviewed in the context of this SWMP study. This includes the 2009 Browns River Corridor Plan, the 2016 Lamoille River Tactical Basin Plan, a VT DEC 2012 Stormwater Mapping Project of the Underhill Flats along Route 15, a Summer 2016 Road Erosion Inventory (REI) Assessment, VT DEC River Corridor maps, Floodplain maps prepared by the Federal Emergency Management Agency, and data on phosphorus-loading from the Vermont Clean Water Roadmap interactive website.

Relevant Geographic Information System (GIS) data was drawn from a variety of public resources including the Agency of Natural Resources' Atlas, Vermont Center for Geographic Information Open Geodata Portal, and data created by the University of Vermont's Spatial Analysis Lab. A file geodatabase was created to ensure organization and for ease of use. These data represent the "best available" data at the time of data collection (2017). See Appendix A.

The project team met with Town of Underhill stakeholders and the Chittenden County Regional Planning Commission (CCRPC) on July 10th, 2017 to discuss the SWMP and solicit information on problem areas from the Town. During this meeting, a list of potentially important sites was discussed with the project team. This list included particular parcels as well as general areas of importance. These areas were noted and added to the list of sites identified during the desktop assessment (see section 4.1.2).

4.1.2 Desktop Assessment and Digital Map Preparation

4.1.2.1 Desktop Assessment

A desktop assessment was completed to identify additional potential sites for stormwater BMP implementation. This process involved a thorough review of existing GIS resources and associated attribute data, as well as other resources.

One such resource was the Towns of Underhill and Jericho Stormwater Mapping Project completed by the VT DEC in 2012. These stormwater infrastructure mapping projects provided current drainage maps and potential locations of BMP stormwater retrofit sites for the municipalities. It is important to note that no priority BMPs were identified within the Town of Underhill itself. The designated priority areas, as part of the Stormwater Mapping Project, were located in the Town of Jericho and assessed as part of the 2017 Jericho SWMP. See the Dickenson St Gravel Wetland concept plan, located on the Browns River Middle School parcel in Appendix A.

Another resource utilized during the desktop assessment was the Underhill REI Assessment. This assessment was conducted in the summer of 2016 by the CCRPC. The assessment was conducted to help the Town prepare for compliance with the, then pending, Municipal Roads General Permit (MRGP), later issued in early 2018. See Appendix A. The assessment looked at how well hydrologically-connected, 100-meter road segments were complying with MRGP standards such as road crown, berm issues, ditches, cross culverts, driveway culverts, outfalls, and presence of rill or gully erosion.

Of the 524 hydrologically connected, 100-meter road segments in Underhill, the CCRPC found 289 that did not meet current MRGP draft standards. The Town will have until 2036 to bring those 289 segments, totaling 17.96 miles, up to standards. Initially, to comply with the permit, the Town will need to focus its work on 23 non-compliant road segments with drainage ditches scoring "Does Not Meet" on the REI, on slopes greater than 10%, as these are considered by the Permit as "Very High Priority Road Segments" which, "shall be upgraded to meet the MRGP standards listed in Part 6 of this General Permit by December 31, 2025."

The intent of the MRGP is to reduce stormwater-related erosion from municipal roads by stabilizing municipal road drainage systems to basic maintenance standards and taking preventative measures to mitigate erosion when necessary. The table below summarizes these segments by standards compliance and surface type. See Table 1.

In addition to assessing which hydrologically-connected road segments did not meet the MRGP standards, the CCRPC engaged the services of Fitzgerald Environmental Services, LLC (FEA) to determine which segments, not meeting current MRGP standards (both PARTIALLY MEETS and DOES NOT MEET), should be fixed in terms of reducing their negative impacts on water quality. These segments were scored by FEA with a severity rating via a 0 to 10 scoring system in which 0 is the best, and 10 is the worst – in terms of a segment's ability to impact water quality.

After sorting all segments and ranking them from worst to best, the CCRPC further investigated the top 10 segments to detail additional information including pictures and problem/solution identification. The locations of the "top 10" road erosion priority sites can be seen in Figure 4. See Appendix A for the detailed site and problems descriptions for these ten locations.

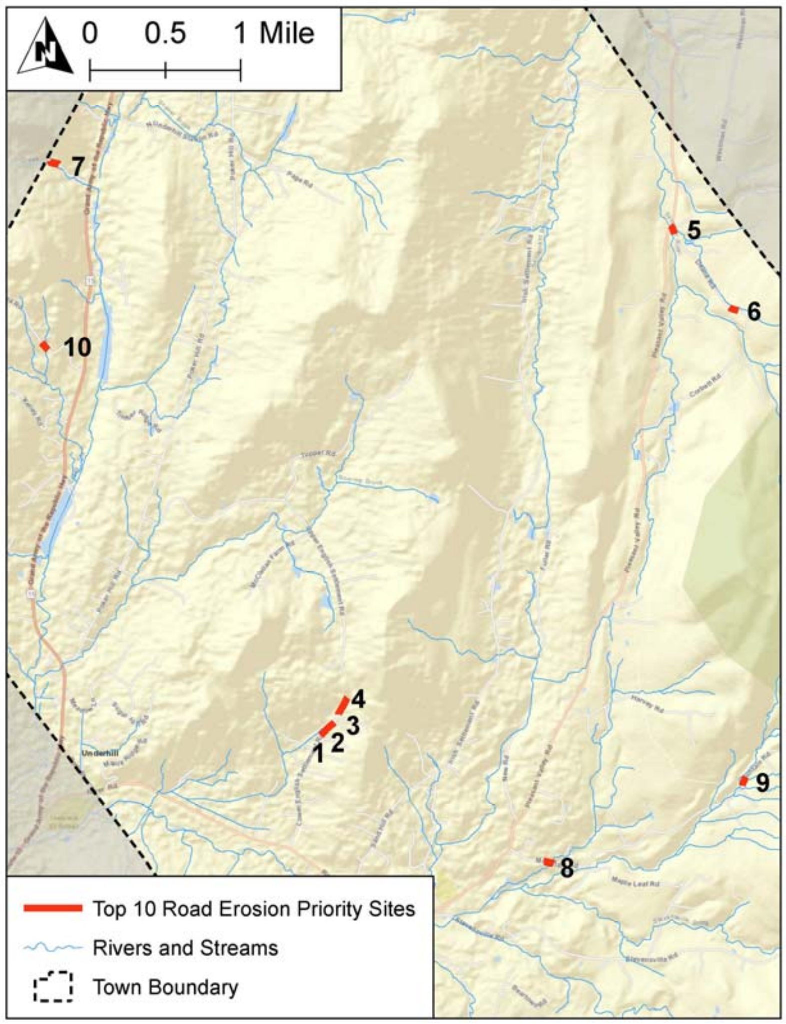

Figure 4. The top 10 road erosion priority site locations are shown throughout the Town in red.

Table 1. Top 10 Erosion Priority Sites

Priority	Road Name	Segment ID	Overall Segment Score	Field Determined Slope	Road Type	Roadway Crown / Travel Lane	Grader Berm / Windrow	Road Drainage	Conveyance Area / Turnout	Erosion Type Present	Driveway & Drainage Culvert	Lack of Standards Compliance	Fix / BMP Upgrades
1	Lower English Settlement Road	16	Does Not Meet	11%	Gravel	Fully Meets (90%)	Does Not Meet (30%)	Does Not Meet (20%)	4 Poor, 2 Filtered	Rill	1 Driveway	• Presence of grader berm • Rill erosion along edge of roadway • Inadequate ditch	• Stabilize conveyances • Re-rock line ditch • Remove grader berm
2	Lower English Settlement Road	17	Does Not Meet	12%	Gravel	Partially Meets (85%)	Partially Meets (75%)	Does Not Meet (30%)	5 Poor	Rill & Gully	1 Drainage	• Gully erosion as a result of inadequate road drainage • Presence of grader berm • Unstable culvert header (gully erosion) • Rill erosion in roadway	• Stabilize poor conveyances • Re-rock line ditch • Improve culvert header • Remove grader berm
3	Lower English Settlement Road	19	Does Not Meet	11%	Gravel	Partially Meets (50%)	Does Not Meet (30%)	Does Not Meet (40%)	2 Poor	Rill	None	• Presence of high shoulder • Inadequate roadway crown	• Stabilize poor conveyances • Regrade roadway
4	Lower English Settlement Road	20	Does Not Meet	11%	Gravel	Does Not Meet (30%)	Does Not Meet (10%)	Does Not Meet (40%)	2 Poor	Rill	None	• Presence of high shoulder • Poor roadway crown	• Stabilize poor conveyances • Regrade roadway
5	Deane Rd	1	Does Not Meet	5%	Gravel	Partially Meets (75%)	Partially Meets (75%)	Does Not Meet (25%)	2 Poor, 1 Filtered	Rill	None	• Presence of rill erosion in travel lane and along roadway edge • Presence of grader berm	• Stabilize poor conveyances • Remove grader berm • Regrade roadway
6	Deane Rd	11	Does Not Meet	6%	Class 4	Fully Meets (100%)	Does Not Meet (30%)	Does Not Meet (30%)	1 Turnout	Rill & Gully	None	• Presence of high shoulder • Rill and gully erosion down sides of roadway	• Grade roadway • Stabilize turnout and/or add another turnout
7	Daudelin Road	3	Does Not Meet	3%	Gravel	Fully Meets (100%)	Partially Meets (85%)	Partially Meets (80%)	1 Poor	Rill	1 Driveway, 1 Drainage	• Presence of grader berm	• Stabilize poor conveyance • Remove grader berm
8	Mountain Rd	6	Does Not Meet	5%	Gravel	Fully Meets (90%)	Partially Meets (50%)	Fully Meets (90%)	1 Poor, 3 Filtered	Rill	None	• Presence of grader berm • Some rill erosion in roadway and along edges	• Remove grader berm • Stabilize poor conveyance
9	Mountain Rd	27	Road is in the process of being repaired as of August 9, 2017. The road was being re-ditched on the eastern side and a stream-road conflict had been mitigated.										
10	Repa Road	11	Partially Meets	4%	Gravel	Fully Meets (95%)	Fully Meets (100%)	Fully Meets (95%)	1 Filtered	Rill	1 Drainage, 1 Driveway	• Some rill erosion in roadway and at drainage culvert	• Add header to drainage culvert • Possibly regrade roadway

GIS data was then reviewed, and included, but was not limited to, storm sewer infrastructure, soils classifications, parcel data, wetlands, and river corridors. This data was used to identify and map stormwater subwatersheds with high impervious cover, stormwater subwatersheds that are more directly connected to water bodies (direct pipes to streams or via overland flow), and areas that may have worsening stormwater impacts in the future. A point location was created for each identified site or area for assessment in the field.

During this initial BMP identification and after incorporating problem areas noted by the Town, a total of 50 locations were identified for field investigation.

4.1.2.2 Basemap and Mobile App Creation

In order to maximize efficiency in the field and better understand site-specific conditions, digital base maps were created for the Town. The maps show parcel boundaries, public parcels, stormwater infrastructure, hydrologic soils groups, river corridors, hydric soils, and wetlands. This information was used in the field to assess potential feasibility issues for proposed practices and to better identify preliminary BMP locations.

The base layers were pre-loaded into a project-specific mobile app that was customized for this project using the Fulcrum platform. The app was also pre-loaded with the 50 point locations for the potential BMP sites. These points allowed for easy site location and data collection in the field (Figure 5).

The app was used to collect information including site suitability, photographic documentation, follow-up notes, and other pertinent data. All collected data was securely uploaded to the Cloud for later use.

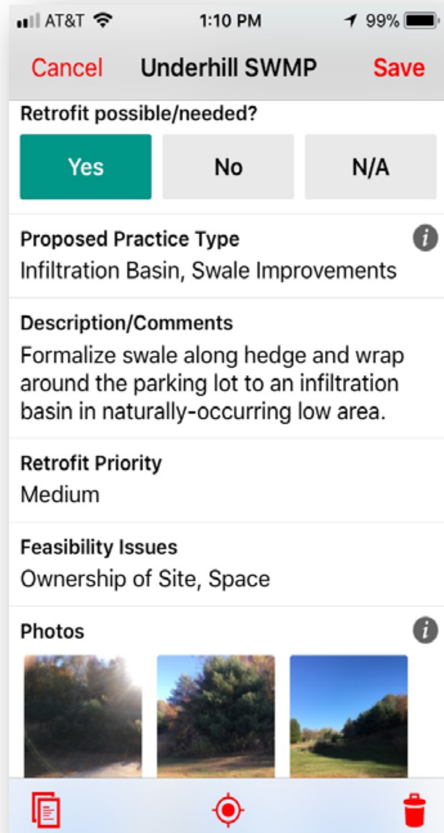

Figure 5. Example screen from data collection app.

4.1.3 Field Data Collection:

Each of the 50 previously identified potential BMP locations were evaluated in the field during the Summer and Fall of 2017 (Figure 6). Data was collected about each site in the mobile app. A large map of these sites with associated site names and a list of these sites including potential BMP options and site notes can be found in Appendix B - Initial Site Identification.

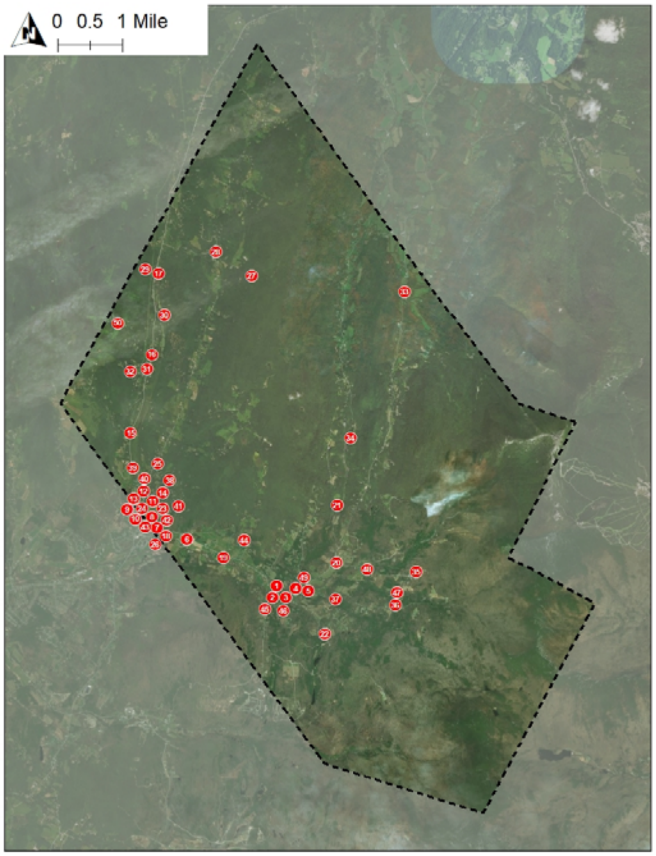

Figure 6. 50 potential sites for BMP implementation were identified for field investigation.

Through the course of these field visits, some site locations that seemed like potential opportunities for BMP implementation were excluded from further analysis due to specific site conditions. A total of 15 sites were removed from this plan, primarily because upon visiting these sites in the field, they were found to be too constrained to retrofit. While some improvement was possible for these sites, due to the fact that resources were limited for this project and these retrofits would have been very expensive for the minimal improvement possible, time and effort were prioritized for less constrained sites without any or without adequate stormwater management.

Following these refinements, the list of potential BMPs in the Town of Underhill decreased to 35 (Figure 7).

4.2 *Preliminary BMP Ranking*

After the initial field visits were completed and the project list was updated, a preliminary ranking system was utilized to prioritize these 35 projects (Figure 7). The goal of this ranking was to identify the 20 sites that would provide the greatest water quality benefit and have a high likelihood of implementation. This prioritization was accomplished by completing an assessment of project feasibility and benefits including drainage area size, pollutant load reduction potential, proximity to water, ownership, and feasibility issues. See Appendix C - Preliminary Site Ranking for the complete list of factors utilized in the preliminary ranking. Also included in Appendix F is the completed ranking for each potential site, and one-page field data summary sheets with initial ranking information.

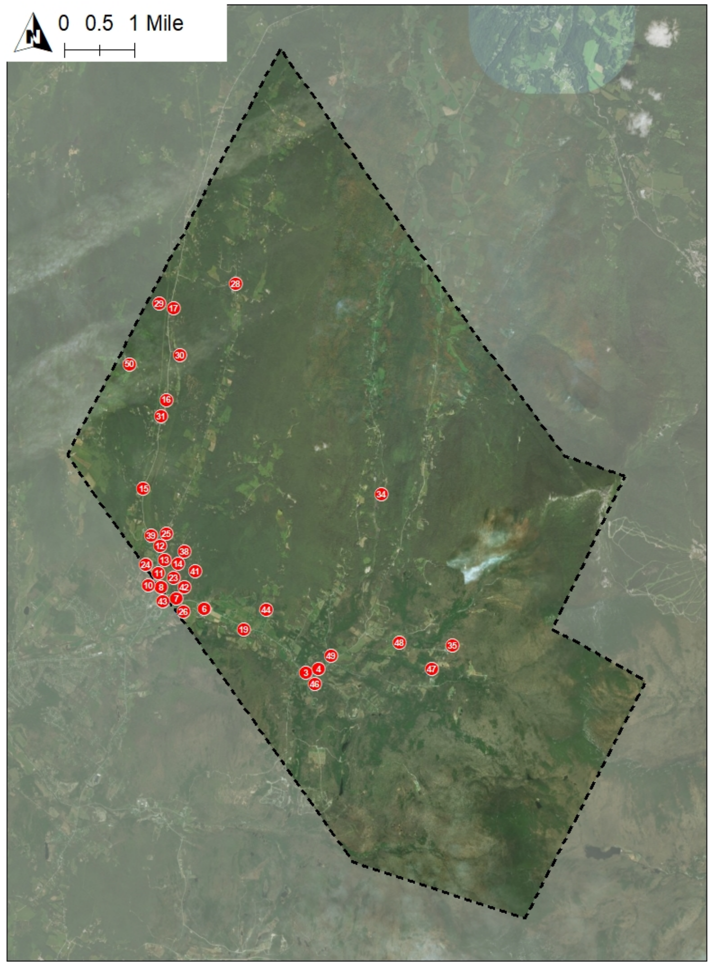

Figure 7. Following field investigations, the list of potential BMP sites decreased to 35. Point locations are shown for each site.

The list of 20 sites was distributed to the Town of Underhill and the CCRPC. As part of this process, the project team met with the stakeholders on January 22th, 2018 to discuss the proposed project sites. During this meeting, the stakeholders nominated the Top 10 projects to be included in the plan, and the Top 5 priority projects for which 30% concept designs and cost estimates would be created. Following feedback from the Town, the list was refined to reflect the Town's priorities. The VT Department of Transportation (VTrans) was also contacted at this time to assess their interest in collaborating on two proposed projects involving drainage from Route 15, which is managed by VTrans. The Top 10 sites are listed in Table 2. Point locations are shown in Figure 8.

Table 2. Top 10 BMPs selected for the Underhill SWMP.

Site ID	Proposed Practice Type
Underhill Central School	Underground Storage / Infiltration
Maple Leaf Rd (1)	Infiltration Basin, Buffer Enhancement and Restoration
Town Clerk's Office and Parking Lot	Bioretention
Fire Department Swale	Underground Storage / Infiltration
St. Thomas Church Parking Lot	Impervious Reduction, Bioretention
Sugar Hill and Meadow Ln	Infiltration Basin, Ditch and Swale Improvements
Krug Rd and Pleasant Valley Rd	Underground Storage / Infiltration
Park St Park	Underground Storage / Infiltration
Harvest Run	Ditch and Swale Improvements, Floodplain Enhancement and Restoration
Underhill Post Office	Vegetated Swale, Infiltration Basin

4.3 *Modeling and Concept Refinement for Top 10 BMPs*

Modeling was completed for each of the Top 10 sites (Figure 8). This modeling allowed for accurate sizing of the proposed practices as well as an understanding of the water quality and quantity benefits. The contributing drainage area of each of the BMPs was defined and land use/land cover was digitized using the best available topographic data and aerial imagery. Drainage areas were refined based on field observations (see Appendix D – Top 10 Sites for drainage area delineations). Each of the sites was modeled in HydroCAD to determine the appropriate BMP size and resultant stormwater volume reductions (see Appendix E - Top 10 Sites Modeling for modeling reports).

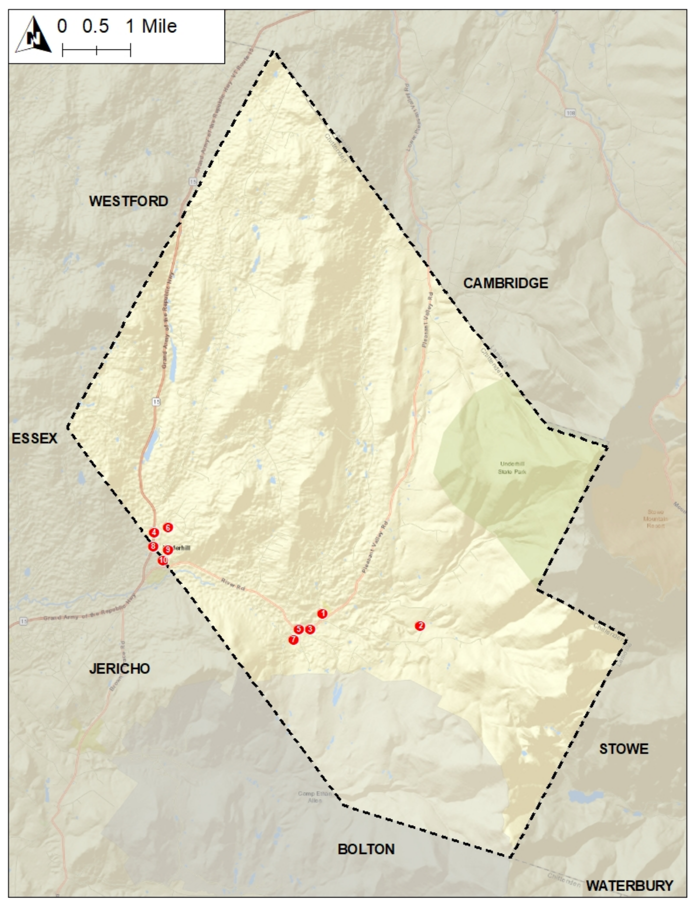

Figure 8. The Top 10 project locations are shown.

Each of these sites was also modeled using the Source Loading and Management Model for Windows (WinSLAMM) to determine the annual total suspended solids (TSS) and total phosphorus (TP) loading from the drainage area of each site. Pollutant load reductions from each of the BMPs were then calculated using WinSLAMM, pollutant removal rates published by the University of New Hampshire Stormwater Center were applied to the initial pollutant loading modeled with WinSLAMM for the site's current conditions. This yielded expected pollutant removal loads (lbs) and rates (%). The modeled volume and pollutant loading reductions are shown in Table 3. Complete modeling results are provided in Appendix E - Top 10 Sites Modeling.

Table 3. Modeled volume and pollutant load reductions for the Top 10 BMPs.

Site ID	Volume Managed (ac-ft)	Volume Infiltrated (ac-ft)	Total Suspended Solids Removal (lbs)	Total Suspended Solids Removal (%)	Total Phosphorus Removal (lbs)	Total Phosphorus Removal (%)
Underhill Central School	0.308	0.31	3,341	100%	3.74	100%
Maple Leaf Rd (1)	0.19	0.19	8,291	97.1%	5.58	97.4%
Town Clerk's Office and Parking Lot	0.031	0.03	1,458	99.8%	0.46	99.7%
Fire Department Swale	0.130	0.13	1,113	100%	0.32	100%
St. Thomas Church Parking Lot	0.113	0.11	1,185	100%	0.45	100%
Sugar Hill and Meadow Ln	0.211	0.21	6,576	74.6%	4.80	75.1%
Krug Rd and Pleasant Valley Rd	2.072	2.07	11,832	100%	8.49	100%
Park St Park	0.18	0.18	4,092	100%	1.13	100%
Harvest Run	1.70	--	23,030	26%	17.32	26%
Underhill Post Office	0.06	0.06	780	100%	0.41	100%

4.4 *Final Ranking Methodology*

A prioritization matrix was utilized in order to quantitatively rank each of the Top 10 projects. Considerations that factored into the ranking of BMP projects included:

- Impervious area managed
- Ease of operation and maintenance
- Volume managed
- Volume infiltrated
- Permitting restrictions
- Land availability
- Flood mitigation
- TSS removed
- TP removed
- Other project benefits
- Project cost

Each of these criteria are listed and explained in Appendix F - Top 10 Site Final Ranking. The scores associated with each of the categories are also provided in this table.

4.4.1 Project Cost Estimation

Project cost, listed as one of the criteria considered, was calculated for each project using a spreadsheet-based method. The methodology for determining these planning level costs was first developed for the City of South Burlington by the Horsley Witten (HW) Group as part of the Centennial Brook Flow Restoration Plan development. The HW Memorandum describing this methodology is provided in Appendix G. Note that a variation of this method was used for this plan. The criteria used in this cost estimation can be found in Appendix F - Top 10 Site Final Ranking. This methodology provides consistent budgetary cost estimates across BMPs.

Cost estimates are based on average costs for conceptual level projects and deviation from these estimates are expected as projects move forward with engineering design. Note that costs are not adjusted for inflation. There are differences between project cost estimates presented in the plan and actual project bid costs. The BMP cost estimates presented in the plan are based on limited site investigation. This methodology, while providing consistency in budget cost estimating, may fail to accurately reflect project cost impacts associated with actual site conditions and constraints. Therefore, the BMP cost estimates presented are suitable for planning purposes only, and not detailed program budgeting. The BMP cost estimates were developed based on the following assumptions:

Design Control Volumes: Design control volumes were based on the estimated runoff volume associated with the CPv or WQv storm events for off-line, underground, or GSI-type practices. Off-line stormwater management systems are designed to manage storm events by diverting a percentage of stormwater from a storm drainage system. Underground systems and GSI-type practices were conceptually designed as offline practices that only accept runoff from the target storm event. Runoff volumes for all storm events were determined based on HydroCAD model results that rely on the Soil Conservation Service (SCS) TR-55 and TR-20 hydrologic methods.

Unit Costs and Site Adjustment Factors: Unit cost for each BMP and site adjustment factors were derived from research by the Charles River Watershed Association and Center for Watershed Protection, as well as from experience with actual construction[1] and modified for this project to reflect the newest cost estimates available. Underground filtration chamber systems were typically designed using Stormtech MC-3500™ chamber systems. Cost adjustment factors were used to account for site-specific differences typically related to project size, location, and complexity. The values used to estimate BMP costs are summarized in Table 4.

Table 4. BMP unit costs and adjustment factors modified to reflect newer information.

BMP Type	Base Cost ($/ft^3)	Site Type	Cost Multiplier
Porous Asphalt	$5.32	Existing BMP retrofit or simple BMP	0.25
Infiltration Basin	$6.24	Large above ground basin projects	0.5
Underground Chamber (infiltration or detention)	$6.25	New BMP in undeveloped area	1
Detention Basin / Dry Pond	$6.80	New BMP in partially developed area	1.5
Gravel Wetland	$8.78	New BMP in developed area	2
Infiltration Trench	$12.49	Difficult installation in highly urban settings	3
Bioretention	$15.46		
Sand Filter	$17.94		
Porous Concrete	$18.07		

[1] Horsley Witten Group, Inc. 2014. Centennial Brook Watershed: Flow Restoration VTBMPDSS Modeling Analysis and BMP Supporting Information. Memorandum dated January 9th, 2014.

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

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

Permits and Engineering Costs: Used either 20% for large above-ground projects or 35% for smaller or complex projects.

Land Acquisition Costs *(Modified)*: A variation from the HW method was applied. Based on prior studies completed by WCA, the land acquisition cost was calculated as $120,000 per acre required for the BMP when located on private land. It should be noted that this value is based on a limited estimate and not necessarily an expected cost per acre. At this time, no land acquisition costs were built into the costs provided for the Underhill SWMP. It is assumed at this time that sites not owned by the Town will retain ownership of the stormwater management sites.

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

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

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

Minimum Cost Adjustment: After total project costs were determined for each proposed BMP based on the HW methodology, costs were reviewed and adjusted so that projects involving a simple BMP such as a small rain garden were assigned a minimum cost of $10,000 and more complex projects were assigned a minimum cost of $25,000.

4.4.2 Final Ranking Scoring

Each of the factors noted in Appendix I - Top 20 Site Final Ranking were scored, and scores were totaled for each of the criteria. Projects were assigned a rank from 1 to 10 with those projects receiving the highest scores assigned the highest rank. In the case of a tie between two projects, the TP removed (lbs) by the practice was used as a tiebreaker.

4.5 Final Modeling and Prioritization

A summary of the practices with scores and ranks are shown below in Table 5. The comprehensive ranking matrix used to rank the proposed BMP projects is provided in Appendix F - Top 10 Site Final Ranking. If future funding becomes available for further implementation, this prioritization matrix can be utilized in selecting additional projects for implementation.

Table 5. Top 10 potential BMP sites for the Town of Underhill.

Rank	Site ID	Address	Proposed Practice Type	Score
1	Underhill Central School	6 Irish Settlement Rd	Underground Storage / Infiltration	61
2	Maple Leaf Rd (1)	31 Maple Leaf Farm Rd	Infiltration Basin, Buffer Enhancement and Restoration	60
3	Town Clerk's Office and Parking Lot	12 Pleasant Valley Rd	Bioretention	53
4	Fire Department Swale	420 VT Route 15	Underground Storage / Infiltration	48
5	St. Thomas Church Parking Lot	6 Pleasant Valley Rd	Impervious Reduction, Bioretention	47
6	Sugar Hill and Meadow Ln	1-5 Sugar Hl	Infiltration Basin, Ditch and Swale Improvements	38
7	Krug Rd and Pleasant Valley Rd	292-298 River Rd	Underground Storage / Infiltration	39
8	Park St Park	2-4 Park St	Underground Storage / Infiltration	37
9	Harvest Run	10 Harvest Run	Ditch / Swale Improvements, Floodplain Enhancement and Restoration	35
10	Underhill Post Office	2 Harvest Run	Vegetated Swale, Infiltration Basin	25

A map of each project showing the drainage areas and BMP locations can be found in Appendix D - Top 10 Sites.

4.6 *Top 5 Potential BMPs*

Selection of the Town's Top 5 sites considered the results from WCA's initial site investigations, preliminary modeling and ranking, input from municipal officials concerning project priorities, and the willingness of select private landowners to voluntarily participate in this plan (Figure 9). As part of this process, WCA met with the Town's Selectboard on March 13th, 2018 to review and discuss the top 5 project sites. The location of the sites within the Town of Underhill can be viewed in Figure 9. In the final ranking (4.4 Final Ranking Methodology), these 5 sites were awarded additional points in the site scoring to reflect the Town's priorities and high probability for implementation. The Top 5 sites are listed in Table 6.

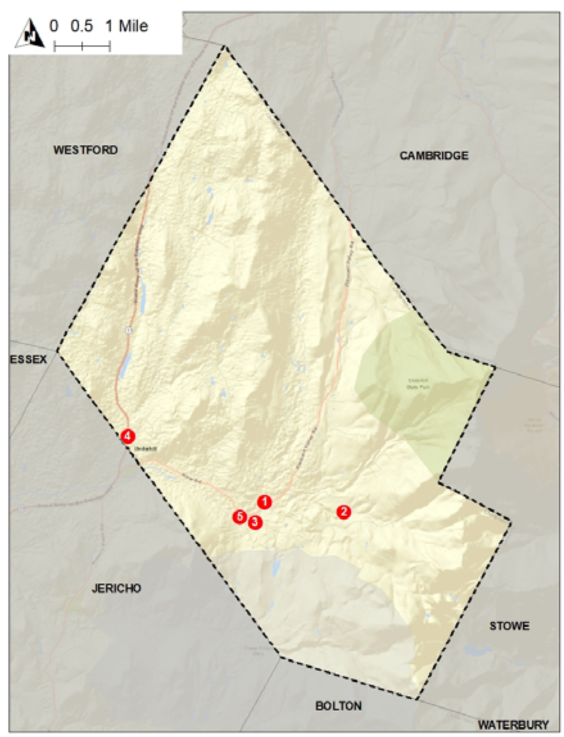

Figure 9. Top 5 sites for the Town of Underhill

Table 6. Top 5 BMP sites for the Town of Underhill.

Rank	Site ID	Address	Proposed Practice Type
1	Underhill Central School	6 Irish Settlement Rd	Underground Storage / Infiltration
2	Maple Leaf Rd (1)	31 Maple Leaf Farm Rd	Infiltration Basin, Buffer Enhancement and Restoration
3	Town Clerk's Office and Parking Lot	12 Pleasant Valley Rd	Bioretention
4	Fire Department Swale	420 VT Route 15	Underground Storage / Infiltration
5	St. Thomas Church Parking Lot	6 Pleasant Valley Rd	Impervious Reduction, Bioretention

5 Priority BMPs

The selected Top 5 BMP implementation sites are briefly described below. These opportunities are located on Town property and private property. Descriptions of each site are provided below. Individual drainage area maps and an overview map of these Top 5 sites are provided in Appendix H.

Site: 1
Project Name: Underhill Central School
Description: The site includes the School building and associated gravel driveway and parking lot. Stormwater currently drains via surface flow to a ditch along Irish Settlement Rd, and discharges to an unnamed tributary. The concept for this site includes rerouting the ditch to a subsurface infiltration chamber system under the existing parking lot (Figure 10). Soils are mapped as being very good at this site for infiltration (Hydrologic Group A).

Outreach: Contact was made with John Alberghini (Supervisory Union) and Jeff Forward (Facilities Coordinator) prior to advancing concept designs at this site. The school allowed further design to be completed at the site.

Figure 10. Subsurface infiltration chambers are proposed under the parking lot of the Underhill Central School.

Site: 2
Project Name: Maple Leaf Rd (1)
Description: The site includes a cross-culvert under a gravel driveway on Maple Leaf Rd, and the land along the driveway. This land is maintained by one of the residents accessing the driveway. Stormwater currently sheet flows through this area and is conveyed via roadside ditching along Maple Leaf Rd to the cross-culvert. The area between the culvert outlet and Stevensville Brook has been excavated to allow for drainage into the brook. The concept for this site includes restoring the excavated area and riparian buffer, and rerouting drainage from the culvert outlet to an infiltration basin along the driveway (Figure 11). Soils are mapped as being very good and good at this site (Hydrologic Group A and B).

Figure 11. An infiltration basin and riparian buffer restoration are proposed at the Maple Leaf Rd (1) site.

Outreach: Contact was made with Stephen Pitmon (one of the residents accessing the driveway), and Neil Wheelright (Primmer, Piper, Eggleston & Cramer PC, the firm managing the Maple Leaf Treatment Center property in its bankruptcy) prior to advancing concept designs at this site. They allowed further design to be completed at the site.

Site: 3
Project Name: Town Clerk's Office and Parking Lot
Description: The site includes the Town Clerk's Office building, associated driveway and parking, and a culvert which runs under Pleasant Valley Rd. Stormwater currently sheet flows through this area and is collected at the culvert inlet and discharged to the Browns River. The concept for this site includes guttering the roof and directing the drainage to a bioretention at the corner of the front parking lot and the road (Figure 12). Soils are mapped as being very good at this site (Hydrologic Group A).

Outreach: This site is owned by the Town, and as such no additional outreach was carried out.

Figure 12. The Town Clerk's Office and Parking Lot site is the proposed location for a bioretention.

Site: 4

Project Name: Fire Department Swale

Description: The site includes an area of open land next to the Fire Department, half of the Fire Department roof, a portion of their driveways and parking, and a stormline on Route 15. Stormwater currently sheet flows through this area, is collected by the Route 15 stormline, and is discharged across the street adjacent to mapped wetlands (Figure 13). The concept for this site includes rerouting the stormline to a subsurface infiltration chamber system in the lawn northwest of the Fire Department building. Soils are mapped as being very good (Hydrologic Group A) at this site.

Figure 13. An underground storage and infiltration chamber system is proposed at the Fire Department Swale site. The proposed feature would be located in the lawn, northwest of the building.

Outreach: Contact was made with Harry Schoppmann III (Underhill Jericho Fire Department) and Tyler Hanson (VTrans Stormwater Technician) prior to advancing concept designs at this site. The Fire Department and VTrans agreed to allow further design to be completed at the site.

Site: 5

Project Name: St. Thomas Church Parking Lot

Description: The site includes half of the Church building, a portion of Green St and Pleasant Valley Rd, and the Church parking lot (Figure 14). Stormwater currently sheet flows through this area, some of which is collected in catchbasins, and directed the vegetated area between the parking lot, Green St, and Pleasant Valley Rd. Drainage from this area is discharged to Mill Brook via a cross-culvert under the access drive to the parking lot. The concept for this site includes reducing impervious cover by decreasing the width of Green St and utilizing the space to enlarge the existing vegetated area. A bioretention area will be implemented in the swale to allow for more infiltration. Soils are mapped as being good at this site (Hydrologic Group B).

Figure 14. St. Thomas Church Parking Lot site. It is proposed that the existing swale be expanded and retrofitted as a bioretention to provide greater infiltration.

Outreach: Contact was made with church pastor, Father Christopher Micale prior to advancing concept designs at this site. The Church agreed to allow further design to be completed at the site.

When implemented, these five BMPs would treat approximately 65 acres, 7 acres (10%) of which is impervious. Modeled pollutant reductions for each of the projects, shown below in Table 7, indicate that these BMPs will prevent approximately 15,400 lbs of TSS and 11 lbs of TP from reaching receiving waters annually.

Table 7. Pollutant reductions and select ranking criteria for Top 5 projects.

Site ID	Volume Managed (ac-ft)	Volume Infiltrated (ac-ft)	Total Suspended Solids Removal (lbs)	Total Suspended Solids Removal (%)	Total Phosphorus Removal (lbs)	Total Phosphorus Removal (%)
Underhill Central School	0.308	0.31	3,341	100%	3.74	100%
Maple Leaf Rd (1)	0.19	0.19	8,291	97.1%	5.58	97.4%
Town Clerk's Office and Parking Lot	0.031	0.03	1,458	99.8%	0.46	99.7%
Fire Department Swale	0.130	0.13	1,113	100%	0.32	100%
St. Thomas Church Parking Lot	0.113	0.11	1,185	100%	0.45	100%

Site surveys were completed for each of the Top 5 sites, and existing conditions plans were developed. These plans were used as the basis for the 30% proposed condition plans that were developed for each site. See Appendix I - Existing Conditions Plans for these plans.

6 30% Designs

30% engineering designs were completed for each of the Top 5 sites. Site-specific concepts are discussed in the following sections. All 30% designs can be found in Appendix J - 30% Designs.

6.1 Underhill Central School

6.1.1 30% Concept Design Description

Currently, all drainage from the Underhill Central School is unmanaged. Although some of the runoff from the school does naturally infiltrate in pervious areas on site, the majority of the drainage from the roofs and large unpaved parking lot flows to the ditch along Irish Settlement Rd.

The unpaved parking lot frequently has issues associated with unmanaged runoff (puddling, pot holes, etc.). It is recommended that parking lot improvements are made to address these issues when the stormwater improvements are implemented on site.

The proposed retrofit for this site is a subsurface storage and infiltration system in the parking lot area that would overflow to the roadside ditch (see starred location in Figure 15). Additional retrofits for this site could include installation of rain barrels or cisterns for water capture and reuse and removing the defunct driveway in front of the school.

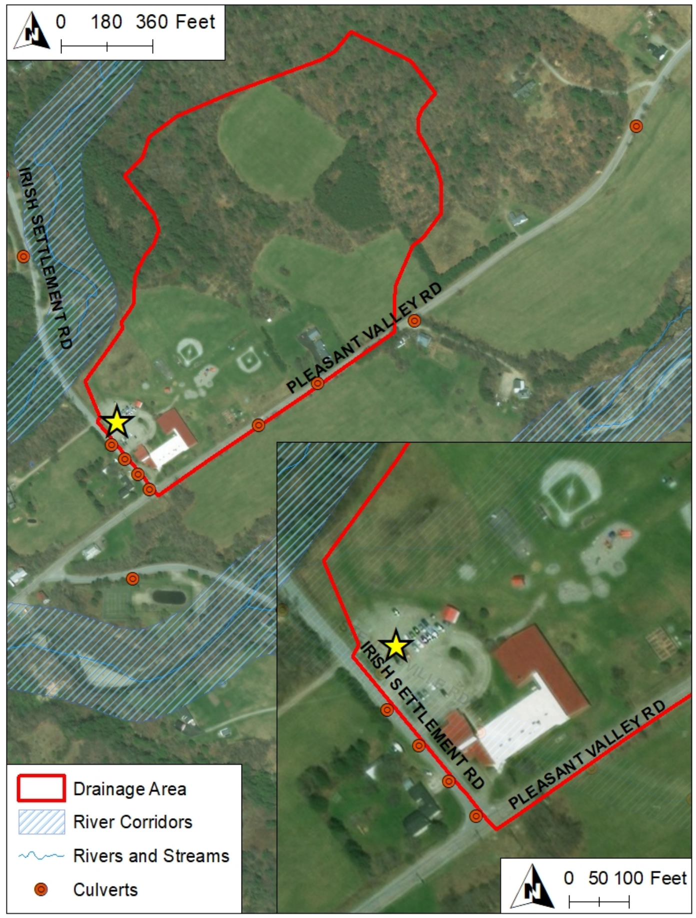

Figure 15. The BMP drainage area is shown in red for the Underhill Central School. The proposed BMP location is shown with a star.

The design standard used for this retrofit was full infiltration of the channel protection volume (CPv, or 2.02" of rain in a 24-hour period), equal to 13,416 ft^3 of runoff.

A 30% design plan is provided in Appendix J - 30% Designs.

6.1.2 Pollutant Removal and Other Water Quality Benefits

This practice has the potential to prevent 3,341 lbs of TSS and 3.74 lbs of TP from entering receiving waters (Table 8). As the project is located at a school, it is recommended that an educational sign be installed in conjunction with the retrofit.

Table 8. Underhill Central School benefit summary table.

Total Suspended Solids Removed	3,341 lbs
Total Phosphorus Removed	3.74 lbs
Impervious Treated	2.03 acres
Total Drainage Area	34.42 acres

6.1.3 Cost Estimates

The provided costs are very preliminary. Initial cost projections can be found in Table 9. This amount differs from the amount initially projected for this site as design-specific amounts and costs were used. The estimated cost for implementation of this project is $80,000.

- The cost per pound of phosphorus treated is $21,390.37.
- The cost per impervious acre treated is $39,408.87.
- The cost per cubic foot of runoff treated is $5.96.

Table 9. Underhill Central School project initial construction cost projection.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
	Mobilization	LS	1	$ 1,000.00	$ 1,000.00
653.55	Project Demarcation Fencing	LF	150	$ 1.17	$ 175.50
652.10	EPSC Plan	LS	1	$ 500.00	$ 500.00
649.51	Geotextile for silt fence	SY	70	$ 4.13	$ 289.10
652.20	Monitoring EPSC Plan	HR	4	$ 37.22	$ 148.88
	Construction Staking	HR	8	$ 90.00	$ 720.00
				Subtotal:	$ 2,833.48
Chambers - Costs					
	MC3500	EACH	28	$ 400.20	$ 11,205.60
	MC3500 Plain End Cap	EACH	6	$ 300.15	$ 1,800.90
	MC3500 24" Bottom End Cap	EACH	2	$ 404.23	$ 808.45
	12" 90 Manifold - 1298AN	EACH	2	$ 57.10	$ 114.20
	11" Single Tee Manifold - 1251AN	EACH	4	$ 109.70	$ 438.79
	12" Coupler - 1265AA	EACH	16	$ 8.29	$ 132.66
	12" N12 for splicing as needed (AASHTO)	EACH	80	$ 7.45	$ 596.16
	24" N12 for Isolator Row (AASHTO)	LF	20	$ 21.67	$ 433.32
	601TG to wrap system (SY)	SY	1000	$ 0.67	$ 667.00
	315WTM for scour protection (SY)	SY	500	$ 0.70	$ 350.75
	Inline Drain for Inspection Port	EACH	1	$ 310.50	$ 310.50
	Inserta Tee for Inspection Port	EACH	1	$ 86.32	$ 86.32
	6" N12 for inspection ports	LF	20	$ 2.70	$ 54.05
	6" Hole Saw	EACH	1	$ 132.43	$ 132.43
				Subtotal:	$ 17,131.14
Materials and Excavation Costs					
604.20	Concrete Catch Basin	EACH	3	$ 3,387.59	$ 10,162.77
203.15	Common Excavation	CY	368	$ 9.86	$ 3,628.48
629.54	Crushed Stone Bedding	TON	325	$ 34.04	$ 11,063.00
601.0915	18" CPEP	LF	225	$ 64.04	$ 14,409.00
651.35	Topsoil	CY	60	$30.96	$ 1,857.60
653.20	Temporary Erosion Matting	SY	315	$ 2.20	$ 693.00
651.15	Seed	LBS	10	$7.66	$ 76.60
				Subtotal:	$ 41,890.45
Subtotal:					$ 61,855.07
	Construction Oversight**	HR	16	$ 100.00	$ 1,600.00
	Construction Contingency - 10%**				$ 6,185.51
	Incidentals to Construction - 5%**				$ 3,092.75
	Minor Additional Design Items - 5%**				$ 3,092.75
	Final Design	HR	30	$ 100.00	$ 3,000.00
	Permit Review and Applications (exclusive of permit fees)	HR	8	$ 100.00	$ 800.00
Total (Rounded)					**$ 80,000.00**

6.1.4 Next Steps

Preliminary outreach has been conducted with the Chittenden East Supervisory Union. They have indicated their willingness to proceed with further design of this retrofit. Further design will involve refinement of the retrofit design with respect to size, outlet design, and routing to ensure that CPv can be completely infiltrated and larger storms passed through the system safely.

6.1.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix K - Permit Review Sheets. In summary:

Stormwater Permit
It is not expected that a stormwater permit will be required at this time.

The site should qualify for an Erosion Prevention and Sediment Control permit (3-9020) under the Low Risk categorization if the following guidelines are followed:

- Less than 2 acres of disturbance at any one time.
- All soils must be stabilized (temporary or final) within 7 days.
- Runoff from the site must pass through a 50' vegetated buffer prior to entering any Water of the State.

Local Permitting
No local permits are anticipated.

Other Permits
This site should be reviewed by the Act 250 Coordinator prior to final design as there is a Vermont Electric Cooperative, Inc. permit (No. 6L0160) for the placement of utility poles and cables. No Wetlands, or River Corridor permitting is anticipated for this project.

6.2 Maple Leaf Rd (1)

6.2.1 30% Concept Design Description

Stormwater from the Maple Leaf Rd (1) site is currently unmanaged. This includes drainage from the road, and the residential subdivision on Wheeler Rd. Stormwater is conveyed in roadside ditching to a cross-culvert under a driveway, and to the Stevensville Brook. This driveway suffers from chronic wash-outs during spring melt and a larger culvert was recently installed to mitigate this problem. At this time, the area between the culvert outlet and the brook was excavated, forming a direct drainage path from the culvert to the brook.

Soils in this location are very good, Hydrologic Soil Group A, with high infiltration potential. As such, the proposed practice for this site is infiltration based.

The proposed retrofit for this site involves rerouting drainage from the culvert to an infiltration basin along the edge of the driveway (see starred location in Figure 16). The basin will be located outside of the defined river corridor. The design for this site also incorporates restoring the riparian buffer and the excavated area between the culvert and the brook to its natural state (Figure 16).

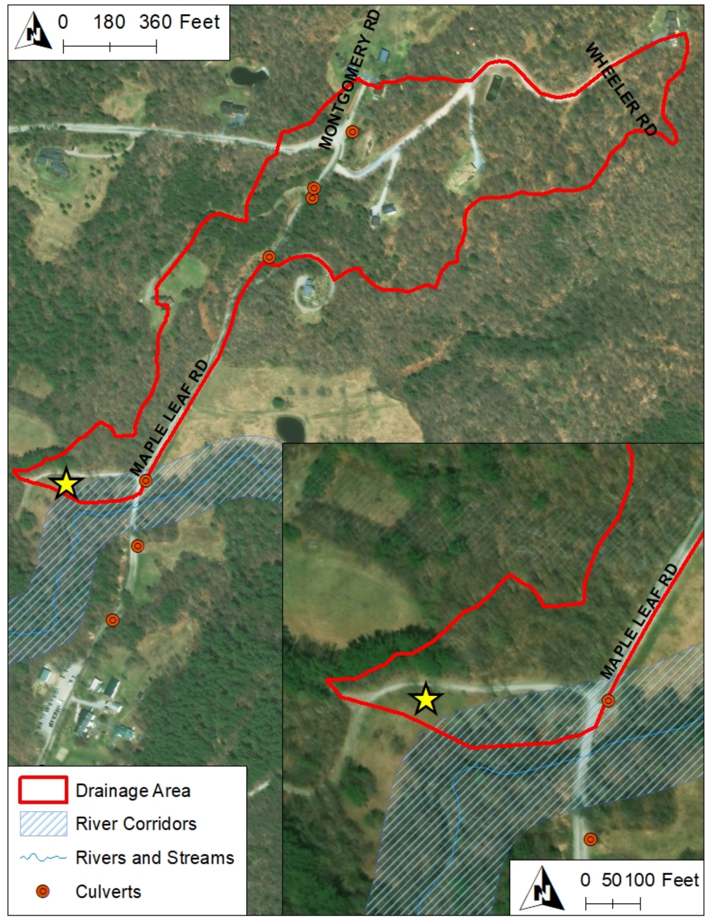

Figure 16. The drainage area for the proposed BMP is shown in red for the Maple Leaf Rd (1) site. The proposed BMP location is shown with a star.

The design standard used for this retrofit was full infiltration of the channel protection volume (CPv, or 2.02” of rain in a 24-hour period), equal to 8,276 ft^3 of runoff.

A 30% design plan is provided in Appendix J - 30% Designs.

6.2.2 Pollutant Removal and Other Water Quality Benefits

A retrofit of this site has the potential to prevent 8,291 lbs of TSS and 5.58 lbs of TP from entering receiving waters annually (Table 10).

Table 10. Maple Leaf Rd (1) benefit summary table.

Total Suspended Solids Removed	8,291 lbs
Total Phosphorus Removed	5.58 lbs
Impervious Treated	2.63 acres
Total Drainage Area	27.1 acres

6.2.3 Cost Estimates

Note that these costs and benefits are very preliminary. Initial cost projections can be found in Table 11. This amount differs from the amount initially projected for this site as design-specific amounts and costs were used. The estimated cost for implementation of this project is $36,000.

- The cost per pound of phosphorus treated is $6,451.61.
- The cost per impervious acre treated is $13,688.21.
- The cost per cubic foot of runoff treated is $4.35.

Table 11. Maple Leaf Rd (1) project initial construction cost projection.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
	Mobilization	LS	1	$ 500.00	$ 500.00
653.55	Project Demarcation Fencing	LF	250	$ 1.17	$ 292.50
653.20	Temporary Erosion Matting	SY	100	$ 2.20	$ 220.00
649.51	Geotextile for silt fence	SY	25	$ 4.13	$ 103.25
652.10	EPSC Plan	LS	1	$ 500.00	$ 500.00
652.20	Monitoring EPSC Plan	HR	8	$ 37.22	$ 297.76
				Subtotal:	$ 2,633.51
Infiltration Basin					
203.15	Common Excavation	CY	750	$ 9.86	$ 7,395.00
613.10	Type I Stone	CY	80	$ 43.91	$ 3,512.80
651.15	Seed (grass)	LBS	20	$ 7.66	$ 153.20
601.0920	24" CPEP Outlet Works	LF	10	$ 64.04	$ 640.40
N/A	24" Beehive Grate with Anti-Vortex Baffle	EACH	1	$ 615.00	$ 615.00
				Subtotal:	$ 12,316.40
New Infrastructure					
601.0915	24" CPEP	LF	50	$ 64.04	$ 3,202.00
				Subtotal:	$ 3,202.00
Riparian Buffering & Trench Filling					
656.16	Deciduous Seedling	EACH	65	$ 81.47	$ 5,295.55
651.35	Topsoil	CY	60	$ 30.96	$ 1,857.60
653.20	Temporary Erosion Matting	SY	200	$ 2.20	$ 440.00
651.15	Seed (grass)	LBS	5	$ 7.66	$ 38.30
				Subtotal:	$ 7,631.45
Subtotal:					$ 25,783.36
	Construction Oversight**	HR	16	$ 100.00	$ 1,600.00
	Construction Contingency - 10%**				$ 2,578.34
	Incidentals to Construction - 5%**				$ 1,289.17
	Minor Additional Design Items - 5%**				$ 1,289.17
	Final Design	HR	30	$ 100.00	$ 3,000.00
	Permit Review and Applications (exclusive of permit fees)	HR	8	$ 100.00	$ 800.00
Total (Rounded)					**$ 36,000.00**

6.2.4 Next Steps

This site is located on Maple Leaf Farm property, which has filed for bankruptcy. It is recommended that the Town waits until the property is under new ownership before proceeding with further design of this retrofit. Further design will involve refinement of the retrofit design with respect to size, outlet design, and routing to ensure that CPv can be completely managed and larger storms passed through the system safely.

6.2.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix K - Permit Review Sheets. In summary:

Stormwater Permit
It is not expected that a stormwater permit will be required at this time.

The site should qualify for an Erosion Prevention and Sediment Control permit (3-9020) under the Low Risk categorization if the following guidelines are followed:

- Less than 2 acres of disturbance at any one time.
- All soils must be stabilized (temporary or final) within 7 days.
- Runoff from the site must pass through a 50’ vegetated buffer prior to entering any Water of the State.

Local Permitting
No local permits are anticipated.

Other Permits
This site should be reviewed by a State River Scientist prior to final design. It should be noted that although the swale conveying drainage to the infiltration basin is in the river corridor, the proposed BMP is located outside of the corridor. There is an Act 250 permit (4C0658-11) for the parcel where the farm buildings are located, however, this should not impact this project. No Act 250 or Wetlands permitting is anticipated for this project.

6.3 Town Clerk's Office and Parking Lot

6.3.1 30% Concept Design Description

The Town Clerk's Office and Parking Lot site is located on Pleasant Valley Rd in Underhill Flats. Presently in the drainage area to the proposed BMP, runoff is generated from the roof and parking lot. The runoff is collected in a culvert in front of the building and is conveyed under the road before discharging to the riverbank without any water quality management.

Soils in this location are very good, Hydrologic Soil Group A, with high infiltration potential. As such, the proposed practice for this site is infiltration based.

The proposed BMP includes a bioretention between the side of the front parking lot and the culvert inlet (see Figure 17). The roof should also be guttered with a downspout draining directly to this feature. This practice will provide water quality benefit by treating runoff from the site's impervious surfaces (see Table 12). Note that any needed municipal culvert upgrades could be coordinated with the construction of the bioretention feature.

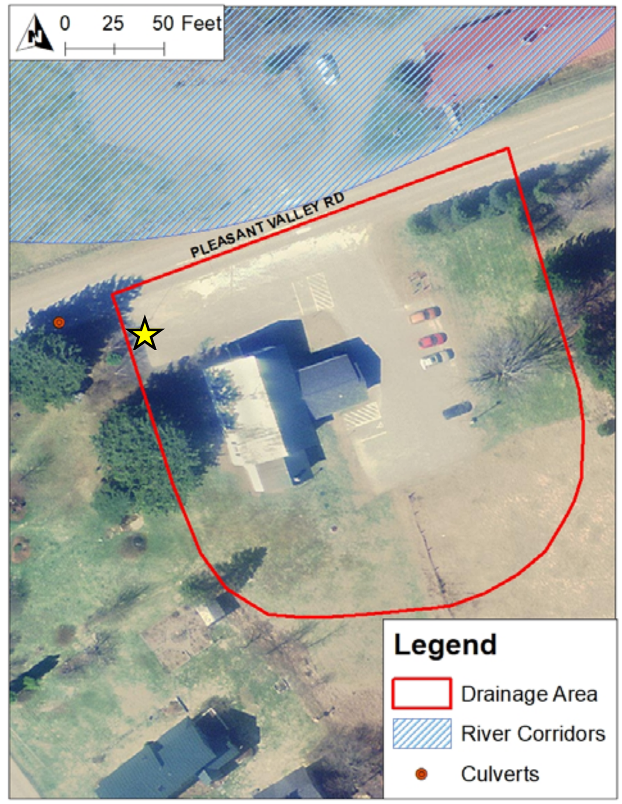

Figure 17. The drainage area for the Town Clerk's Office and Parking Lot project is shown in red. The location of the proposed BMP is shown with a star.

The drainage area for this proposed BMP is 0.91 acres, approximately 40% of which is classified as impervious. This practice will provide a water quality benefit (Table 14), but is also a high visibility site within the Town, and this practice could spur additional retrofits and awareness of stormwater issues in the area. It is recommended that an educational sign be installed in conjunction with the retrofit.

The design standard used for this retrofit was full infiltration of the water quality volume (WQv, or 1" of rain in a 24-hour period), equal to 1,350 ft^3 of runoff.

A 30% design plan is provided in Appendix J - 30% Designs.

6.3.2 Pollutant Removal and Other Water Quality Benefits

A retrofit of this site has the potential to prevent 1,458 lbs of TSS and 0.46 lbs of TP from entering receiving waters annually (Table 12).

Table 12. Town Clerk's Office and Parking Lot benefit summary table.

Total Suspended Solids Removed	1,458 lbs
Total Phosphorus Removed	0.46 lbs
Impervious Treated	0.36 acres
Total Drainage Area	0.91 acres

6.3.3 Cost Estimates

Note that these costs and benefits are very preliminary. Initial cost projections can be found in Table 13. This amount differs from the amount initially projected for this site as design-specific amounts and costs were used. The estimated cost for implementation of this project is $16,000.

- The cost per pound of phosphorus treated is $34,782.61.
- The cost per impervious acre treated is $44,444.44.
- The cost per cubic foot of runoff treated is $11.85.

Table 13. Town Clerk's Office and Parking Lot project initial construction cost projection.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
	Mobilization	LS	1	$ 500.00	$ 500.00
653.55	Project Demarcation Fencing	LF	100	$ 1.17	$ 117.00
652.10	EPSC Plan	LS	1	$ 250.00	$ 250.00
652.20	Monitoring EPSC Plan	HR	4	$ 37.22	$ 148.88
	Construction Staking	HR	4	$ 90.00	$ 360.00
				Subtotal:	$ 1,375.88
Bioretention					
203.28	Excavation of Surfaces and Pavements	CY	40	$ 21.94	$ 877.60
N/A	Rain Guardian Inlet Device	EACH	1	$ 1,500.00	$ 1,500.00
651.35	Bioretention Media (Topsoil)	CY	35	$ 30.96	$ 1,083.60
629.54	Crushed Stone Bedding (weed suppression)	TON	12	$ 34.04	$ 408.48
656.41	Plants* (Perennials)	EACH	100	$ 8.77	$ 877.00
N/A	Plant Seeds	LBS	2	$ 125.00	$ 250.00
601.0920	24" CPEP Outlet Works	LF	5	$ 64.04	$ 320.20
616.21	Vertical Granite Curb	LF	90	$ 35.69	$ 3,212.10
				Subtotal:	$ 8,528.98
New Infrastructure					
601.0915	24" CPEP	LF	15	$ 64.04	$ 960.60
				Subtotal:	$ 960.60
Subtotal:					$ 10,865.46
	Construction Oversight**	HR	8	$ 100.00	$ 800.00
	Construction Contingency - 10%**				$ 1,086.55
	Incidentals to Construction - 5%**				$ 543.27
	Minor Additional Design Items - 5%**				$ 543.27
	Final Design	HR	15	$ 100.00	$ 1,500.00
	Permit Review and Applications (exclusive of permit fees)	HR	4	$ 100.00	$ 400.00
Total (Rounded)					**$ 16,000.00**

6.3.4 Next Steps

As this site is owned and operated by the Town of Underhill, it is recommended that the Town proceed with further design of this retrofit. Further design will involve refinement of the retrofit design with respect to size, outlet design, and routing to ensure that CPv can be completely managed and larger storms passed through the system safely.

6.3.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix K - Permit Review Sheets. In summary:

Stormwater Permit
It is not expected that a stormwater permit will be required at this time.

The site should qualify for an Erosion Prevention and Sediment Control permit (3-9020) under the Low Risk categorization if the following guidelines are followed:

- Less than 2 acres of disturbance at any one time.
- All soils must be stabilized (temporary or final) within 7 days.
- Runoff from the site must pass through a 50’ vegetated buffer prior to entering any Water of the State.

Local Permitting
No local permits are anticipated.

Other Permits
This site should be reviewed by a State River Scientist prior to final design. However, it should be noted that the proposed BMP is located outside of the river corridor. No Act 250 or Wetlands permitting is anticipated for this project.

6.4 Fire Department Swale

6.4.1 30% Concept Design Description

The Underhill Jericho Fire Department is located on Route 15, north of Park Street. At this site, stormwater runoff from half of the Fire Department roof, and portions of the driveway and parking lot are collected in a stormline located on Route 15. Drainage from a section of Route 15 is also collected in this line. The line discharges to an area adjacent to wetlands across the street (Figure 18).

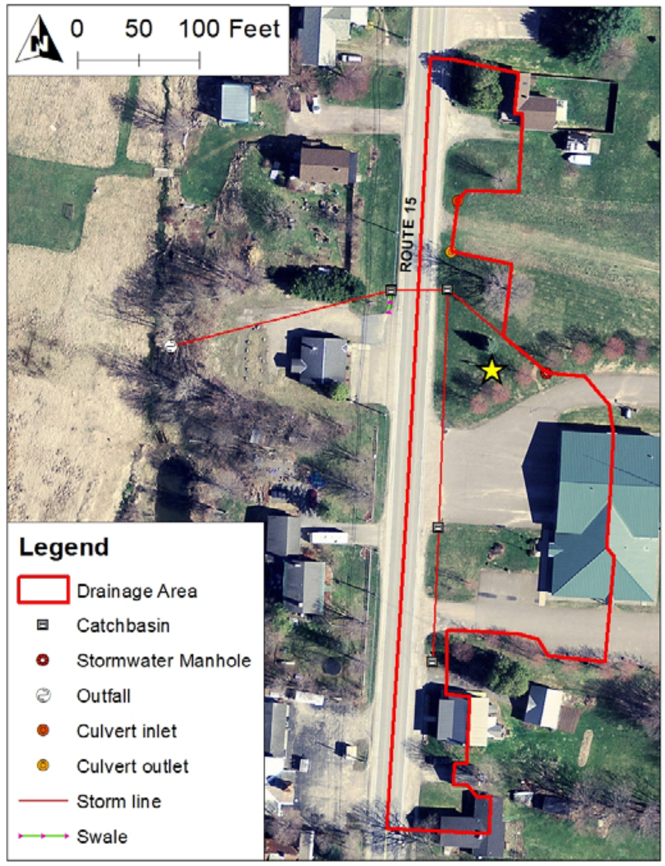

Figure 18. The proposed chamber system is located in the corner (see starred location) between Route 15 and the fire department driveway. The drainage area is shown in red.

Soils in this location are very good, Hydrologic Soil Group A, with high infiltration potential. As such, the proposed practice for this site is infiltration based.

An underground storage and infiltration chamber system is proposed in the lawn at the corner of the northern driveway and Route 15 (see Figure 18). The stormline on Route 15 would be intercepted and routed to this system.

The drainage area for this proposed BMP is 1. 43acres, approximately 61.7% of which is classified as impervious. This practice will provide a water quality benefit (Table 14), but is also a high visibility site within the Town, and this practice could spur additional retrofits and awareness of stormwater issues in the area. It is recommended that an educational sign be installed in conjunction with the retrofit.

The design standard used for this retrofit was full infiltration of the channel protection volume (CPv, or 2.02” of rain in a 24-hour period), equal to 5,663 ft^3 of runoff.

A 30% design plan is provided in Appendix J - 30% Designs.

6.4.2 Pollutant Removal and Other Water Quality Benefits

A retrofit of this site has the potential to prevent 1,113 lbs of TSS and 0.32 lbs of TP from entering receiving waters annually (Table 14).

Table 14. Fire Department Swale benefit summary table.

Total Suspended Solids Removed	1,113 lbs
Total Phosphorus Removed	0.32 lbs
Impervious Treated	0.88 acres
Total Drainage Area	1.43 acres

6.4.3 Cost Estimates

Note that these costs and benefits are very preliminary. Initial cost projections can be found in Table 15. This amount differs from the amount initially projected for this site as design-specific amounts and costs were used. The estimated cost for implementation of this project is $59,000.

- The cost per pound of phosphorus treated is $184,375.00.
- The cost per impervious acre treated is $67,045.45.
- The cost per cubic foot of runoff treated is $10.42.

Table 15. Fire Department Swale project initial construction cost projection.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
	Mobilization	LS	1	$ 1,000.00	$ 1,000.00
653.55	Project Demarcation Fencing	LF	250	$ 1.17	$ 292.50
652.10	EPSC Plan	LS	1	$ 500.00	$ 500.00
649.51	Geotextile for silt fence	SY	55	$ 4.13	$ 227.15
652.20	Monitoring EPSC Plan	HR	4	$ 37.22	$ 148.88
	Construction Staking	HR	8	$ 90.00	$ 720.00
				Subtotal:	$ 2,888.53
Chambers - Costs					
	MC3500	EACH	18	$ 400.20	$ 7,203.60
	MC3500 Plain End Cap	EACH	4	$ 300.15	$ 1,200.60
	MC3500 24" Bottom End Cap	EACH	2	$ 404.23	$ 808.45
	12" 90 Manifold - 1298AN	EACH	2	$ 57.10	$ 114.20
	11" Single Tee Manifold - 1251AN	EACH	2	$ 109.70	$ 219.40
	12" Coupler - 1265AA	EACH	10	$ 8.29	$ 82.92
	12" N12 for splicing as needed (AASHTO)	EACH	60	$ 7.45	$ 447.12
	24" N12 for Isolator Row (AASHTO)	LF	20	$ 21.67	$ 433.32
	601TG to wrap system (SY)	SY	1000	$ 0.67	$ 667.00
	315WTM for scour protection (SY)	SY	500	$ 0.70	$ 350.75
	Inline Drain for Inspection Port	EACH	1	$ 310.50	$ 310.50
	Inserta Tee for Inspection Port	EACH	1	$ 86.32	$ 86.32
	6" N12 for inspection ports	LF	20	$ 2.70	$ 54.05
	6" Hole Saw	EACH	1	$ 132.43	$ 132.43
				Subtotal:	$ 12,110.65
Materials and Excavation Costs					
604.20	Concrete Catch Basin	EACH	4	$ 3,387.59	$ 13,550.36
203.15	Common Excavation	CY	253	$ 9.86	$ 2,494.58
629.54	Crushed Stone Bedding	TON	237	$ 34.04	$ 8,067.48
601.0910	15" CPEP	LF	80	$ 34.05	$ 2,724.00
651.35	Topsoil	CY	60	$ 30.96	$ 1,857.60
653.20	Temporary Erosion Matting	SY	375	$ 2.20	$ 825.00
651.15	Seed	LBS	10	$ 7.66	$ 76.60
				Subtotal:	$ 29,595.62
Subtotal:					$ 44,594.80
	Construction Oversight**	HR	12	$ 100.00	$ 1,200.00
	Construction Contingency - 10%**				$ 4,459.48
	Incidentals to Construction - 5%**				$ 2,229.74
	Minor Additional Design Items - 5%**				$ 2,229.74
	Final Design	HR	30	$ 100.00	$ 3,000.00
	Permit Review and Applications (exclusive of permit fees)	HR	8	$ 100.00	$ 800.00
Total (Rounded)					**$ 59,000.00**

6.4.4 Next Steps

Contact was made with Harry Schoppmann III (Underhill Jericho Fire Department) and Tyler Hanson (VTrans Stormwater Technician) prior to advancing concept designs at this site. The Fire Department and VTrans agreed to allow further design to be completed at the site. Further design will involve refinement of the retrofit design with respect to size, outlet design, and routing to ensure that CPv can be completely managed and larger storms passed through the system safely. A formal agreement will need to be reached with the Fire Department and VTrans prior to final design.

6.4.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix K - Permit Review Sheets. In summary:

Stormwater Permit
It is not expected that a stormwater permit will be required at this time.

The site should qualify for an Erosion Prevention and Sediment Control permit (3-9020) under the Low Risk categorization if the following guidelines are followed:

- Less than 2 acres of disturbance at any one time.
- All soils must be stabilized (temporary or final) within 7 days.
- Runoff from the site must pass through a 50’ vegetated buffer prior to entering any Water of the State.

Local Permitting
No local permits are anticipated.

Other Permits
This project should be reviewed by a wetland ecologist prior to final design. However, it should be noted that although there are hydric soils within the drainage area of the proposed BMP, hydric soils are not mapped as present in the location of the proposed BMP. No Act 250 or River Corridor permitting is anticipated for this project.

6.5 St. Thomas Church Parking Lot

6.5.1 30% Concept Design Description

The site includes half of the church roof, half of a residential roof, a portion of Green St and Pleasant Valley Rd, and the majority of the church parking lot. Stormwater currently sheet flows through this area to the vegetated area dividing the parking lot from Green St and Pleasant Valley Rd. Drainage is discharged via a cross culvert to a short ditch, and travels via surface flow into Mill Brook (to the east in Figure 19).

Soils are mapped as being good at this site for infiltration (Hydrologic Group B).

The concept for this site includes widening the vegetated divide, decreasing the overall width of Green St, and formalizing this area as an infiltration based bioretention. This feature would outlet to the existing cross culvert (see Figure 19).

The drainage area for these proposed BMPs is 0.89 acres, approximately 75% of which is classified as impervious. This practice will provide a water quality benefit (Table 16) and is also a high-visibility site within the Town. This practice could spur additional retrofits and awareness of stormwater issues in the area. It is recommended that an educational sign be installed in conjunction with the retrofit.

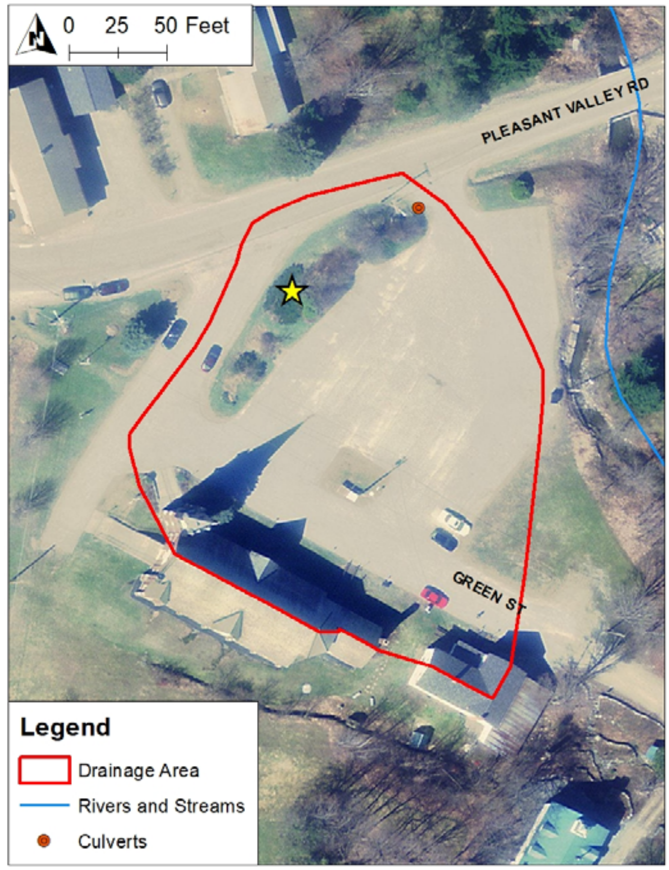

Figure 19. Runoff from the St. Thomas Church Parking Lot drainage area, shown in red, is proposed to be directed to a bioretention shown with a star.

The design standard used for this retrofit was full infiltration of the channel protection volume (CPv, or 2.02" of rain in a 24-hour period), equal to 4,922 ft^3 of runoff.

A 30% design plan is provided in Appendix J - 30% Designs.

6.5.2 Pollutant Removal and Other Water Quality Benefits

A retrofit of this site has the potential to prevent 1,185 lbs of TSS and 0.45 lbs of TP from entering receiving waters annually (Table 16).

Table 16. St. Thomas Church Parking Lot benefit summary table.

Total Suspended Solids Removed	1,185 lbs
Total Phosphorus Removed	0.45 lbs
Impervious Treated	0.67 acres
Total Drainage Area	0.89 acres

6.5.3 Cost Estimates

Note that these costs and benefits are very preliminary. Initial cost projections can be found in Table 17. This amount differs from the amount initially projected for this site as design-specific amounts and costs were used. The estimated cost for implementation of this project is $29,000.

- The cost per pound of phosphorus treated is $64,444.44.
- The cost per impervious acre treated is $43,283.58.
- The cost per cubic foot of runoff treated is $5.89.

Table 17. St. Thomas Church Parking Lot project initial construction cost projection.

VTrans Code	Description	Unit	Quantity	Unit Price	Amount
Site Preparation					
	Mobilization	LS	1	$ 1,000.00	$ 1,000.00
653.55	Project Demarcation Fencing	LF	250	$ 1.17	$ 292.50
653.20	Temporary Erosion Matting	SY	100	$ 2.20	$ 220.00
649.51	Geotextile for silt fence	SY	25	$ 4.13	$ 103.25
652.10	EPSC Plan	LS	1	$ 500.00	$ 500.00
652.20	Monitoring EPSC Plan	HR	8	$ 37.22	$ 297.76
	Construction Staking	HR	8	$ 90.00	$ 720.00
				Subtotal:	$ 3,133.51
Bioretention					
203.15	Common Excavation	CY	230	$ 9.86	$ 2,267.80
651.35	Bioretention Media (Topsoil)	CY	65	$ 30.96	$ 2,012.40
613.10	Type I Stone	CY	15	$ 43.91	$ 658.65
656.41	Plants* (Perennials)	EACH	500	$ 8.77	$ 4,385.00
N/A	Plant Seeds	LBS	5	$ 125.00	$ 625.00
651.15	Seed (grass)	LBS	5	$ 7.66	$ 38.30
601.0915	18" CPEP Outlet Works	LF	10	$ 64.04	$ 640.40
N/A	18" Beehive Grate with Anti-Vortex Baffle	EACH	1	$ 615.00	$ 615.00
				Subtotal:	$ 11,242.55
New Infrastructure					
601.0915	18" CPEP	LF	75	$ 64.04	$ 4,803.00
				Subtotal:	$ 4,803.00
Subtotal:					$ 19,179.06
	Construction Oversight**	HR	16	$ 100.00	$ 1,600.00
	Construction Contingency - 10%**				$ 1,917.91
	Incidentals to Construction - 5%**				$ 958.95
	Minor Additional Design Items - 5%**				$ 958.95
	Final Design	HR	30	$ 100.00	$ 3,000.00
	Permit Review and Applications (exclusive of permit fees)	HR	8	$ 100.00	$ 800.00
Total (Rounded)					**$ 28,000.00**

6.5.4 Next Steps

Contact was made with the church pastor, Father Christopher Micale prior to advancing concept designs at this site. The Church agreed to allow further design to be completed at the site. Further design will involve refinement of the retrofit design with respect to size, outlet design, and routing to ensure that CPv can be completely managed and larger storms passed through the system safely. A formal agreement will need to be reached with the church prior to final design.

6.5.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix K - Permit Review Sheets. In summary:

Stormwater Permit
It is not expected that a stormwater permit will be required at this time.

The site should qualify for an Erosion Prevention and Sediment Control permit (3-9020) under the Low Risk categorization if the following guidelines are followed:

- Less than 2 acres of disturbance at any one time.
- All soils must be stabilized (temporary or final) within 7 days.
- Runoff from the site must pass through a 50' vegetated buffer prior to entering any Water of the State.

Local Permitting
No local permits are anticipated.

Other Permits
This site should be reviewed by a State River Scientist prior to final design. However, it should be noted that the proposed BMP is located outside of the river corridor. No Act 250 or Wetlands permitting is anticipated for this project.

Final Recommendations

The results of this SWMP have identified a number of potential BMP concepts and locations that would have a positive impact on water quality in the Town of Underhill and receiving waters. Although designs were only advanced for the top 5 projects, this plan also serves to highlight these other opportunities throughout the Town. The momentum developed during this study should be strengthened and continued.

The practices proposed in this study all stand to have a substantial impact on abating water pollution and setting a precedent for integrating GSI in Underhill's landscape. It is our recommendation that the Town, in partnership with the CCRPC move to implement the Top 5 practices, but also to move forward with additional design and implementation of other projects presented in this plan (see Appendix L – Projects for Watershed Projects Database, for projects identified to the DEC to be inputted into the Watershed Projects Database). As these practices are the result of a stormwater master planning effort under a VT DEC Clean Water Fund grant, they are well-suited as candidates for an implementation grant from this same source. We recommend the following steps in proceeding with this:

- For priority projects already at the 30% concept level, consider grant request for final design and implementation.

- Following implementation of the priority projects, submit grant funding requests for higher scoring projects that may include both preliminary and final design.

It is further recommended that a stormwater-specific ordinance be developed for the Town of Underhill. Although existing municipal documents note stormwater mitigation efforts in regards to roads, bridges, driveways, and trails, a freestanding policy would clearly define best practices for stormwater management throughout the Town. Additionally, it would make the standards more accessible to Town residents and would be easier to update in response to new research and legislation.

In accordance with the 2015 Underhill Town Plan, we recommend conducting a Fluvial Erosion Hazard assessment to protect those areas subject to erosion, limit new development in hazard zones, and allow for natural equilibrium and flow of rivers and streams.

The Vermont Agency of Transportation (VTrans), as part of their Transportation Separate Storm Sewer System (TS4) General Permit, will be completing their own retrofit assessment of VTrans-owned impervious surfaces throughout the Town. Projects identified in this plan that involve VTrans drainage should be coordinated with the VTrans TS4 permitting efforts to allow for potential collaboration.

To map and interact with watershed modeling results related to non-point total phosphorus loading sources within the Vermont portion of the Lake Champlain Basin, we recommend using the Clean Water Roadmap (CRW). This web-based tool supports the VT DEC’s tactical basin planning and outreach efforts related to Lake Champlain Phosphorus TMDL. For more information, or to use the CWR, see Appendix A for the web document link.

Upcoming regulatory requirements under Act 64 will require management of sites with ≥3 acres of unmanaged and unpermitted (current State stormwater permit) impervious cover. These areas are an issue given the large concentration of impervious surfaces. One such area is the Mt Mansfield State Forest parcel. However, it should be noted that the impervious area within this parcel is well disconnected from surface waters and, as such, was not considered to be a priority within this plan. Another area is the Camp Ethan Allen Training Site located off Browns Trace Road by Mount Mansfield Union High School. This facility is managed by the Vermont Army National Guard encompassing an area of approximately 5,074 acres, and has >3 acres of impervious cover. The Lee River, tributary to the Browns River, flows directly through this site. Although the Camp is federally owned, they adhere to State stormwater permitting requirements and standards as well as to the U.S. Army Operational Range Assessment Program in the U.S. Department of Defense Sustainable Ranges Initiative. See Appendix A. From conversations with the Construction and Facilities Manager, all existing stormwater systems are permitted and inspected annually. Beyond efforts to control erosion and runoff, while containing and managing all stormwater from their installation, the Camp also reuses water collected in onsite stormwater ponds for fire prevention, dust control, and snow making. Flood mitigation has also been the focus of a number of recently implemented BMPs due to an increase in regional flooding events. Although the Camp was not included as part of this study, a stand-alone master planning assessment could be completed for this property in future stormwater investigations.