Stormwater Master Plan for the Town of Arlington, Vermont

FINAL REPORT

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1.0 Introduction

The Bennington County Regional Commission (BCRC) assisted the Town of Arlington with the preparation of a Hazard Mitigation Plan (HMP) through grant funding provided by FEMA via Vermont Emergency Management. The HMP addresses natural hazards that have affected and could affect the Town, including but not limited to flooding, fluvial erosion, winter storms, invasive species and others and recommend actions to mitigate the impacts of those events on the town population, facilities, businesses and infrastructure. As part of the planning process, BCRC and the Town identified stormwater runoff as a priority problem with respect to the protection of the Town's infrastructure. On behalf of the Town, BCRC sought to address this planning need through the development of a Stormwater Master Plan (SWMP) for the Town. A team of Fitzgerald Environmental Associates, LLC (FEA) and partnering firm Dufresne Group was hired by BCRC in the Spring of 2018 to develop the SWMP. The recommendations outlined in the following report and appendices have been incorporated into the HMP approved by FEMA and adopted by the Town.

1.1 Stormwater Master Planning

Stormwater runoff is generated any time rain or melting snow/ice runs off the land; stormwater runoff typically increases when the land use has been altered from its natural state. Typically, hardened surfaces such as rooftops and roads are the primary sources of stormwater runoff, however in a rural setting it is important to consider hayfields, pasture, and other developed or agricultural areas that may increase and concentrate runoff. Increased stormwater runoff leads to higher magnitude flood flows and greater erosive power in stream channels, increased delivery of sediment, nutrients, and other pollutants to waterways, and increased flooding conflicts with improved properties downstream. The network of roads, ditches, and culverts that are found in steep rural settings are important for conveying stormwater and protecting infrastructure. However, these systems concentrate runoff, reduce infiltration, and may lead to areas of erosion and sediment generation. Increased stormwater runoff is directly linked to the quality of water in our streams, rivers, ponds, and lakes that we depend on for drinking water, healthy fisheries, and recreation.

Stormwater master plans can prevent problems from happening either by mitigating impacts before they create problems or by avoiding the creation of problems; in other words, prevention is cheaper than restoration. If we are to avoid the high cost of restoring degraded surface waters, we must better manage stormwater runoff before waters become impaired. Plans are developed with public involvement and comment and should be as comprehensive as possible in listing all known problems. Plans are based on a prioritized list of projects or a strategic approach and are therefore more likely to succeed than a reactionary approach that addresses problems as they arise. Historically almost all Vermont municipalities have responded to stormwater runoff or drainage problems the latter way, and frequently during an emergency or after a structural failure has occurred. Stormwater management plans contain important information about preserving natural features and functions of a watershed and provide a list of evaluated alternatives such as using traditional pipe (gray) infrastructure versus green stormwater infrastructure.

1.2 Project and Town Background

Like its neighboring towns, Arlington is predominantly forested. However, stormwater from developed lands consisting of low to moderate density residential and industrial areas are a significant concern for runoff quality and quantity in the Town. Most of Arlington's impervious surfaces are located on the eastern side of town, near the intersections of Route 313, 7A, and East Arlington Road.

Stormwater planning efforts in rural areas are most successful when carried out within a context of overarching watershed and stream corridor concerns including transportation infrastructure and maintenance, agricultural land uses, and areas of problematic stream channel erosion. The Batten Kill Corridor Plan (FGS, 2007), Phase 2 assessments on the Fayville and Roaring Branches (SMRC, 2009), Walloomsac and Hoosic Tactical Basin Plan (VTANR, 2016) summarized stream corridor conflicts and watershed scale stressors and prioritized areas where specific projects and management strategies could reduce erosion conflicts and improve the ecological health of the watersheds. Additional information from high-resolution Light Detection and Ranging (LiDAR) elevation data, a stormwater infrastructure mapping completed by the Vermont Department of Environmental Conservation (VTDEC), meetings with stakeholders in Arlington, and field visits to the Town were incorporated into this planning effort to build on past work and identify problem areas associated with stormwater in Arlington. Best Management Practices (BMPs) are suggested to mitigate stormwater problem areas contributing to infrastructure vulnerability and degradation of water quality in the watershed.

The Town has completed a hazard mitigation plan that addresses natural hazards affecting the town. As part of the hazard mitigation planning process, the Town chose to develop a SWMP to explore specific actions for reducing stormwater impacts on infrastructure. The Arlington SWMP follows the VTANR SWMP guidelines with a hybrid 1c and 3b approach to address potential site-specific green stormwater infrastructure (GSI) retrofits (template 1c) as well as the rural road focus template (3b). The plan was developed over the course of 2018 and 2019 through extensive field survey work, interaction with multiple stakeholders in the Town of Arlington to prioritize projects, and follow-up analysis and design work. The new Municipal Roads General Permit (MRGP) requires a Road Erosion Inventory (REI) be conducted on all hydrologically connected (HC) town-maintained roads. FEA conducted road erosion inventories on all HC town-maintained roads and outfalls in the Town of Arlington as part of the stormwater master planning process. Drafts of reports completed for those studies were incorporated into the hazard mitigation plan.

1.3 Project Goals and Objectives

The goal of this project was to evaluate developed lands and road corridors in the Town to identify sources of increased stormwater runoff and associated sediments and nutrients discharging to the waterways draining Arlington, particularly in areas affecting Town infrastructure. The work involved identifying sources of stormwater, prioritizing sources based on various environmental, economic, and social criteria, and designing projects to mitigate those sources. Stormwater mitigation projects are aimed at reducing or eliminating stormwater at the source through green stormwater infrastructure (GSI) approaches, retrofits of older and underperforming stormwater features, and back road erosion projects.

Specific project tasks and deliverables included: 1) identify, evaluate, and prioritize stormwater problem areas throughout the Town; 2) complete the REI for all on all hydrologically connected (HC) town-maintained roads; 3) develop one-page project summary sheets for approximately 30 projects; and 4) develop conceptual designs (30% level of completion) for at least five (5) project areas.

2.0 Study Area Description

Arlington is a 42.2 square mile town located in Bennington County in the southwestern corner of Vermont (Fig. 2.1). Arlington is bordered by 5 towns in Vermont (Sandgate, Sunderland, Shaftsbury, Manchester, and Glastenbury) and 3 towns in New York (Salem, Jackson, and White Creek). The Town is entirely drained by Hudson River tributaries, with the 442 square mile Batten Kill watershed draining approximately 84% of Arlington. The remainder of the town is drained by the Owl Kill, a Hoosic River tributary, and Little White Creek, which drains to the Hoosic River via the Walloomsac River. The Town has a total population of 2,317 as of the 2010 Census (U.S. Census Bureau, 2011).

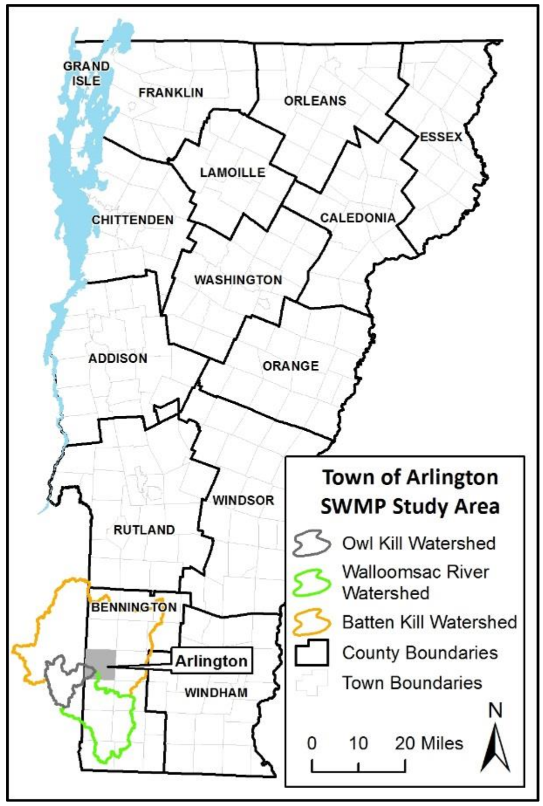

Figure 2.1: Town of Arlington location map.

Land cover data based on imagery from 2011 National Land Cover Dataset (Homer et al., 2015) are summarized in Table 2.2. The Town of Arlington is drained by rural watersheds, with forests representing the dominant land cover type. Agricultural lands, primarily as pastureland and hay fields, cover 6.7% of the Town, with a majority of the farmlands found along the Route 313 and Route 7A corridors. Development is low in the study area (3.7%), with much of the development concentrated along Route 7A in the Village of Arlington. There are 73.8 miles of roads in Arlington (Table 2.1), made up mainly of state highways (19.1%), town highways (50.0%) and private roads (24.4%). Road distances are based on road centerline data from VTrans (2017).

Table 2.1: Road length by AOT class in Arlington (VTrans, 2017)

AOT Class	Description	Length (miles)	% of Town Road Length (excluding discontinued)
2	Class 2 Town Highway	7.9	10.7
3	Class 3 Town Highway	26.6	36.0
4	Class 4 Town Highway	2.4	3.3
7	Legal Trail	4.8	6.5
8	Private Road	18.0	24.4
30	Vermont State Highway	14.1	19.1
96	Discontinued Road	2.6	-

Table 2.2: Land cover in Arlington (Homer et al., 2015)

Land Cover/Land Use Type	% of Town
Agriculture	6.7
Developed	3.7
Forest	85.6
Open Water	0.1
Shrub/Scrub	0.7
Grassland/Herbaceous	0.1
Wetland	3.0

3.0 Stormwater Management Planning Library

We began our SWMP efforts by gathering and reviewing information and documentation related to stormwater runoff and watershed management in the Town of Arlington as it pertains to the Arlington SWMP. Below is a summary of available data, mapping, and documentation at the local, state, and federal level. Much of this information is from previously completed studies in Arlington, but also includes sites discussed during a SWMP steering committee meeting on March 12, 2018. Other potential sources of data and data gaps are also addressed.

Watershed Planning Data and Mapping

Basin Plan

The Tactical Basin Plan for the Batten Kill, Walloomsac and Hoosic Rivers was prepared by the Vermont Agency of Natural Resources in 2015 (VTANR, 2016). The basin plan catalogs current surface water quality conditions, stressors, and recommended actions for water quality restoration. Arlington surface waters include the Green River, Roaring Branch, and Warm Brook, Batten Kill tributaries which originate in the higher elevations of neighboring towns, as well as the Batten Kill mainstem. Overall water quality in Arlington is good to excellent based on macroinvertebrate data collected by VTDEC over the last 25 years.

Ecological Condition

The Basin Plan summarizes streams and waterbodies with notable in ecological significance in the watersheds. Miller Pond is identified as Very High Quality based on Vermont DEC criteria, including its biodiversity and wildlife value. The Roaring Branch and Batten Kill are designated by Vermont Department of Fish and Wildlife as Very High Quality spawning and nursery tributaries for trout, and the Batten Kill is designated as a Very High Quality stream for supporting significant wild trout populations.

The Batten Kill has historically had one of Vermont's best trout fisheries, but in the 1990's trout populations dramatically declined. The lower 20 miles of river in Vermont, covering all of the Batten Kill in Arlington, now have a no-harvest designation. The Batten Kill is listed both as an Outstanding Resource Water and stressed due to sedimentation, temperature, and habitat alteration from loss of riparian vegetation, erosion and runoff concerns, and lack of habitat features. It is hypothesized that the trout habitat in the stream has been in decline, and experimental treatments of wood and stone to increase cover have been installed in Arlington.

Water Quality Stressors

Runoff from developed land, land erosion, and nutrient loading are identified as potential stressors for Arlington surface waters. Addressing the contribution of these loads to nutrient enrichment of the Hudson River is identified as a priority. Basin-wide restoration recommendations include riparian buffer plantings, agricultural BMP implementation in fields with high erosion risk, and identifying opportunities for dam removals and retrofits.

Warm Brook, Fayville Branch, Dry Brook, and the Batten Kill within Arlington and East Arlington are listed as affected by runoff from developed areas, as well as land erosion and nutrient loading. The Basin Plan recommends stormwater monitoring and mapping and Illicit Discharge Detection and Elimination (IDDE) to reduce these impacts. Recent stormwater infrastructure mapping from VTDEC and the ongoing road erosion inventories and stormwater master planning will support these objectives.

Roaring Branch/Batten Kill Corridor Plan

Field Geology Services prepared the Roaring Brach/Batten Kill Corridor Plan for the Vermont Department of Environmental Conservation in in 2007 (FGS, 2007). Several background themes relevant to stormwater master planning are touched on in the plan. Highlights from the Corridor Plan relevant to recent flooding and stormwater runoff in the watershed are summarized below.

Flood Damage

The Roaring Branch/Batten Kill Phase 2 assessments were conducted prior to Tropical Storm Irene. However, berms constructed in response to flooding in 1973 and older berms that may have been constructed in response to early 20th century flooding were identified in the Corridor Plan. These berms were found along lower reaches of Batten Kill River tributaries, such as reach T2.01 of the Roaring Branch.

Hydrologic and Sediment Regime Stressors

The Corridor Plans include maps of stressors on the hydrologic and sediment regimes of the Batten Kill and Roaring Branch based on data collected during the Phase 2 Stream Geomorphic Assessments between 2000 and 2005. These maps provide a means for linking the effects of increased stormwater runoff (i.e., gullying, severe channel sedimentation) to known stormwater problem areas in upslope watersheds. The hydrologic regime stressors identified in the Corridor Plan include areas of locally high road densities at the subwatershed level and wetland loss. The sediment regime stressors identified in the Corridor Plan include areas of higher densities of depositional and migration features in the channel such as bar features and flood chutes, identified at the reach-scale.

Overall Stream Stability and Habitat Conditions

Table 3.1 outlines the reference stream types based on valley slope, channel slope, and sinuosity according to Rosgen (1994) and Montgomery and Buffington (1997) classification systems. Characterization of reference stream types is based on the channel forms and processes expected in a particular geologic and geomorphic setting without human influences. A summary of the geomorphic and habitat conditions is provided below in Table 3.2. Overall the stream conditions are fair to good for those river reaches assessed in more detail in the field. Where the Batten Kill flows through Arlington, the conditions are fair due to channel alterations and widening with stretches of good conditions where the river has maintained or regained natural meanders. In the lower reaches of Fayville Branch and the Roaring Branch, the conditions are fair mainly due to channel degradation (i.e., channel incision) which has resulted in several stream type departures from reference conditions.

Phase 2 Stream Geomorphic Assessment: Roaring & Fayville Branch, Towns of Sunderland & Arlington

South Mountain Research and Consulting conducted Phase 2 assessments on the Fayville and Roaring Branches in Arlington under contract to the Bennington Country Regional Commission (SMRC, 2009). Concerns along reaches of the Fayville Branch include the two bridges in Arlington (Ice Pond Road and East Arlington Road) that are bankfull width constrictions, a berm and retaining wall that constrict flow in East Arlington, and stormwater runoff from roads in East Arlington.

Table 3.1. Reference stream type characteristics

Stream Type	Valley Confinement	Channel Slope	Sinuosity	Bedform
A	Confined	> 4%	Low	Cascade or Step-pool
B	Confined	2 – 4%	Low	Step-pool or Plane bed
C	Unconfined	< 2%	Moderate	Riffle Pool
E	Unconfined	<2%	Highly	Dune Ripple

Table 3.2. SGA reaches and selected attributes in Arlington, VT

Stream	Reach	Reference Stream Type	Existing Stream Type	Confinement Type	Habitat Condition	Geomorphic Condition	Notes
Batten Kill	M01A	C	C	Broad	Fair	Fair	
	M01B	C	C	Broad	Fair	Fair	
	M01C	C	C	Broad	Fair	Fair	
	M02	C	C	Broad	Good	Good	
	M03A	C	C	Semi-Confined	Fair	Fair	
	M03B	C	C	Semi-Confined	Good	Fair	
	M03C	C	C	Semi-Confined	Fair	Fair	
	M04	C	C	Very Broad	Fair	Fair	
	M05A	E	E	Very Broad	Fair	Fair	
	M05B	E	E	Very Broad	Good	Good	
Green River	T1.01	C	C	Very Broad	Fair	Fair	

Stream	Reach	Reference Stream Type	Existing Stream Type	Confinement Type	Habitat Condition	Geomorphic Condition	Notes
Roaring Branch	T2.01	C	F_c	Broad	Fair	Fair	
	T2.02	C	D_c	Broad	Fair	Fair	
	T2.03A	C_b	C	Very Broad	Good	Fair	
Warm Brook	T2S1.01A	C	C	Very Broad	Fair	Fair	
	T2S1.01B	C	C	Very Broad	Fair	Fair	
	T2S1.02*	C	-	Very Broad	-	-	
	T2S1.03*	E	-	Very Broad	-	-	
Warm Brook Tributary	T2S1S2.01*	C_b	-	Very Broad	-	-	
Fayville Branch	T2S1S1.01A	C	C	Narrow	Fair	Good	
	T2S1S1.01B	C	F	Narrow	Fair	Fair	
	T2S1S1.01C	C	C	Broad	Fair	Good	
	T2S1S1.02A	B	B	Semi-Confined	-	Good	Bedrock Gorge
	T2S1S1.04*	C	-	Very Broad	-	-	

** Phase 1 assessment only*

VTDEC Hydrologically Connected Road Segment Data

VTDEC created a statewide inventory of roads that are likely to be hydrologically connected to surface waters. The road network was split into 100-meter segments and then checked for proximity to surface waters and river corridors. Variables including road slope, adjacent hill slope, and soil erodibility were used to create a preliminary "road erosion risk rank". These ranking provide a good starting point for identifying areas of potential sediment generation from erosion of road surfaces and ditches. Road erosion risks are predicted to be low along low-gradient paved roads near Arlington; moderate and high-risk segments become more prevalent along gravel roads in close proximity to streams and in steeper portions of town (see attached map). There are 433 hydrologically connected road segments in Arlington in the 2018 dataset.

Light Detection and Ranging (LiDAR)

LiDAR returns for Bennington County were collected in a series of flights conducted in the Fall of 2017 as part of the VT LiDAR Initiative. Derivations of LiDAR data, such as Digital Elevation Models (DEMs), terrain models, and contours are useful tools for stormwater feature identification and site design. The 0.7-meter DEM is useful for culvert watershed delineation and the design of stormwater management projects. Terrain models assisted in remote identification of erosion features, such as stormwater gullies.

Town of Arlington Stormwater Infrastructure Mapping Project

The VT Agency of Natural Resources completed infrastructure mapping for the Town of Arlington (VTDEC 2018). The mapping products include drainage maps, stormwater infrastructure, and potential locations for stormwater BMP retrofits. The retrofit projects are described in detail in the mapping project report.

Local Data

<u>Town of Arlington Town Plan</u>

The Town of Arlington completed a Town Plan in 2015. The plan describes efforts to protect surface and ground water. Groundwater protection is especially important as the Villages of East Arlington and Arlington both rely on well water.

Tropical storm Irene (TSI) hit Vermont on August 28th, 2011 and dumped 3-5 inches of rain throughout the state with localized areas receiving totals from 7-11 inches. This rainfall coupled with high antecedent soil moisture conditions produced flooding that approached or exceeded the historic flood of 1927 in many large basins. In Arlington, damages resulting from Tropical Storm Irene were primarily due to erosion. Required repairs to the damages included rehabilitation of the West Arlington covered bridge (Figure 3.1).

Figure 3.1: Post-Irene repairs in progress at the West Arlington covered bridge. Photo by Harold Stiver.

<u>Arlington Culvert Records</u>

The Town of Arlington completed bridge and culvert inventories in 2013. Data from the 2013 inventory included 339 culverts and 9 bridges. The 2013 inventory included the structure dimensions and overall conditions but appeared to be missing several key attributes including the presence/absence of erosion. Jim Henderson, with the Bennington County Regional Commission, has updated culvert the inventory with this information. We reviewed the culvert data for overall condition characteristics to guide the focus of our field survey work.

Data Gaps

The watershed library describes the available documents, reports, and datasets that characterize stormwater and flooding concerns within the Town of Arlington. The geomorphic field data available for the Batten Kill River and its tributaries through Arlington were collected prior to Tropical Storm Irene. A full Phase 2 SGA may not be appropriate for these sections; however, additional data collection for stormwater concerns would be beneficial.

Related to the SWMP project, BCRC has assisted the Town in updating the Hazard Mitigation Plan (HMP) for the Town of Arlington. That plan has been approved by FEMA, making the Town eligible for increased state assistance for flood mitigation projects.

4.0 Road Erosion Inventory

The new Municipal Roads General Permit (MRGP) requires a Road Erosion Inventory (REI) be conducted on all hydrologically connected (HC) town-maintained roads. FEA conducted road erosion inventories on all HC town-maintained roads and outfalls in the Town of Arlington. In addition to providing a baseline assessment of work required to bring road segments up to the MRGP standard, this assessment allowed for a simultaneous initial assessment of stormwater problem areas throughout the town.

4.1 REI Methods

FEA followed the methods described in the January 2018 MRGP (VTANR). A municipal road segment was determined to be HC if it:

a) was within 100’ to a water of the state or wetland;

b) bisected a water of the state or a wetland or a defined channel; or

c) was uphill from, and drained to, a municipal road that bisected a water of the state or wetland, or a define channel.

Stormwater infrastructure mapping was available from VTDEC (Feb. 2018) and was used to locate outfalls draining Town roads. An outfall was determined to be HC if it was located 500 feet or less from a water of the state. In the field, FEA added HC and deleted not HC (NHC) road segments based on observations of hydrologic connectivity. Although Arlington had no road segments curbed on both sides, some segments did have networks of catch basins draining to outfalls. FEA visited 14 outfall locations draining town-maintained roads that were identified in the Arlington stormwater infrastructure mapping prepared by VTDEC.

FEA also took inventory of the presence or absence of invasive species that were present in each HC road segment. Species identified include Japanese Knotweed, Wild Parsnip, Bush Honeysuckle, Common Buckthorn, Japanese Barberry, Phragmites, Multiflora Rose, Oriental Bittersweet, Burning Bush, and Garlic Mustard.

4.2 REI Results

Added and Dropped Road Segments and Outfalls

Of the 429 segments in Arlington identified as HC in the June 2018 update to the HC roads layer from VTDEC, 121 (28%) were determined to be not HC based on field observations. Reasons for dropping segments included:

- Mapped roads where the existing road was private
- Mapped roads where the existing road ended or did not exist
- Segments that were field-determined not to be HC based on the MRGP REI criteria

Overall, the road segments identified as HC appear to be selected conservatively. The features used to select segments include potential intermittent streams that were not observed in the field as well as mapped river corridors. As observed on River Road in Arlington, a number of segments were identified as HC that are well over 100 feet from the Battenkill. Outfalls that ran off into a forest or field over 500 feet from surface waters were also identified as not HC.

Eleven (11) segments were added based on field observations of hydrologic connectivity. Generally, these were segments that drained to connected segments via sheet flow over the road or through connected ditch networks.

Number and Condition of Outfalls

Of the 14 outfalls identified from stormwater infrastructure mapping completed in February 2018 by VTDEC, 13 outfalls were assessed for erosion because one of them could not be located. Only one outfall had erosion, which was present at the outlet (Figure 4.1).

Figure 4.1: An outfall that "Partially Meets" the REI standards due to rill erosion at the outlet.

MRGP Standards

An overview of the MRGP standards compliance of the hydrologically connected segments covered in the inventory is presented below. Any municipal road segment that scored a "Does Not Meet" or a "Partially Meets" will have to be upgraded to meet MRGP standards. Any road segment that scored a "Fully Meets" needs to be consistently maintained to continue to meet MRGP standards. Figure 4.2 summarizes the MRGP compliance of hydrologically connected road segments in Arlington. Examples photographs of segments that fully meet, partially meet, and do not meet are presented in Figure 4.4.

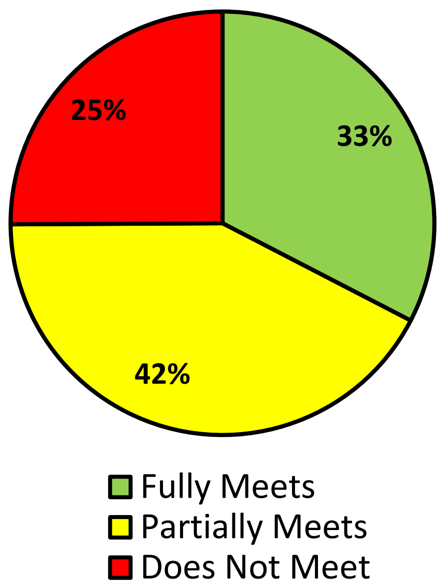

Figure 4.2: Standards compliance of HC road segments in Arlington based on the MRGP (VT ANR 2018).

Prioritization of Road Segments

While the Town has some flexibility in deciding how and when to address road segments that "Do Not Meet" or "Partially Meet" the MRGP standards, these segments will need to be brought up to the standards unless an exemption to minimize disturbance of resources is granted. These exemptions include road work that would disturb wetlands, historic large trees, historic stone walls, and lakeshore vegetation. To aid in the Town's prioritization process, a second map is attached that shows the highest priority HC road segments to be upgraded to the MRGP standards ("Does Not Meet" with >10% slope) as well as the results of a prioritization method developed by FEA.

The FEA prioritization is based on a concept for categorizing REI data based on each variable's potential impact on stormwater runoff, sedimentation, and overall water quality in adjacent waterways. We organized the data based on water quality processes that indicate sources of sedimentation and transport mechanisms. This approach is similar to other projects in the region to prioritize stormwater and water quality remediation projects (i.e., Critical Source Area analysis). This framework identifies areas with the greatest water quality impacts where there is 1) a source of pollution, and 2) a transport mechanism to move the pollution to nearby waterways, whereby road segments with both source and transport mechanisms have a higher impact rating than those lacking one. A composite score for each hydrologically connected road segment was calculated by weighting scaled Slope, Source, and Transport scores and summing the three components. In the database and map attachments, road segments with higher prioritization scores indicate a greater threat to water quality (Figure 4.5).

Figure 4.3 shows the comparison between the VT ANR prioritization categories and the FEA water quality prioritization. Overall, the FEA prioritization may be viewed as a way to prioritize projects with the greatest potential to benefit water quality within the VT ANR categories. Other variables, such as anticipated costs, should be taken into consideration as the Town selects segments to address.

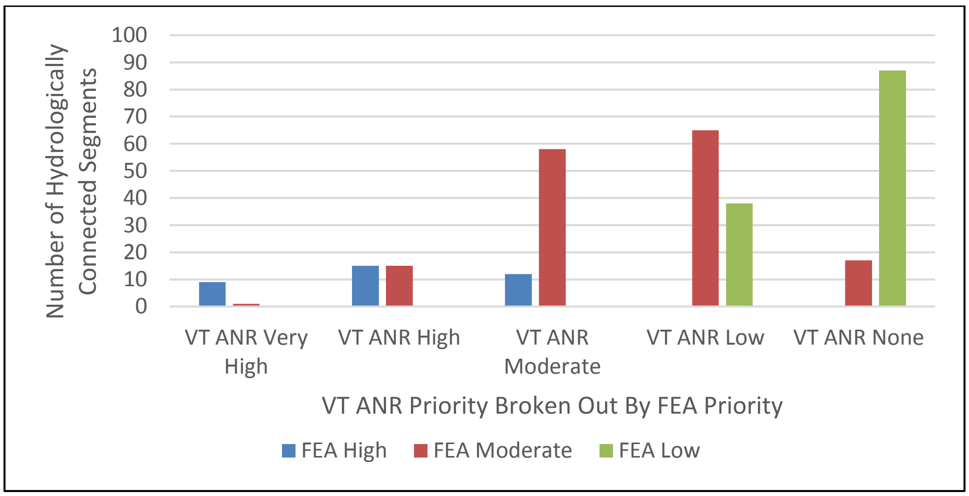

Figure 4.3: VT ANR Priority Broken out by FEA priority. Note that VT ANR does not prioritize segments that fully meet MRGP standards

4.3 REI Discussion

According to the new MRGP REI standards, "Very High Priority Road Segments" must be upgraded to meet MRGP standards. These highest priority road segments and outfalls to bring up to standards are defined as:

- HC paved and gravel road segments with drainage ditches that score a "Does Not Meet" and have a slope greater than 10% (Upgrade by December 31, 2025)
- HC Class 4 road segments that score a "Does Not Meet" and have a slope greater than 10% (Upgrade by December 31, 2028)
- Outfalls with more than 3 cubic yards of erosion (Upgrade by December 31, 2025)

There are 11 very high priority segments in Arlington. There are 9 located on gravel road segments and 2 located on paved road segments, each with drainage ditches. There are no Class 4 roads not meeting the standards with greater than 10% slope or outfalls with gully erosion over 3 cubic yards. Out of the 11 very high priority road segments, 10 of them could benefit from better stabilized stone-lined ditches to improve water drainage.

Overall, 32% of the HC municipal road segments “Fully Meet”, 42% “Partially Meet”, and 25% “Do Not Meet” the MRGP REI standards. Road segments not meeting the standards most often lacked drainage ditches, had eroded drainage ditches, or had unstable and eroded conveyances. In some cases, as noted in the database, roadsides lacked the space for a drainage ditch (due to the presence trees, homes, stone walls, or ledge). These cases may require exemption from the MRGP standards by VTDEC. Common conditions for road segments partially meeting the standards include only one side of the road having adequate drainage (e.g. downslope side sheets off, but upslope side lacks ditch), eroded culvert headers, grader berms that resulted in drainage issues, and a lack of vegetation or stone at conveyances.

		
Fully Meets	Partially Meets	Does Not Meet

Figure 4.4: Examples of road segments with different levels of MRGP compliance.

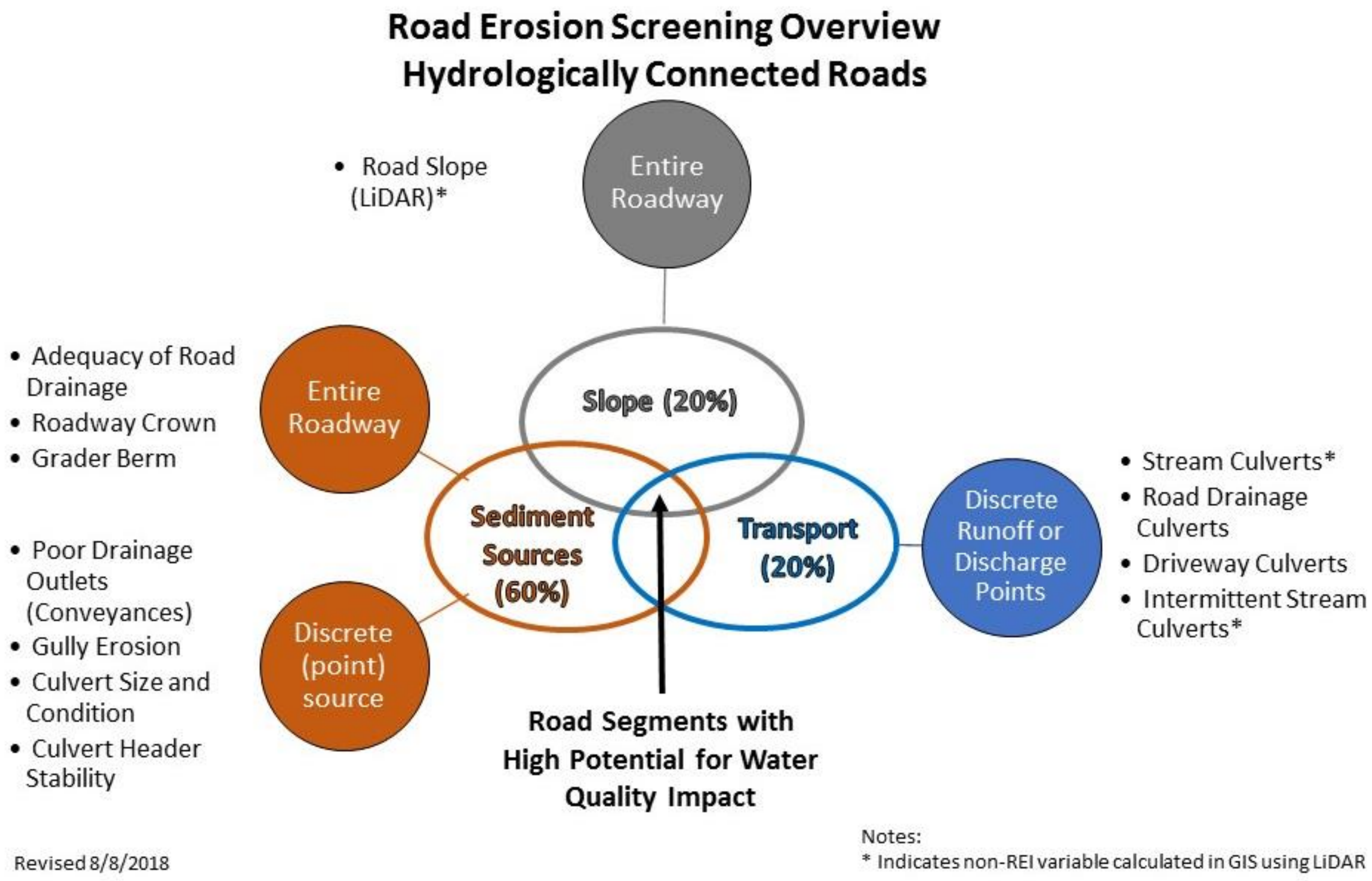

Figure 4.5: Conceptual framework for prioritization of hydrologically connected road segments.

4.4 REI Next Steps

All REI data collected in the Town of Arlington are housed in the VT ANR online database. VT ANR is integrating the REI results in each town into the basic prioritization from the MRGP permit (links to the implementation portal with MRGP status and the first-cut VTANR prioritization are located here: https://anrweb.vt.gov/DEC/IWIS/MRGPReportViewer.aspx?ViewParms=True&Report=Portal). The state has also added the results to the VT ANR Natural Resources Atlas - Municipal Roads Theme for a map view of the results (https://anrmaps.vermont.gov/websites/anra5/). This information can be accessed by the Town to develop a plan for addressing segments that "Do Not Meet" or "Partially Meet" the MRGP standards.

The next step will involve thought from the Town on how to sort the list of road segments that need work, based on MRGP requirements for high priority sites, expected costs, and other factors. In addition to upgrading the "Very High Priority Road Segments", the Town is required to upgrade 15% of non-compliant road segments by January 2023. The segments chosen will be included in an implementation table developed by the Town, outlining a plan for complying with the permit by the December 31, 2036 deadline. To aid in this process, FEA developed a table of the high and very high priority segments identified by VT ANR and the work needed to bring the segments into compliance. The prioritization map, data files, and water quality screening were provided to BCRC and the Town by FEA in December 2018 may be viewed as further guidance in developing the 20-year plan for the MRGP.

5.0 Stormwater Problem Areas

One of the primary objectives of the SWMP is to develop a comprehensive list of stormwater problems within the Town of Arlington. FEA conducted multiple field tours of the project area after the REI was completed to identify existing problem areas, evaluate and prioritize sites, and recommend potential solutions.

5.1 Identification of Problem Areas

The initial round of problem area scoping began with the identification of stormwater related projects using a desktop exercise scanning the watershed with aerial imagery, NRCS soils data, VTDEC stormwater infrastructure mapping, contour data, and road erosion risk in a GIS. Potential project areas were identified and mapped for review during site visits. Sites identified during road erosion inventories as potential stormwater problem areas were revisited during field tours. A total of 40 stormwater problem areas were identified and assessed in the field (see map in Appendix A and table in Appendix B). We grouped the problem areas into three (3) project categories described below.

- **BMP Installation or Retrofit –** Sites were identified where runoff and associated sediment and nutrient loads could be reduced through the implementation or retrofit of stormwater best management practices in areas of concentrated surface runoff or stormwater drainage infrastructure.
- **Road, Ditch, Culvert, or Conveyance Stabilization/Improvement –** Potential areas of sediment and nutrient loading from the erosion of roads and their associated Town infrastructure were identified during field visits. Runoff and erosion projects were identified in many areas where

runoff from steep roads (typically gravel) was causing increased sediment and nutrient loading due to ditch erosion.

- **Culvert Replacement –** Seven (7) Town culverts, mainly draining first order and intermittent streams, were analyzed for hydraulic capacity. Runoff volumes for different design storms (e.g., 2-year 24-hour rainfall) were modeled for each crossing using standard rainfall-runoff methods to recommend appropriate replacement culvert sizing.

5.2 Evaluation and Prioritization of Problem Areas

The 40 projects described in Appendix B were prioritized based on the potential for each project to reduce impacts on water quality and Town infrastructure. The prioritization considered the potential reduction of nutrient and sediment inputs to surface waters, landowner support for the project, operation and maintenance requirements for the recommended project, cost and constructability of the project, and additional benefits associated with implementation of the project.

GIS-based Site Screening

Using the field data points collected with sub-meter GPS during our watershed tours, we evaluated key characteristics for each site indicating the potential for increased stormwater runoff and pollutant loading, among several other factors described below. These GIS-based observations, along with field-based observations of site characteristics, are summarized in the Appendix B table under the "Problem Area Description" column.

The following geospatial data were reviewed and evaluated as part of the GIS-based screening:

- **Aerial Photography** – We used the 0.5 m 2015 imagery collected for Bennington County and 0.6 m 2016 NAIP imagery to review the site land cover characteristics (i.e., forest, grass, impervious) and measure the total impervious area in acres draining to the project area as identified in the field.
- **NRCS Soils** – We used the Bennington County Soils data to evaluate the inherent runoff and erosion potential of native soil types (i.e., hydrologic soil group, erodible land class). For project sites with potential for green stormwater infrastructure (GSI), we assessed the general characteristics of the proposed BMP area using hydrologic soil group (HSG) to recommend a stormwater treatment practice most likely to be compatible with the soil's infiltration capacity.
- **Parcel Data** – We used the parcel data available through VCGI to scope the limits of potential projects based on approximate parcel boundaries and road right-of-way.
- **VTDEC Stormwater Infrastructure Mapping** – We used maps completed by VTDEC in 2018 to locate outfalls and other drainage features as well as determine drainage areas and flow paths of stormwater features.
- **VTDEC Hydrologically Collected Road Segment Data –** We used a statewide inventory of road erosion risk and hydrologic connectivity of road segments, updated with information collected during the Road Erosion Inventory, to prioritize areas of potential sediment loading to visit for field surveys.

The stormwater problem areas identified during field tours of the study area were assigned several numerical scoring metrics that are weighted to assist in prioritizing each project based on water quality benefits, project feasibility, maintenance requirements, costs, and any additional benefits. The maximum possible score is 30 and the individual site scores ranged from 9 to 19 (Figure 5.1). Each category is described below and includes a description of the scoring for each criterion. Final evaluation criteria summarized in the table in Appendix B included the overall prioritization and the following components of the score:

- **Water Quality Benefits (15 points total)**
  - **Nutrient Reduction Effectiveness (4 points)** – Degree of nutrient removal potential with project implementation, this accounts for both the existing nutrient loads and the removal efficiency and capacity of the proposed treatment. Nutrient loading was quantified based on the watershed size, the land cover types, and percent impervious surfaces, and the effectiveness was based on the treatment efficacy of the potential mitigation options appropriate for the space and location of the treatment area.
    - 0 points – No nutrient source and/or no increased treatment
    - 1 point – Minor nutrient source and/or minor increase in treatment
    - 2 points – Moderate nutrient source with some increase in treatment
    - 3 points – Moderate nutrient source with significant increase in treatment
    - 4 points – Major nutrient source with significant increase in treatment
  - **Sediment Reduction Effectiveness (4 points)** – Degree of sediment removal potential with project implementation, this accounts for both the existing sediment loads and the removal efficiency and capacity of the proposed treatment. Sediment loading was quantified based on the watershed size, the land cover types, and percent impervious surfaces, and the effectiveness was based on the treatment efficacy of the potential mitigation options appropriate for the space and location of the treatment area.
    - 0 points – No sediment source and/or no increased treatment
    - 1 point – Minor sediment source and/or minor increase in treatment
    - 2 points – Moderate sediment source with some increase in treatment
    - 3 points – Moderate sediment source with significant increase in treatment
    - 4 points – Major sediment source with significant increase in treatment
  - **Drainage Area (1 point)** – Approximate drainage area to site is greater than 2 acres
  - **Impervious Drainage (3 points)**– Approximate area of impervious surfaces draining to the site.
    - 0 points – Area of impervious surfaces is less than 0.25 acres
    - 1 point – Area of impervious surfaces is 0.25-0.5 acres
    - 2 points – Area of impervious surfaces is 0.5-1.0 acres
    - 3 points – Area of impervious surfaces is >1.0 acres
  - **Connectivity to Surface Waters (3 points)**
    - 0 points – All stormwater infiltrates on site
    - 1 point – Stormwater receives some treatment before reaching receiving waters
    - 2 points – Stormwater drains into drainage infrastructure that directly outlets to receiving waters (assumes no erosion or additional pollutant loading to discharge point)

        - 3 points – Stormwater drains directly into receiving waters (typically stormwater draining directly into a large wetland is assigned 2 points)

- **Landowner Support (2 points)**
    - 0 points – Project is located on private property, no contact with landowner
    - 1 point – Project is on Town or State property with no contact
    - 2 points – Project has been discussed and is supported by landowner
- **Operation and Maintenance Requirements (2 points)**
    - 0 points – Project will require significant increased maintenance effort
    - 1 point – Project will require some increased maintenance effort
    - 2 points – Project will require no additional maintenance effort
- **Cost and Constructability (6 points) –** This score is based on the overall project cost (low score for high cost) and accounts for additional design, permitting requirements, and implementation considerations, such as site constraints and utilities, prior to project implementation.
- **Additional Benefits (5 points total) –** Description of other project benefits, total score is roughly a count of the number of additional benefits. Additional benefits considered in the prioritization are as follows:
    - **(1) Chronic Problem Area** – The site requires frequent maintenance and/or is an ongoing problem affecting water quality
    - **(2) Seasonal Flooding** – The site is affected by or contributes to seasonal flooding
    - **(3) Educational** – The site provides an opportunity to educate the public about stormwater treatment practices
    - **(4) High Visibility** – The site is highly visible and will benefit from aesthetically designed treatment practices
    - **(5) Infrastructure Conflicts** – The stormwater problem area is increasing erosion or inundation vulnerability of adjacent infrastructure (i.e. roads, buildings, etc.)
    - **(6) Drains to Connected Stormwater Infrastructure** – The site drains into a larger stormwater conveyance system that is less likely to receive downstream treatment
    - **(7) Reduces Thermal Pollution** – Project implementation will reduce the risk of thermal loading from runoff to receiving surface waters
    - **(8) Improves BMP Performance** – Project implementation will improve the performance of existing stormwater treatment practices that receive runoff from the site
    - **(9) Peak Flow Reduction** – Project implementation will significantly reduce stormwater peak flows leaving the site

Figure 5.1: An unstable drainage ditch on the southern section of Tory Lane was tied for the lowest individual score (RD-15). An eroded flow path to a catch basin receiving runoff from impervious areas at Arlington Memorial High School (SW-12) was tied for the highest problem area score.

Problem area summary sheets were developed for each identified project and are provided in Appendix C. The summaries include a site map and description, site photographs, description of the proposed practice, prioritization criteria, and an initial cost range. Problem areas and prioritization strategies were discussed and refined with input from representatives of BCRC and the Town of Arlington.

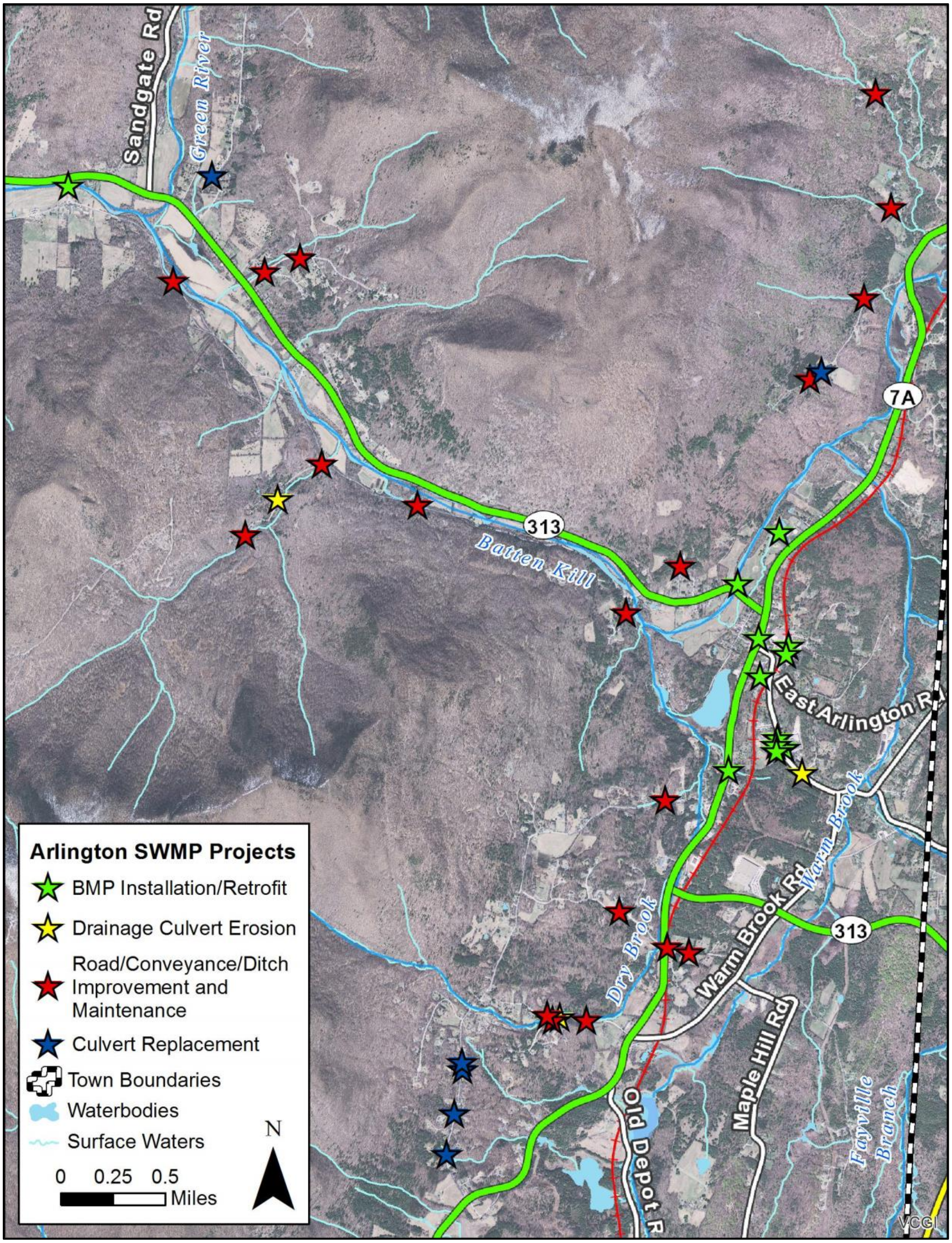

Figure 5.2: Stormwater Problem Area Overview Map. See large map in Appendix A for greater detail.

5.3 Project Prioritization and Conceptual Designs

The Arlington SWMP partners reviewed and commented on the list of preliminary projects during various meetings and email correspondences. A total of 40 projects are described in the SWMP, and a subset of projects were discussed for further development. Based on stakeholder input six (6) project areas were chosen for 30 percent conceptual design development.


Figure 5.3: Exploring drainage patterns and discovering a buried catch basin during concept design development in the Chittenden Drive area (SW-7 & SW-8).

30% Concept Designs

Six (6) projects were selected for 30% concept designs (Appendix D). Additional survey data was collected at each site (Figure 5.3) and hydrologic models were utilized to estimate runoff volumes and inform BMP design and sizing. Conceptual designs include:

- A site plan with contours and drainage area mapping
- Where relevant, hydrologic and hydraulic modeling data of the contributing drainage area and proposed BMP sizing and design specifications
- Typical details for proposed practices
- A preliminary cost opinion

The projects chosen for 30% conceptual design were:

1. **Project C-1: Berwal Road Culvert Replacement –** The culvert conveys a first order stream and is undersized. The channel downstream of the outlet is severely eroded, with 4-to-5-foot vertical banks extending for 280 linear feet.
2. **Projects RD-8 and RD-9: River Road Infiltration Steps and Drainage Improvement –** At one location, an eroded conveyance drains directly to the Batten Kill following a river access point at a pull off along the road embankment. At the second location the road embankment is eroding

directly into a wetland alongside a Batten Kill flood chute. Flowing water from a spring emerging from the slope is undermining the road embankment.

3. **Projects SW-7 & SW-8: Chittenden Drive Area Stormwater Improvements –** The area around Chittenden Drive is the headwaters for a large network of stormwater infrastructure that has been linked to flooding and erosion problems downstream. We evaluated the upslope drainages of the Chittenden Drive stormwater network, identified opportunities to mitigate the quantity of stormwater entering the network, and recommended practices to reduce stormwater sediment and nutrient loads.
4. **Project SW-9: American Legion Gravel Parking Infiltration –** The gravel parking lot drains to a catch basin located in the middle of the lot. This conveys stormwater and sediment to a nearby wetland.

6.0 Next Steps

This Stormwater Master Plan represents an extensive effort to identify, describe, and evaluate stormwater problem areas affecting Arlington, Vermont. For each project recommendation, we provided a preliminary cost estimate and a site rating to aid the BCRC and the Town of Arlington in planning and prioritizing restoration efforts. Many of the problem area descriptions (e.g., roadside ditches) will aid the Town Highway Department in proactively stabilizing and maintaining these features to avoid future stormwater problems, and to come into compliance with the VTANR Municipal Roads General Permit.

We recommend that BCRC works with the Town, VTDEC, and BCCD to secure funding for the high priority projects described in Appendices B, C, and D. Based on the level of scoping and design work already completed to date, overall project prioritization, and past stakeholder input, we recommend that the following projects are prioritized for further work in the near term.

- Berwal Road Project, C-1 (30% design already complete)
- River Road Projects, RD-8 & RD-9 (30% design already complete)
- Chittenden Drive Area Projects, SW-7 & SW-8 (30% design already complete)
- American Legion Project, SW-9 (30% design already complete)

In addition to addressing the problem areas identified in this document, the Town can take steps to reduce future stormwater problems through planning and zoning regulations. Stormwater best management strategies and other planning and zoning regulations may be applied to existing and future growth to reduce the risk of stormwater runoff conflicts and nutrient and sediment loading to receiving waters.

Finally, though 11 projects were selected as high-priority based on selected criteria (Total score of 17 or higher), the other identified projects (and any additional new problem areas that develop over time) are also important and should be remediated as time and resources permit.

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