Chase Brook Stormwater Master Plan

Final Report

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SUBMITTED TO:

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I. Disclaimer

The intent of this report is to present the data collected, evaluations, analyses, designs, and cost estimates for the Chase Brook Stormwater Master Plan under a contract between the Town of Fayston and Watershed Consulting Associates, LLC. Funding for the project was provided by the Vermont Department of Environmental Conservation's 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 this area. There is great need to reduce stormwater impacts including phosphorus and sediment from stormwater runoff to receiving waters within the municipalities and the greater Lake Champlain Basin considering current and future regulation under the Lake Champlain Total Maximum Daily Load requirements. Although there are other BMP strategies that could be implemented in the study area, those presented in this document 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 at this time, nor is any property owner within the watershed obligated to implement them. However, it should be noted that for properties with three or more acres of impervious cover without a current State stormwater permit, regulations will require management of existing impervious areas. This stormwater master plan, and therefore its resultant strategies, is one of the actions in the Winooski 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 gravel wetlands, infiltration basins, 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 or stone.

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 BMP 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 the permeability of 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 Chase Brook, this includes the entire area draining to the point where the river discharges to Mill Brook.

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 must 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 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 many of the developed areas within the State of Vermont predate 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 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 Guidelines

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. This 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 limited 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 Existing Conditions

The study area for this Stormwater Master Plan (SWMP) includes the Chase Brook watershed (larger red polygon in Figure 1) and a section of the Slide Brook watershed that includes Low Rd, High Rd, Village Rd, and Snowside (smaller red polygon in the southeast corner of Figure 1). Both watersheds are located in the Town of Fayston and are tributaries of the Mad River, which ultimately drains to Lake Champlain. The study area spans approximately 1,437 acres in Washington County and is primarily forested (81%) while 11% is classified as urban (including urban open space). Of that area, there are 26.6 acres (1.9%) of impervious cover. A larger overview map can be found in Appendix A.

Surrounding the development in this watershed, concentrated at Sugarbush's Mount Ellen Resort, areas are more residential and rural. The study area contains roads that are generally unpaved with open roadside ditches, and many of these roads have steep slopes. 100% of soils in the study area are classified as either highly erodible or potentially 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 study area, the majority of areas belong to Hydrologic Soil Group D (57%) while only 2% are in group A. 31% are in group B and 10% are in group C. This combination of steep slopes with limited infiltration capacity and a highly erodible surface makes the area particularly susceptible to erosion.

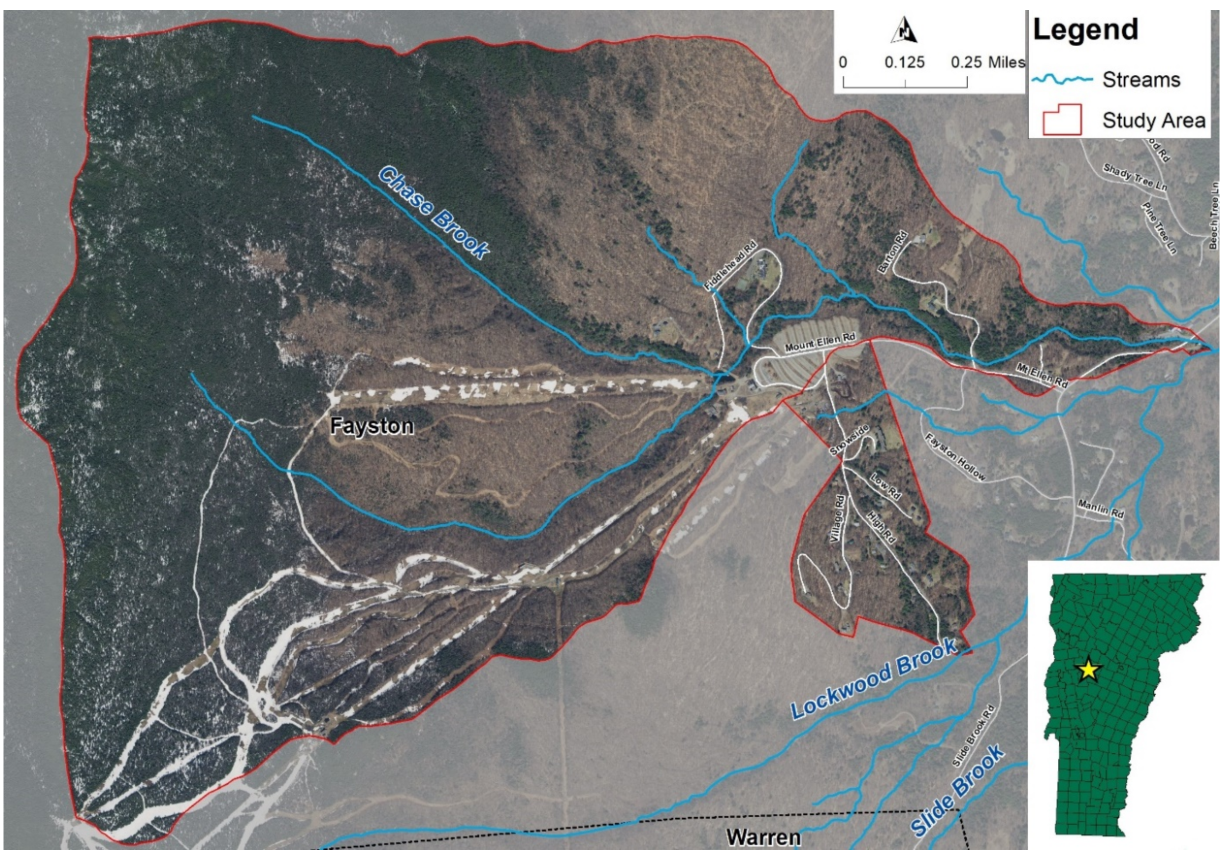

Figure 1. The SWMP study area includes the Chase Brook watershed and a residential section of upper Slide Brook watershed.

Maps depicting existing watershed conditions can be found in Appendix B. Maps include:

- river corridors, wetlands, and hydric soils;
- impervious cover;
- soil infiltration potential;
- soil erodibility;
- land cover;
- slope;
- stormwater infrastructure and stormwater permits;
- and parcels with ≥3 acres of impervious cover.

3.2 Problem Definition

The study area faces unique challenges as it includes steep headwater tributaries with distributed residential development and significant development associated with the Sugarbush Resort Mount Ellen Resort. Many of the older developments within this area were constructed before current stormwater standards were developed, and they were constructed without any or with only minimal stormwater management, often on steep slopes with highly erodible soils. This has resulted in untreated stormwater draining developed lands, transporting pollutants and discharging to surface waters.

In the mid 1990's, both Chase Brook and Slide Brook were designated as impaired due to stormwater runoff and efforts were subsequently made to control erosion and sedimentation. In 2004, the streams were removed from the 303 (d) list for stormwater-related issues, but significant challenges still remain in these watersheds. Slide Brook remains on the 2018 303(d) list of waters for the length of 0.8 miles due to being altered by flow regulation.

4 Methodology

4.1 Identification of All Opportunities

4.1.1 Data collection and review

All relevant prior watershed studies and any studies that could inform planning in the project area were assembled and reviewed in the context of this SWMP study. These include general documents such as past studies conducted within the greater Mad River watershed, future regional planning goals, and previously recommended stormwater improvements for the Mount Ellen parking lot.

Relevant Geographic Information System (GIS) data was drawn from a variety of public resources including the Agency of Natural Resources Atlas and Vermont Center for Geographic Information Open Geodata Portal. 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 (2018). The information collected and reviewed for the creation of this SWMP as well as a summary memo are included as Appendix C.

The project team met with stakeholders Friends of the Mad River (Friends) and Sugarbush Resort (Sugarbush) on September 21, 2018 at the Fayston Town Offices to discuss the SWMP and solicit information on specific stormwater-related problems in the study area as well as any planned developments or other relevant activities. The noted areas included specific parcels and general areas of importance. Meeting minutes from this meeting are included in Appendix D.

4.1.2 Desktop Assessment and Digital Map Preparation

Desktop Assessment

A desktop assessment was completed to identify additional potential sites for stormwater best management practice (BMP) implementation. This process involved a thorough review of existing GIS resources and associated attribute data. Data included, but was not limited to, storm sewer infrastructure, soils classifications, parcel data, wetlands, impervious cover, and river corridors. This data was used to identify and map stormwater subwatersheds with particularly high impervious cover, stormwater subwatersheds that are more directly connected to water bodies (direct pipes to streams or via overland flow), areas where infill development may occur, areas that may have worsening stormwater impacts in the future, and parcels with ≥3 acres of impervious cover without a current stormwater permit as these areas will be subject to permitting. A point location was created for each identified site or area for assessment in the field.

A 'green streets' assessment was also conducted to identify any road segments in the study area potentially appropriate for streetscape green stormwater infrastructure (GSI) retrofit opportunities. This assessment identifies roads that are fairly flat, wide, and have moderate to high infiltration potential. However, due to the study area's rural characteristics and abundance of steep unpaved roads, it was determined that no viable green streets opportunities existed within the study area.

A total of 25 locations were identified for stormwater retrofit potential including sites noted by stakeholders and those located during the desktop assessment. For a map of these sites, see Figure 2. A larger map of the sites, a table listing the sites with descriptions, point locations in geodatabase format, and a memo describing this process are included in Appendix E.

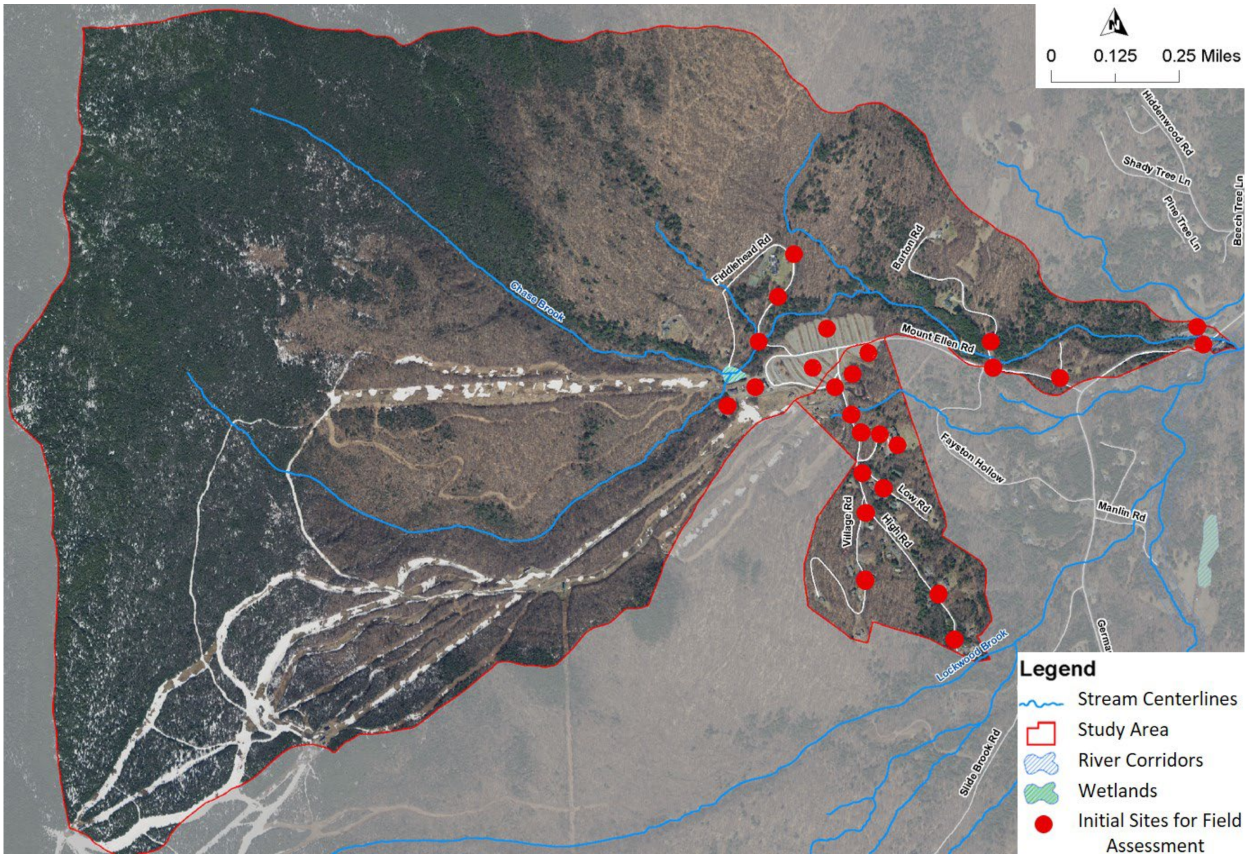

Figure 2. The 25 sites identified for field assessment are shown with red circles.

Digital Map and App Preparation

In order to maximize efficiency in the field and better understand site-specific conditions, digital base maps were created for the study area. 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 SWMP using the Fulcrum platform[1]. A screenshot of the mobile data collection app with several of these layers displayed is shown in Figure 3. The app was also pre-loaded with the 25-point locations for the potential BMP sites, which included locations of problem areas and potential opportunities (see green pins in Figure 3). These points allowed for easy site location and data collection in the field. A memo further describing this process can be found in Appendix F.

Figure 3. Screenshot of mobile data collection app.

[1] www.fulcrumapp.com

4.1.3 Field Data Collection

Targeted investigations were completed for the 25 sites identified on the initial retrofit list as well as sites encountered during field work that were not initially identified. These investigations involved a visit to the prospective BMP location to assess the best retrofit appropriate for site-specific conditions and complete an initial assessment of project feasibility. Factors considered included but were not limited to potential utility conflicts, ownership of site, space, poor soils, steepness, and current and future site use. During the assessment, the team also determined if there were any ancillary benefits to the project (e.g., educational, flood mitigation, etc.), obtained photo documentation, and noted any potential questions about the site for follow-up (e.g., parcel ownership, location of utilities, road right-of-way width, etc.).

Through the course of these field visits, 2 additional stormwater retrofit sites were identified that had not been included in the initial assessment, so a total of 27 sites were assessed as part of this plan (Figure 4). Additionally, 2 site locations that seemed like potential opportunities for BMP implementation were excluded from further analysis due to specific, prohibitive site conditions. 2 assessed sites were combined into 1 larger project given observed drainage patterns. Following this process, a total of 24 sites remained as potential BMP opportunities. See Appendix G for an overview map, table, a list of sites removed and combined, one-page summary sheets, and a summary memo describing these projects.

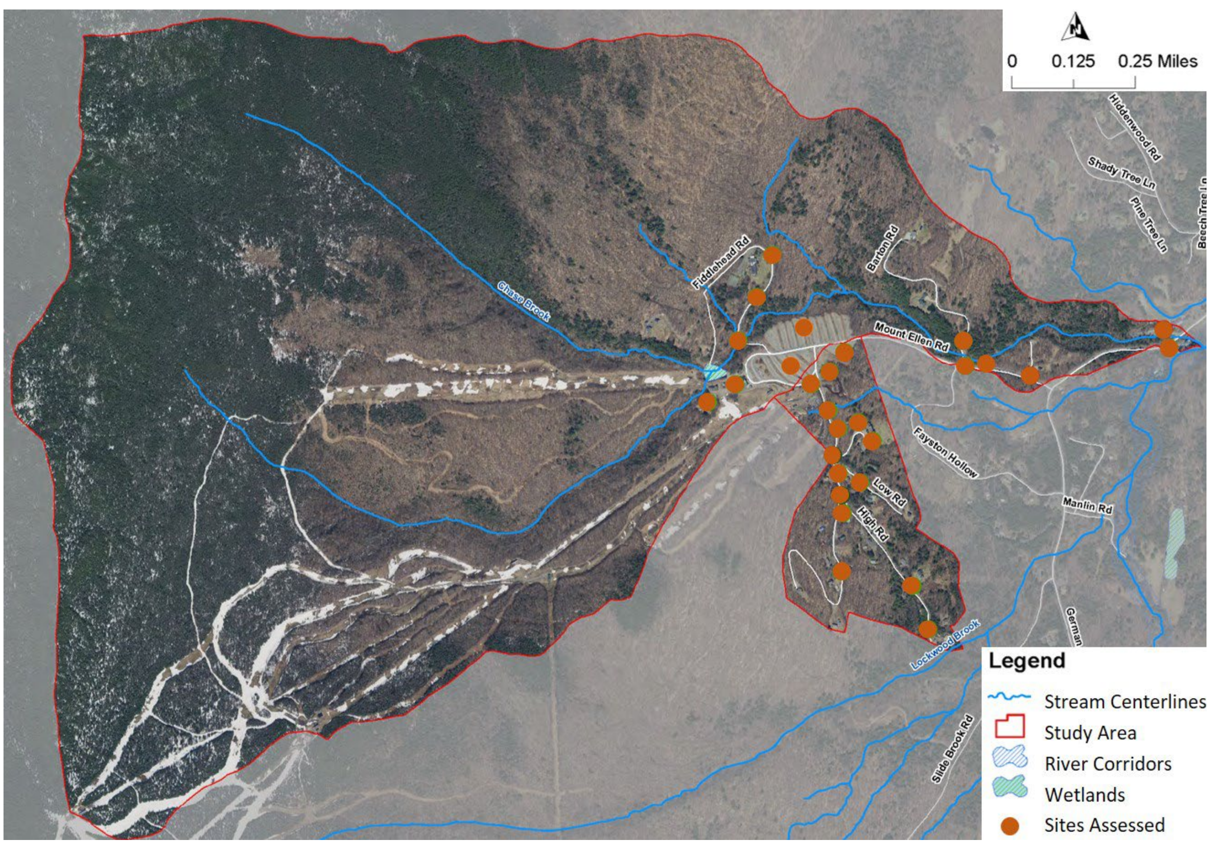

Figure 4. 27 sites were assessed during initial field work, depicted above with orange circles.

4.2 Preliminary BMP Ranking

After initial field visits were completed and the project list was updated, a preliminary ranking system was utilized to prioritize these 24 projects (see Figure 4 for project locations). The goal of this ranking was to prioritize this large list of projects and identify 10 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, hydrologic connectivity, land ownership, hydrologic soil group, and feasibility issues. See Appendix H-1 for the complete list of factors utilized in the preliminary ranking. Also included in Appendix H-1 is the completed ranking for each potential site, one-page field data summary sheets with initial ranking information, and a memo detailing this ranking process.

The initial preliminary ranking list was distributed to project stakeholders, and the project team then met with these stakeholders on January 31, 2019 to discuss the ranking and the proposed Top 10 project list. Following this initial prioritization meeting and given the stakeholder feedback, many of the identified projects were combined into larger scale BMPs. The revised list of projects included 13 sites (Figure 5). Each project was rescored using the same ranking system as described above. The revised ranking and supporting materials can be found in Appendix H-2.

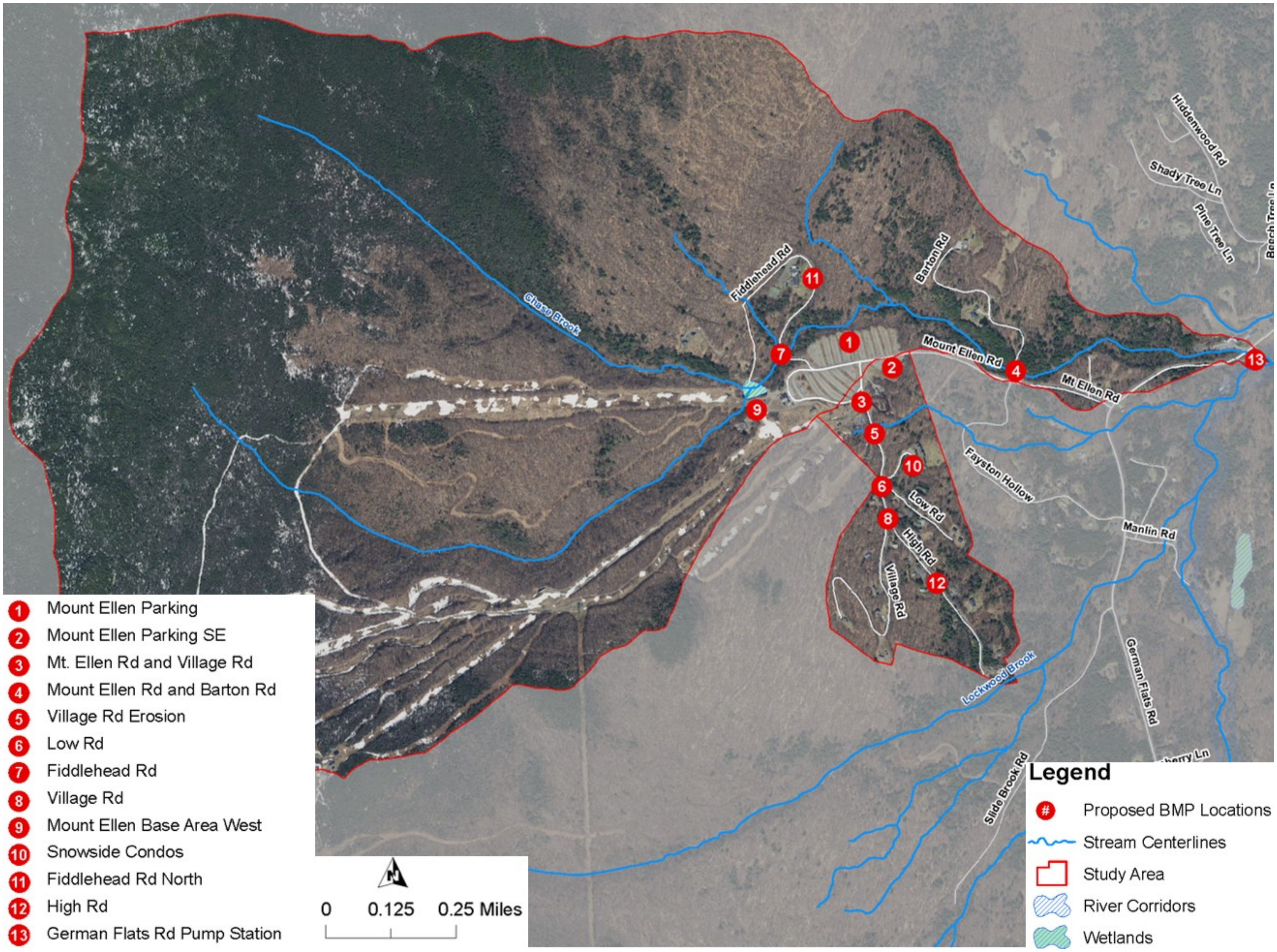

Figure 5. The locations of the 13 sites included in the preliminary ranking are shown within the study area.

4.3 Top 10 BMPs

The revised preliminary ranking was sent to project stakeholders and feedback was requested to finalize the Top 10 sites list. The updated Top 10 list, shown below in Table 1, reflects the results of the preliminary ranking as well as stakeholder priorities and any feasibility issues previously unknown to the project team. The table includes the total score assigned during the preliminary ranking and the BMP rank within the list of projects. Note that if two projects were assigned the same score, they are noted as being tied for that rank. A table summarizing these sites, a larger overview map, one-page summary sheets, and a descriptive memo can be found in Appendix I.

Table 1. The Top 10 projects are listed in preliminary ranked order.

Project Name	***Total Score (%)***	***BMP Rank***
Mount Ellen Parking	86.84	1
Mount Ellen Parking SE	52.63	2
Mt. Ellen Rd and Village Rd	50	3
Mount Ellen Rd and Barton Rd	44.74	4
Village Rd Erosion	36.84	5 (tie)
Low Rd	36.84	5 (tie)
Fiddlehead Rd	34.21	7
Village Rd	31.58	8
Mount Ellen Base Area West	28.95	9 (tie)
Snowside Condos	28.95	9 (tie)

4.4 Modeling and Concept Refinement

Modeling was completed for each of the Top 10 sites. 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 using the best available topographic data and land use/land cover was digitized using the best available aerial imagery. Drainage areas were then refined as needed based on field observations. Each of the sites was modeled in HydroCAD to determine the appropriate BMP size and resultant stormwater volume benefits (see Appendix J-1 for modeling reports).

Each of these sites was also modeled to understand the existing condition pollutant loading and pollutant loading reductions associated with the proposed BMPs. This was completed using two methods. The first method utilized the VT Department of Environmental Conservation's Stormwater Treatment Practice (STP) Calculator[2]. This model is used within the Lake Champlain Basin for estimation and tracking of BMP pollutant load reductions. The STP Calculator is currently only programmed to provide total phosphorus (TP) loading and reductions and cannot at this time be used to estimate total suspended solids (TSS). Pollutant loading estimates were also calculated using the Source Loading and Management Model for Windows (WinSLAMM) to determine the annual TSS and TP loading from the drainage area of each site. Pollutant load reductions from each of the BMPs were then calculated using one of two sources, depending on the practice type. WinSLAMM was used when possible, and, for those practices that WinSLAMM does not model well (generally non-infiltration-based practices; based on experience and literature), pollutant removal rates published by the University of New Hampshire Stormwater Center were applied to the initial

[2] https://anrweb.vt.gov/DEC/CleanWaterDashboard/STPCalculator.aspx

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 2. If these 10 projects were to be implemented, it would reduce annual TSS loading by 36,783 lbs and annual TP loading by nearly 48 lbs according to the STP Calculator and 24 lbs according to the more conservative WinSLAMM models. Note that discussions of TP reductions in the remainder of this report will reference the STP Calculator modeling results unless otherwise noted. WinSLAMM models can be found in Appendix J-2. Complete modeling results are provided in Appendix J-3.

Table 2. Modeling results for the Top 10 projects are shown below.

Project Name	*Volume Managed (ac-ft)*	*Volume Infiltrated (ac-ft)*	*TSS Yield (lbs)*	*TSS Removal (lbs)*	*TSS Removal (%)*	*WinSLAMM TP Yield (lbs)*	*WinSLAMM TP Removal (lbs)*	*WinSLAMM TP Removal (%)*	*STP Calculator TP Yield (lbs)*	*STP Calculator TP Removal (lbs)*	*STP Calculator TP Removal (%)*
Mount Ellen Parking	0.815	0.815	10,569	10,094	95.51%	6.44	6.08	94.35%	14.16	14.16	100.00%
Mount Ellen Parking SE	0.714	0.714	11,602	11,151	96.11%	5.77	5.41	93.73%	12.83	12.83	99.98%
Mt. Ellen Rd and Village Rd	0.21	0.21	8,039	7,503	93.33%	6.13	5.52	89.99%	9.17	8.42	91.78%
Village Rd Erosion	0.059	0.051	3,029	2,293	60% (Ditching) 77% (Infiltration Basin)	3.45	2.45	60% (Ditching) 70% (Infiltration Basin)	3.92	3.44	87.59%
Mount Ellen Rd and Barton Rd	0.042	0	2,629	1,577	60.00%	1.99	1.19	60.00%	2.65	2.29	86.70%
Mount Ellen Base Area West	0.044	0.008	2,725	1,540	60% (Ditches) 41% (Drywells)	2.82	1.67	60% (Ditches) 51% (Drywells)	3.02	2.60	86.13%
Snowside Condos	0.059	0.041	294	281	60% (Ditches) 97.43% (Sediment Trap)	0.18	0.17	60% (Trench Drain) 97.24% (Sediment Trap)	2.27	2.06	90.91%
Village Rd	0.014	0.014	922	656	71.16%	0.55	0.40	72.89%	1.35	1.12	83.36%
Fiddlehead Rd	0.059	0.059	1,243	1,212	97.47%	0.8	0.78	97.79%	1.19	0.27	22.76%
Low Rd	0.015	0	793	476	60.00%	0.56	0.34	60.00%	0.82	0.73	88.90%

4.5 Final Ranking Methodology

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

- 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

The final ranking table is included as Appendix K-1. Each of the criteria used in the final ranking and their associated scores are listed and explained in Appendix K-2. An overview map, one-page summary sheets, and a descriptive memo are also included in Appendix K.

4.5.1 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 is a variation of the method 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 criteria used in this cost estimation can be found in Appendix K. 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 is expected as projects move forward with engineering design. 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 Channel Protection volume (CPv) or Water Quality volume (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[3] and modified for this project to reflect the newest cost estimates

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

available and inflation from 2016 dollars to 2019 dollars. Cost adjustment factors were used to account for site-specific differences typically related to project size, location, and complexity.

Underground filtration chamber systems were typically designed using Stormtech MC-4500™ chamber systems.

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 aboveground projects or 35% for smaller or complex projects.

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 were assigned a minimum cost of $10,000 and more complex projects were assigned a minimum cost of $25,000.

4.6 Final Prioritization

Each of the factors noted in Appendix K 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; as calculated by the STP Calculator) by the practice was used as a tiebreaker. A summary of the practices with their assigned rank are shown below in Table 3. The location of the Top 10 projects within the study area are shown below in Figure 6.

As future funding becomes available for project implementation, this prioritization matrix can be utilized in selecting additional projects for implementation. Also included in Appendix K is an overview map of the ranked sites, one-page summary sheets, and a memo further describing the ranking methodology.

Table 3. The Top 10 projects are shown in ranked order.

Project Name	*Proposed BMP Practice Type*	*Total Score*	*BMP Rank*
Mount Ellen Parking	Infiltration Basin, General Road Improvements	36	1
Mount Ellen Parking SE	Infiltration Basin, Ditch / Swale Improvements, Dry Well	35	2
Mt. Ellen Rd and Village Rd	Infiltration Basin	33	3
Village Rd Erosion	Check Dams, Ditch / Swale Improvements, Dry Well, Infiltration Basin	26	4
Mount Ellen Rd and Barton Rd	Ditch / Swale Improvements, Step Pools, Filter Strip / Buffer Enhancement	26	5
Mount Ellen Base Area West	Bioretention, Ditch / Swale Improvements, Dry Well	25	6
Snowside Condos	Filter Strip / Buffer Enhancement, Infiltration Trench, Stormwater Planter, Dry Well, Ditch / Swale Improvements	23	7
Village Rd	Check Dams, Ditch / Swale Improvements, Dry Well, Infiltration Basin	23	8
Fiddlehead Rd	Check Dams, Ditch / Swale Improvements, Sediment Trap	21	9
Low Rd	Check Dams, Cross Culverts, Ditch / Swale Improvements, Sediment Trap, Step Pools	20	10

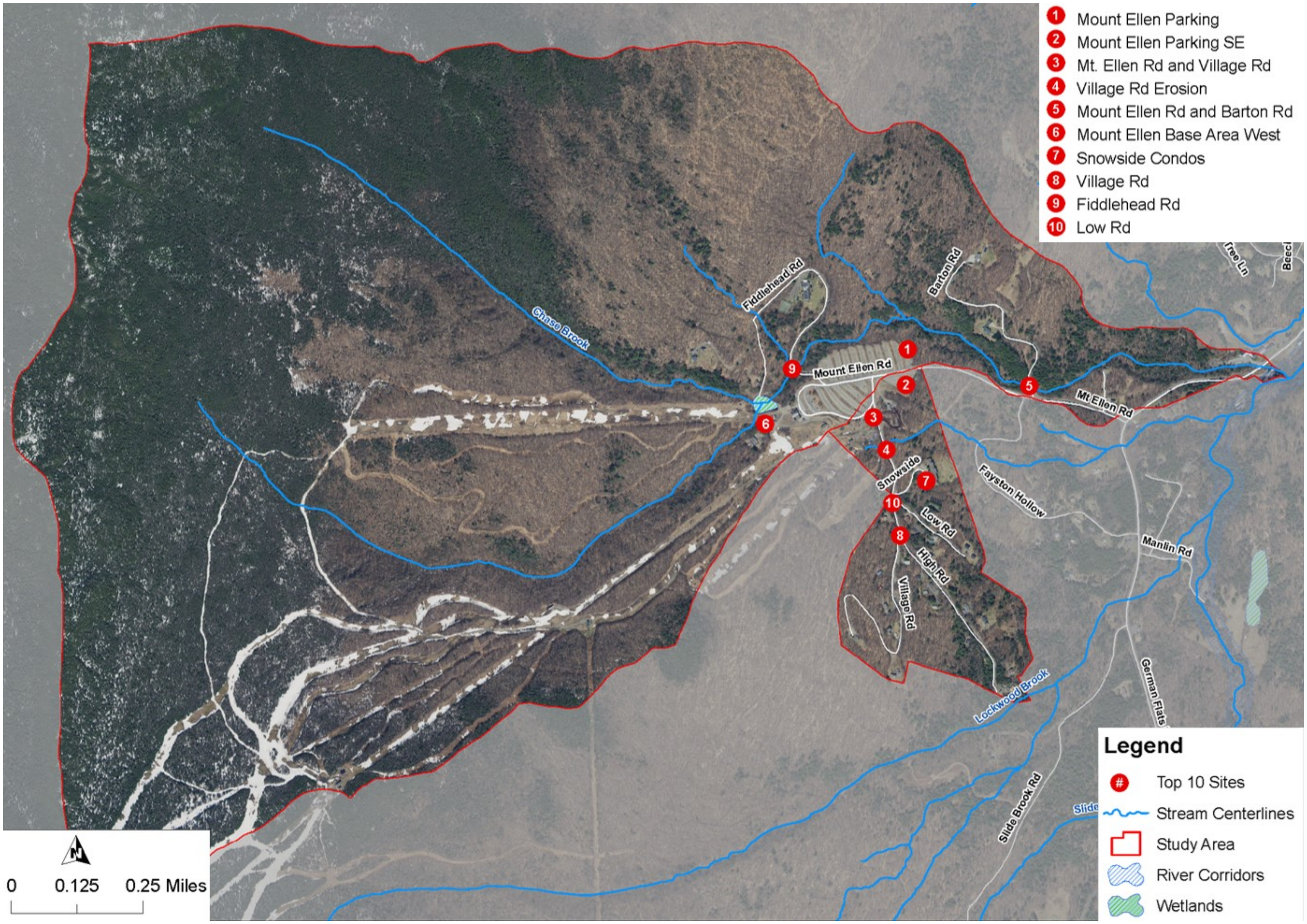

Figure 6. The location of the Top 10 projects in final ranked order are shown within the study area.

4.7 Selection of Top 3 Potential BMPs

Selection of the Top 3 sites considered the results from initial site investigations, modeling and ranking matrices, input from stakeholders concerning project priorities, and the willingness of the private landowners at the Sugarbush Resort to voluntarily participate in this plan. Ultimately, the top 3 ranked sites (Mount Ellen Parking, Mount Ellen Parking SE, and Mt. Ellen Rd and Village Rd) were selected as the Top 3 projects for the SWMP. The locations of these Top 3 sites within the study area are shown in Figure 7. The Top 3 sites are listed in Table 4.

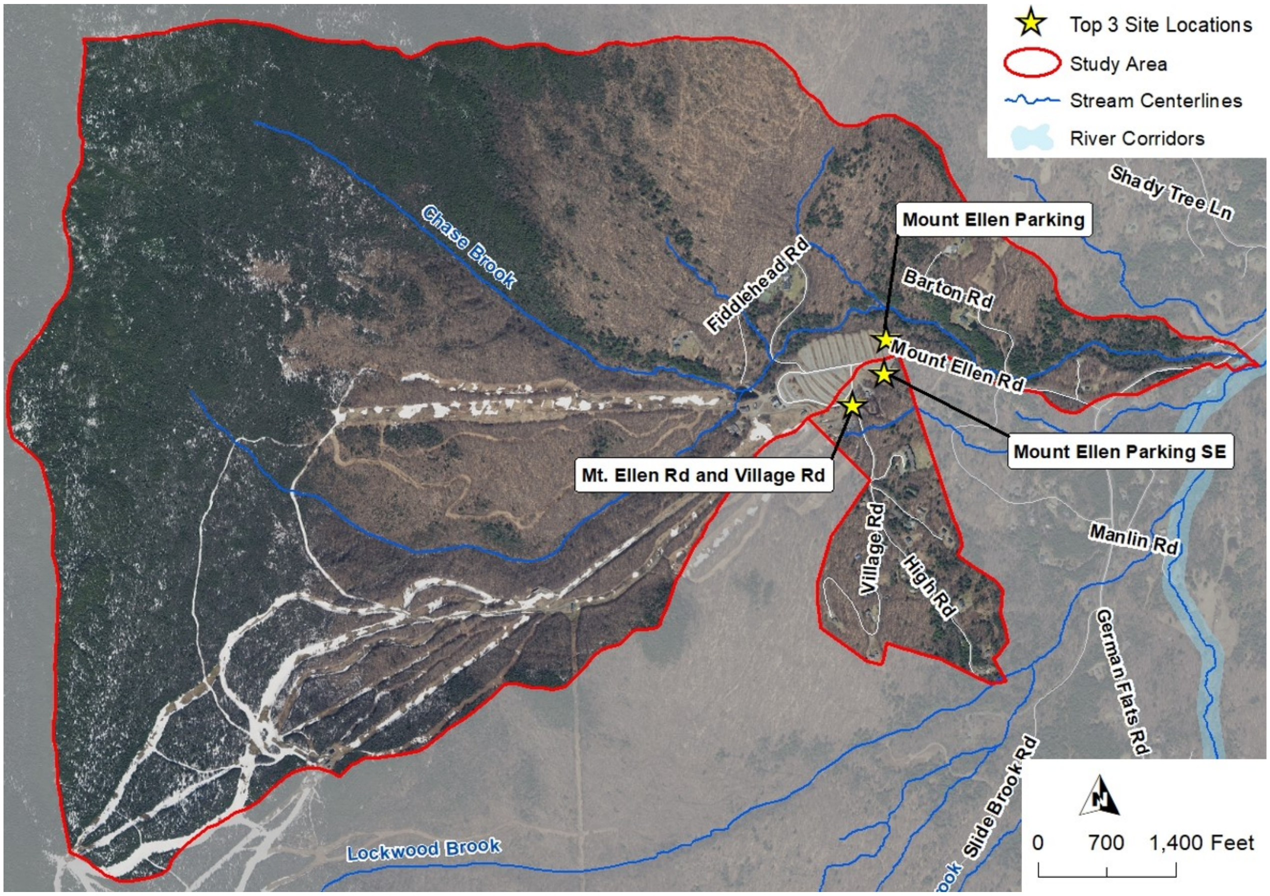

Figure 7. The Top 3 site locations are shown within the study area.

Table 4. The Top 3 sites are listed in ranked order below.

Project Name	*Proposed BMP Practice Type*	*BMP Rank*
Mount Ellen Parking	Infiltration Basin, General Road Improvements	1
Mount Ellen Parking SE	Infiltration Basin, Ditch / Swale Improvements	2
Mt. Ellen Rd and Village Rd	Infiltration Basin	3

5 Priority BMPs

The selected Top 3 BMP sites are briefly described below. A memo describing these sites, an overview map, and updated field data sheets are provided in Appendix L for the Top 3 sites. Landowner outreach investigations are described in Appendix M.

Site: 1

Project Name: Mount Ellen Parking

Description: The first site selected as a priority site consists of the large parking area located along the northern side of Mount Ellen Rd and used to access the Mount Ellen Ski Resort. Currently, stormwater is transported in a series of swales (depicted with green lines on the map to the right, Figure 8). Individual sediment traps were previously constructed to filter sediment from these swales (see blue circles along the northern side of the parking lot on the map to the right, Figure 8). However, over time these sediment traps have filled in and are no longer effectively managing this stormwater runoff. A large infiltration basin is proposed to manage the drainage from this site. The concept includes redirecting drainage to the east via subsurface piping along the northern edge of the parking lot. The basin is proposed in the approximate location of the yellow star in Figure 8 and the area that will drain to this basin is shown outlined in purple. The drainage area is 7.1 acres, 5.4 acres (76%) of which is classified as impervious.

Figure 8. The drainage area for the Mount Ellen Parking site is shown outlined in purple. The location for the proposed infiltration basin is depicted with a yellow star.

Outreach: The area where the proposed retrofit is located is owned by Sugarbush Resort. Eric Hanson, the Environmental Compliance Coordinator at Sugarbush Resort, and Margo Wade, the Director of Planning at Sugarbush Resort, confirmed that Sugarbush is willing to move forward with further design.

Site: 2

Project Name: Mount Ellen Parking SE

Description: The second location selected as a priority site is located just south of Site 1 and includes the parking lots along the southern side of Mount Ellen Rd as well as a portion of Mount Ellen Rd and Village Rd and a portion of several access drives for Mount Ellen Resort. A large infiltration basin is proposed in the approximate location of the yellow star on the map to the right (Figure 9). The concept for this site includes redirecting the culvert that passes under Mount Ellen Rd (near the intersection with Village Rd) to the east and into the proposed infiltration basin. The design included this redirection of drainage because there is more space to expand the basin in this location than for Site 1. To expand the basin at Site 1, significant parking would need to be removed to manage this additional stormwater volume. The stormwater from the area outlined in purple is proposed to be directed to a new infiltration basin at the approximate location of the yellow star on the map above (Figure 9). The drainage area includes 7.1 acres, 4.7 acres (66%) of which is classified as impervious.

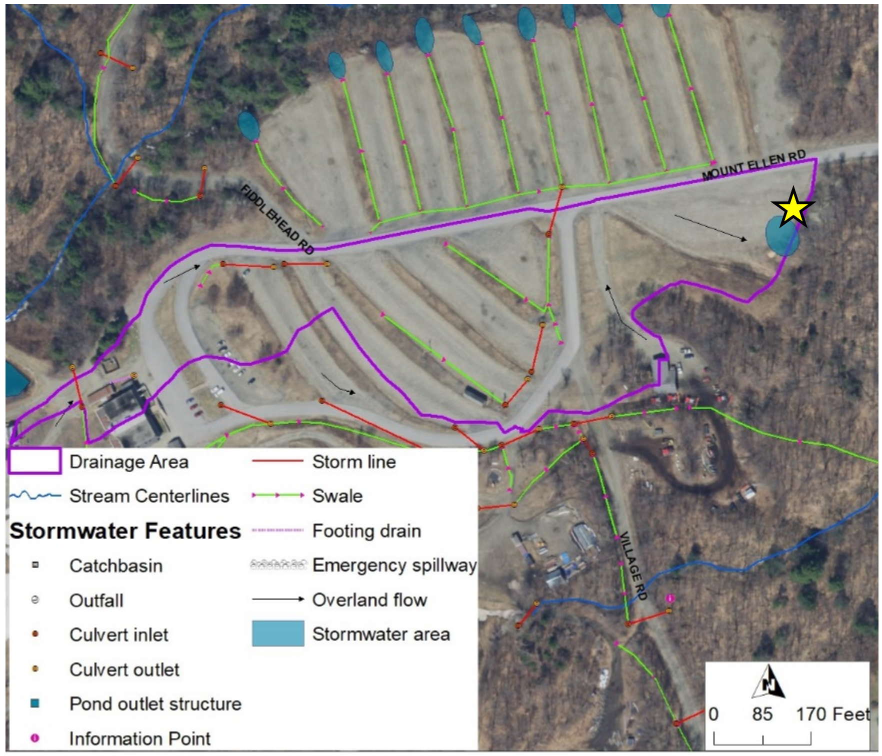

Figure 9. The drainage area for the Mount Ellen Parking SE site is shown outlined in purple. The location for the proposed infiltration basin is depicted with a yellow star.

Outreach: The area where the proposed retrofit is located is owned by Sugarbush Resort. Eric Hanson, the Environmental Compliance Coordinator at Sugarbush Resort, and Margo Wade, the Director of Planning at Sugarbush Resort, confirmed that Sugarbush is willing to move forward with further design.

Site: 3

Project Name: Mt. Ellen Rd and Village Rd

Description: The third site is located just south of the intersection of Mount Ellen Rd and Village Rd. The site includes landscaped areas, access drives, and several parking areas. Currently, the drainage from this area is collected in a series of swales and culverts and directed to the east under Village Rd. The drainage ultimately discharges to a tributary of Chase Brook without management. It is proposed that the drainage from this area be managed in a new infiltration basin in the approximate location of the yellow star shown in Figure 10. The area that will drain to the basin is shown outlined in purple on the map. This practice would manage 8.8 acres, 2.4 acres (27%) of which is classified as impervious.

Outreach: The area where the proposed retrofit is located is owned by Sugarbush Resort. Eric Hanson, the Environmental Compliance Coordinator at Sugarbush Resort, and Margo Wade, the Director of Planning at Sugarbush Resort, confirmed that Sugarbush is willing to move forward with further design.

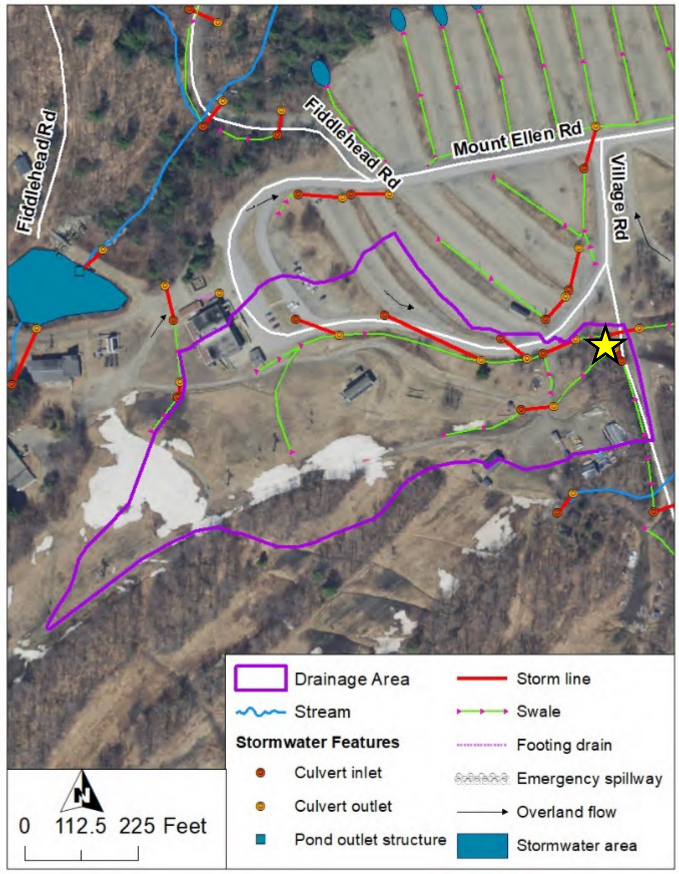

Figure 10. The drainage area for the Mt Ellen Rd and Village Rd site is shown outlined in purple. The location for the proposed infiltration basin is depicted with a yellow star.

6 30% Designs

As all three sites for 30% design are located in close proximity, one plansheet was developed depicting existing conditions at these locations. See Appendix N for the existing conditions plansheet. This information was used as the basis for the 30% proposed condition plan that was created for these sites.

Site-specific concepts are discussed in the following sections. Geotechnical analyses, completed by Watershed staff on June 11th, 2019, were carried out for the Top 3 sites as the proposed practices for these areas are all infiltration based.

When implemented, these three BMPs would treat drainage from approximately 23 acres, 12.5 acres (54%) of which is impervious. Modeled pollutant reductions for these projects, shown below in Table 5, indicate that these BMPs will prevent nearly 29,000 lbs of TSS and 35 lbs of TP from reaching receiving waters annually. They will also infiltrate 1.74 ac ft of stormwater, reducing the volume of stormwater reaching receiving waters via piped and overland flow and providing significant groundwater recharge. See Appendix J for complete modeling reports. The 30% designs can be found in Appendix O.

Table 5. Modeling results for the Top 3 projects are shown below.

Project Name	Volume Managed (ac-ft)	Volume Infiltrated (ac-ft)	TSS Yield (lbs)	TSS Removal (lbs)	TSS Removal (%)	WinSLAMM TP Yield (lbs)	WinSLAMM TP Removal (lbs)	WinSLAMM TP Removal (%)	STP Calculator TP Yield (lbs)	STP Calculator TP Removal (lbs)	STP Calculator TP Removal (%)
Mount Ellen Parking	0.815	0.815	10,569	10,094	95.51%	6.44	6.08	94.35%	14.16	14.16	100.00%
Mount Ellen Parking SE	0.714	0.714	11,602	11,151	96.11%	5.77	5.41	93.73%	12.83	12.83	99.98%
Mt. Ellen Rd and Village Rd	0.21	0.21	8,039	7,503	93.33%	6.13	5.52	89.99%	9.17	8.42	91.78%

6.1 Mount Ellen Parking

6.1.1 30% Concept Design Description

A large infiltration basin is proposed along the eastern edge of the parking lot. Drainage from the parking lots is collected in series of pretreatment vegetated swales and conveyed to the practice via a system of catchbasins and culverts. It should be noted that if additional pretreatment above and beyond that provided by the vegetated low gradient swales is required, the catchbasin rim elevations could be slightly elevated to allow for more settling of solids. During the final design process, drainage entering the basin via the inlet pipe could be routed to the south using stone to ensure that the basin would not short circuit during very high flows.

Figure 11. The Constant Head Borehole Permeameter Test in progress using a Johnson Meter.

Infiltration testing at the Mount Ellen Parking site was completed using a Constant-Head Borehole Permeameter Test (USBR 7300-89 Condition I, Deep Water Table or Impermeable layer) using a Johnson Meter (see Figure 11 for a photo of the Johnson Meter in use). The result of this testing is a value for the saturated hydraulic conductivity (K_{sat}) of soils on site. This value measures the movement of water through saturated soils and yields a conservative estimate of infiltration. See Table 6 for typical permeability classes and ranges for K_{sat}.

Figure 12. Test pit at the Mount Ellen Parking site.

Soils are mapped as being very good to good at this site (Hydrologic Group A/B), so an analysis was conducted to evaluate the potential for an infiltration practice. Infiltration testing was completed using a Johnson Meter. The K_{sat} value was measured at 3.53 in/hr. This value is classified within the high permeability class (Table 6).

Table 6. Typical permeability classes and ranges for K_{sat}.

Permeability Class	------------------------ Permeability Class Range				----------------------	
	(cm/sec)		(cm/day)		(in/hr)	
	High end	Low end	High end	Low end	High end	Low end
Very Low	1 X 10^{-6}	< 1 X 10^{-6}	0.0864	< 0.0864	0.0014	< 0.0014
Low	1 X 10^{-5}	1 X 10^{-6}	0.864	0.0864	0.014	0.0014
Moderately Low	1 X 10^{-4}	1 X 10^{-5}	8.64	0.864	0.14	0.014
Moderately High	1 X 10^{-3}	1 X 10^{-4}	86.4	8.64	1.4	0.14
High	1 X 10^{-2}	1 X 10^{-3}	864.0	86.4	14.0	1.4
Very high	> 1 X 10^{-2}	1 X 10^{-2}	> 864.0	864.0	> 14.0	14.0

Soils conditions were assessed at the proposed BMP location in a soil test pit dug with an excavator (Figure 12). Analysis at this site included documentation of depth to water table (as applicable), horizon breaks, soil structure, type, moisture, color, presence or absence of redoximorphic features, and size and quantity of roots and coarse fragments. Any other notes considered to be important were recorded during this time.

Soils were found to be generally loamy with a high percentage of sand. Soils conditions observed during analysis did not prompt a need to alter the proposed retrofit design. See Appendix P-1 for this site's complete soil log and Appendix P-2 for the completed K_{sat} workbook.

6.1.2 Pollutant Removal and Other Water Quality Benefits

This practice has the potential to prevent more than 10,500 lbs of total suspended solids (TSS) and 14.2 of total phosphorus (TP) from entering receiving waters annually. The design standard used for this retrofit was infiltration of the Channel Protection volume (CPv, or 2.02 inches of rain in a 24-hour period), equal to 35,501 ft^3 of runoff. See Table 7 for the benefit summary table.

Table 7. Mount Ellen Parking benefit summary table.

TSS Removed	10,569 lbs
TP Removed	14.2
Impervious Treated	5.4 acres
Total Drainage Area	7.1 acres

6.1.3 Cost Estimates

The total estimate cost for this project is $213,936. Note that these costs are preliminary. Cost projections can be found in Table 8.

- The cost per pound of phosphorus treated is $15,117.
- The cost per impervious acre treated is $39,617.
- The cost per cubic foot of runoff treated is $6.03.

Table 8. The initial construction cost projection for the Mount Ellen Parking is included below.

ITEM NUMBER	ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL PRICE
201.11	CLEARING AND GRUBBING, INCLUDING INDIVIDUAL TREES AND STUMPS	ACRES	0.3	$33,805.52	$10,864.95
203.15	COMMON EXCAVATION	CY	3657	$9.86	$36,061.67
601.0915	CPEP	LF	1118	$64.04	$71,596.72
604.18	PRECAST REINFORCED CONCRETE DROP INLET WITH CAST IRON GRATE	EACH	11	$4,009.29	$44,102.19
613.11	STONE FILL, TYPE II	CY	30	$42.49	$1,258.96
629.54	CRUSHED STONE BEDDING	TON	73	$34.04	$2,485.17
635.11	MOBILIZATION/DEMOBILIZATION	LS	1	$10,000.00	$10,000.00
651.15	SEED	LB	10	$7.66	$76.60
651.12	STRAW MULCH	TON	1	$455.33	$455.33
653.20	ROLLED EROSION CONTROL PRODUCT, TYPE 1	SY	900	$2.20	$1,980.00
653.50	BARRIER FENCE	LF	2500	$2.03	$5,075.00
900.620	48" ANTI-VORTEX PYRAMID GRATE	EACH	1	$2,075.00	$2,075.00
	5% Incidentals				$9,302
	10% Contingency				$18,603
TOTAL					**$213,936**

6.1.4 Next Steps

As this site is owned and operated by Sugarbush, it is recommended that final design and implementation of this retrofit be completed. Further design will involve refinement of the 30% retrofit concept with respect to size, outlet design, and routing to ensure that the target volume can be completely infiltrated and that larger storms bypass the system safely.

6.1.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix Q. In summary:

Stormwater Permit

As this site has ≥3 acres of impervious cover and does not have a current stormwater permit, it is expected that this site will require coverage under this permit.

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

As there are existing Act 250 permits for this area (5W0023, 5W0221, 5W0263, 5W0538), this site should be submitted for Act 250 review. No wetlands, river corridor, or lakeshore permitting is anticipated for this project.

6.2 Mount Ellen Parking SE

6.2.1 30% Concept Design Description

An infiltration basin is proposed for the Mount Ellen Parking SE site. Soils are mapped as being very good at this site (Hydrologic Group A), so an analysis was conducted to evaluate the potential for an infiltration practice. Soils conditions were assessed at the proposed BMP location in a soil test pit dug with an excavator (Figure 13). Analysis at this site included documentation of depth to water table (as applicable), horizon breaks, soil structure, type, moisture, color, presence or absence of redoximorphic features, and size and quantity of roots and coarse fragments. Any other notes considered to be important were recorded during this time.

Figure 13. The test pit at the Mount Ellen Parking SE site.

Soils were found to be generally loamy with a high percentage of sand. Soil conditions observed during analysis did not prompt a need to alter the proposed retrofit design. See Appendix P-1 for this site's complete soil log.

6.2.2 Pollutant Removal and Other Water Quality Benefits

This practice has the potential to prevent more than 6,800 lbs of total suspended solids (TSS) and 12.8 lbs of total phosphorus (TP) from entering receiving waters. The design standard used for this retrofit was infiltration of the Channel Protection volume (CPv, or 2.02 inches of rain in a 24-hour period), equal to 31,102 ft^3 of runoff. See Table 9 for the benefit summary table.

Table 9. Mount Ellen Parking SE benefit summary table.

TSS Removed	6,867 lbs
TP Removed	12.8 lbs
Impervious Treated	4.7 acres
Total Drainage Area	7.1 acres

6.2.3 Cost Estimates

The total estimate cost for this project is $50,174. Note that these costs are preliminary. Cost projections can be found in Table 10.

- The cost per pound of phosphorus treated is $3,897.
- The cost per impervious acre treated is $10,675.
- The cost per cubic foot of runoff treated is $1.61.

Table 10. The initial construction cost projection for the Mount Ellen Parking SE is included below.

ITEM NUMBER	ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL PRICE
201.11	CLEARING AND GRUBBING, INCLUDING INDIVIDUAL TREES AND STUMPS	ACRES	0.33	$33,805.52	$11,295.67
203.15	COMMON EXCAVATION	CY	1034	$9.86	$10,190.49
601.0915	CPEP	LF	23	$64.04	$1,472.92
604.18	PRECAST REINFORCED CONCRETE DROP INLET WITH CAST IRON GRATE	EACH	1	$4,009.29	$4,009.29
613.11	STONE FILL, TYPE II	CY	21	$42.49	$912.75
629.54	CRUSHED STONE BEDDING	TON	7	$34.04	$225.92
635.11	MOBILIZATION/DEMOBILIZATION	LS	1	$10,000.00	$10,000.00
651.15	SEED	LB	5	$7.66	$38.30
651.12	STRAW MULCH	TON	0.5	$455.33	$227.67
653.20	ROLLED EROSION CONTROL PRODUCT, TYPE 1	SY	722	$2.20	$1,588.40
653.50	BARRIER FENCE	LF	785	$2.03	$1,593.55
900.620	48" ANTI-VORTEX PYRAMID GRATE	EACH	1	$2,075.00	$2,075.00
	5% Incidentals 10% Contingency				$2,181 $4,363
	TOTAL				**$50,174**

6.2.4 Next Steps

As this site is owned and operated by Sugarbush, it is recommended that final design and implementation of this retrofit be completed. Further design will involve refinement of the retrofit design with respect to size, outlet design, and routing to ensure that the target volume can be completely infiltrated and that larger storms bypass the system safely.

6.2.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix Q. In summary:

Stormwater Permit

As this site has ≥3 acres of impervious cover and does not have a current stormwater permit, it is expected that this site will require coverage under this permit.

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

As there are existing Act 250 permits (5W0023, 5W0221, 5W0263, 5W0538), this site should be submitted for Act 250 review. No wetlands, river corridor, or lakeshore permitting is anticipated for this project.

6.3 Mt. Ellen Rd and Village Rd

6.3.1 30% Concept Design Description

An infiltration basin is proposed for the Mt. Ellen Rd and Village Rd site. During final design, the engineers of the project should work closely with Sugarbush to ensure that the location of the basin will leave enough room for groomers to pass safely around the basin.

Figure 14. Location of the test pit at the Mt. Ellen Rd and Village Rd site.

Soils are mapped as being good at this site (Hydrologic Group B), so an analysis was conducted to evaluate the potential for an infiltration practice. Soils conditions were assessed at the proposed BMP location in a soil test pit dug with an excavator (Figure 14). Analysis included documentation of depth to water table (as applicable), horizon breaks, soil structure, type, moisture, color, presence or absence of redoximorphic features, and size and quantity of roots and coarse fragments. Any other notes considered to be important were recorded during this time.

Soils were assessed and were found to be generally loamy with a high percentage of silt. Soils conditions observed during analysis did not prompt a need to alter the proposed retrofit design. See Appendix P-1 for this site’s complete soil log.

6.3.2 Pollutant Removal and Other Water Quality Benefits

This practice has the potential to prevent more than 8,000 lbs of total suspended solids (TSS) and 8.4 lbs of total phosphorus (TP) from entering receiving waters. The design standard used for this retrofit was infiltration of the Water Quality volume (WQv, or 1 inch of rain in a 24-hour period), equal to 9,148 ft^3 of runoff. See Table 11 for the benefit summary table.

Table 11. Mt. Ellen Rd and Village Rd benefit summary table.

TSS Removed	8,039 lbs
TP Removed	8.4 lbs
Impervious Treated	2.4 acres
Total Drainage Area	8.8 acres

6.3.3 Cost Estimates

The total estimate cost for this project is $25,863. Note that these costs are preliminary. Cost projections can be found in Table 12.

- The cost per pound of phosphorus treated is $3,088.
- The cost per impervious acre treated is $10,776.
- The cost per cubic foot of runoff treated is $2.83.

Table 12. The initial construction cost projection for the Mt. Ellen Rd and Village Rd is included below.

ITEM NUMBER	ITEMS	UNIT	QUANTITY	UNIT PRICE	TOTAL PRICE
201.11	CLEARING AND GRUBBING, INCLUDING INDIVIDUAL TREES AND STUMPS	ACRES	0.06	$33,805.52	$2,017.78
203.15	COMMON EXCAVATION	CY	407	$9.86	$4,017.04
601.0915	CPEP	LF	60	$64.04	$3,842.40
604.18	PRECAST REINFORCED CONCRETE DROP INLET WITH CAST IRON GRATE	EACH	1	$4,009.29	$4,009.29
613.11	STONE FILL, TYPE II	CY	10	$42.49	$409.16
629.54	CRUSHED STONE BEDDING	TON	7	$34.04	$225.92
635.11	MOBILIZATION/DEMOBILIZATION	LS	1	$5,000.00	$5,000.00
651.15	SEED	LB	1	$7.66	$7.66
651.12	STRAW MULCH	TON	0.25	$455.33	$113.83
653.20	ROLLED EROSION CONTROL PRODUCT, TYPE 1	SY	312	$2.20	$686.40
653.50	BARRIER FENCE	LF	42	$2.03	$85.26
900.620	48" ANTI-VORTEX PYRAMID GRATE	EACH	1	$2,075.00	$2,075.00
	5% Incidentals				$1,124
	10% Contingency				$2,249
TOTAL					**$25,863**

6.3.4 Next Steps

As this site is owned and operated by Sugarbush, it is recommended that final design and implementation of this retrofit be completed. Further design will involve refinement of the retrofit design with respect to size, location with respect to the route groomers need to take during the winter months, outlet design, and routing to ensure that the target volume can be completely managed and that larger storms bypass the system safely.

6.3.5 Permit Needs

A project readiness screening worksheet has been completed for this project and is included in Appendix Q. In summary:

Stormwater Permit

Although the drainage area for this site has <3 acres of impervious cover, the larger parcel owned by Sugarbush does have ≥3 acres of impervious cover and does not have a current stormwater permit. It is expected that the Sugarbush parcel will require coverage under this permit, and this project would contribute towards Sugarbush's compliance with the permit.

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

As there are existing Act 250 permits for the area (5W0023, 5W0221, 5W0263, 5W0538), this site should be submitted for Act 250 review. No river corridor, wetlands, or lakeshore permitting is anticipated.

7 Final Recommendations

This SWMP has identified a suite of potential BMP concepts and locations that would have a positive impact on water quality in the study area and receiving waters including Chase Brook, Slide Brook, the Mad River, the Winooski River, and Lake Champlain. Although designs were only advanced for the Top 3 projects, this plan also serves to highlight other opportunities throughout the study area. As such, 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 stormwater management into the landscape. It is our recommendation that Sugarbush moves to implement the Top 3 practices and that the Town moves forward with additional design and implementation of the other projects presented in this plan. As these practices are the result of a stormwater master planning effort under a 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 requests 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 the Town look into alternative road surface materials to increase stability and longevity of municipal unpaved roads. We encourage road crews to consider the use of crushed ledge product with a mix of small angular particles (as opposed to bank run gravel with rounded stones) and over 50% fine particles to encourage compaction and cohesion. This product goes by several names such as StayMat, SurePack, or 'plant mix'. This material should be placed on the surface of the road, above a gravel subbase compacted to 90-95 Proctor density. The road surface material should be rolled and compacted to 90-95 Proctor. Another acceptable material is crusher-run gravel which, while it contains fewer fine particles than the aforementioned material, does not have rounded stones like bank run gravel. Where StayMat (or similar) is not available or is prohibitively expensive, crusher run gravel can be used and is preferred to bank run. Compaction procedures should mimic the process outlined for StayMat.