Watershed Action Plan
Lake Eden Watershed
Eden, Vermont

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1.0 Introduction

The Lake Eden watershed is located in Lamoille County, Vermont, and drains a portion of the Town of Eden. In the fall of 2017 and spring of 2018, stakeholders representing the Town of Eden, the Lake Eden Association (LEA), the Vermont Agency of Natural Resources (VTANR), the Lamoille County Planning Commission (LCPC) and the Lamoille County Conservation District (LCCD) met to discuss concerns over increased sediment and phosphorus levels in Lake Eden and initiated the process of securing funding for a thorough assessment of water quality impacts in the Lake Eden watershed. In 2018 LCCD received grant funding from the VTANR Clean Water Fund (2019-CWF-D-1-02) to conduct shoreline and stormwater assessments and develop a water quality restoration plan for the Lake Eden watershed.

LCCD hired Fitzgerald Environmental Associates (FEA) in 2018 to assist with the development of the watershed assessment and accompanying project prioritization and concept designs. The Lake Eden Watershed Action Plan generally follows the VT ANR Stormwater Master Planning (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). In addition, given the need to evaluate water quality impacts from the shoreline zone, shoreline assessments were completed by LCCD and VTANR in conjunction with LEA volunteers. The Watershed Action Plan was developed over the course of 2019 through extensive field work, interaction with multiple stakeholders from the Town of Eden, LEA, VT ANR, and LCCD to identify and prioritize projects, and follow-up analysis and design work.

1.1 Watershed and Planning Background

The Lamoille Tactical Basin Plan found that Lake Eden is exhibiting a decline in water quality due to increased sedimentation and total phosphorus (ANR, 2016, page 37). The goal of the Lake Eden Watershed Action Plan was to identify and evaluate water quality stressors to Lake Eden, and to identify projects to mitigate inputs of sediments and nutrients. Environmental concerns and stressors identified by the group of stakeholders included channel erosion, flow alteration, lakeshore encroachment, invasive species, soil erosion, nutrient loading, and thermal stress. The watershed assessment focused on the evaluation of the lakeshore, tributary, and roadway sources of sediment and nutrients (Figure 1), as well as other concentrated sources of stormwater runoff in the watershed.

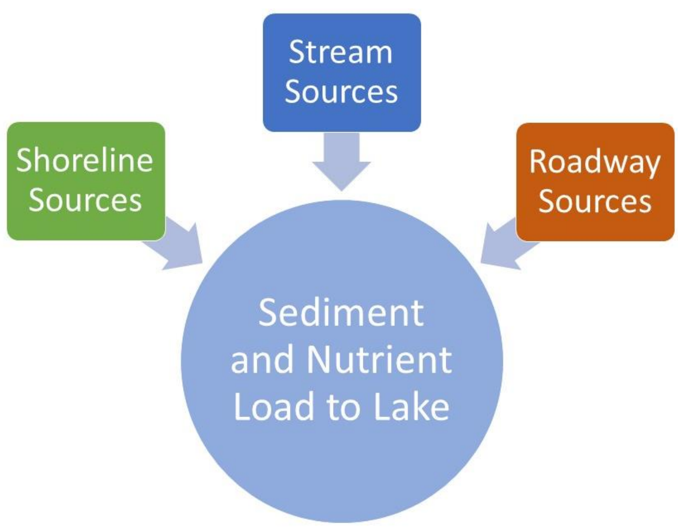

Figure 1: Conceptual diagram of primary water quality stressors on Lake Eden.

1.2 Lake Eden Project Goals

The goal of this project was to evaluate the Lake Eden watershed (Figure 2) to identify sources of increased stormwater runoff and associated sediment and nutrients. Erosion and phosphorus reducing projects are of particular importance given the water quality concerns within the watershed. The work involved identifying sources of water quality impacts, 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, back road erosion projects, and improving floodplain access within the river corridor to increase sediment and nutrient attenuation.

Stream and lakeshore projects can include stormwater treatment practices, erosion stabilization, floodplain restoration, and vegetation/habitat restoration. Near-channel and near-shore projects are especially important to improving water quality due to the high potential for transport of sediment and nutrients to adjacent waterbodies. The initial project goals were to identify at least 30 projects and to create conceptual designs (roughly 30% design) for at least five projects.

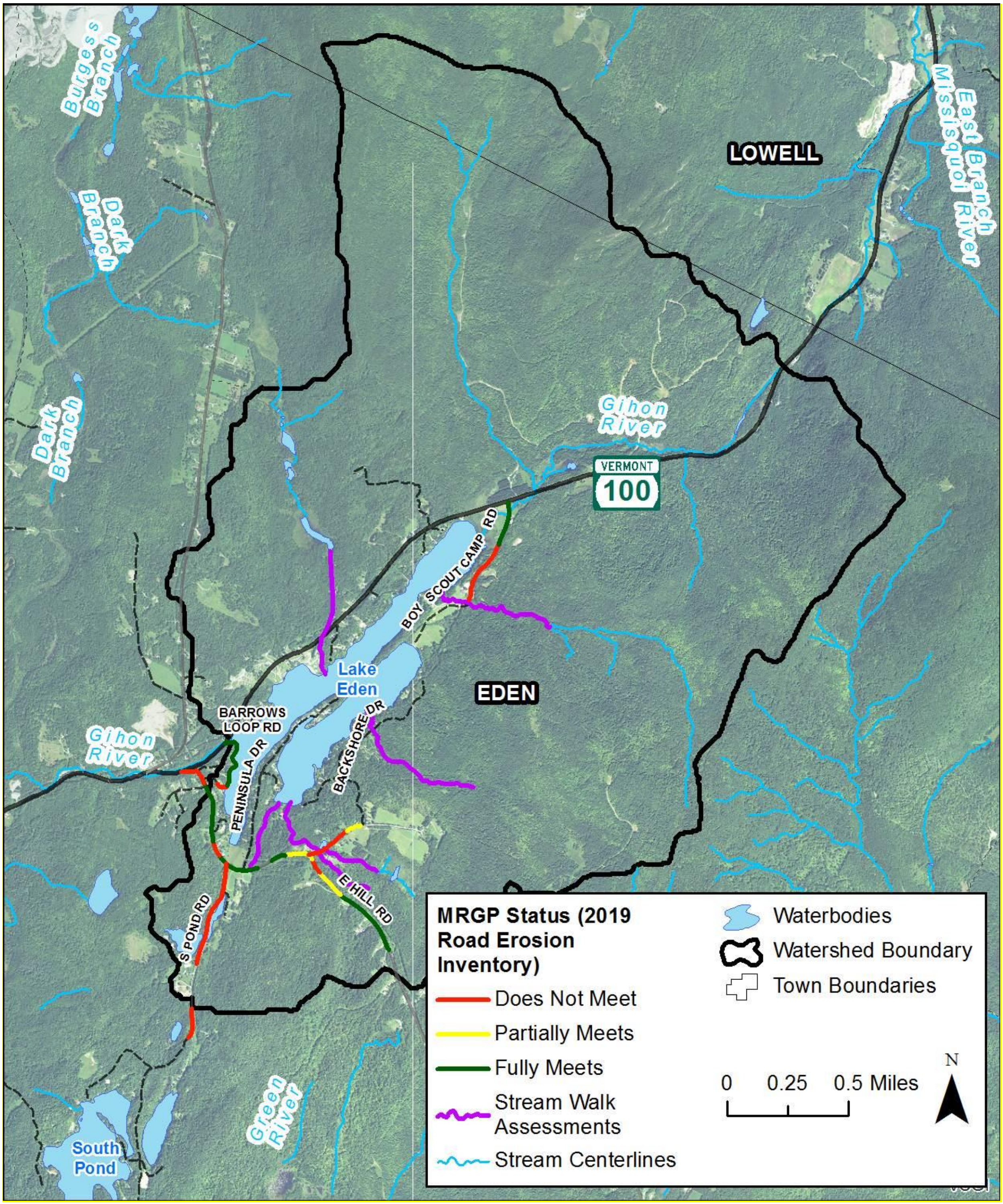

Figure 2: Lake Eden watershed study area

2.0 Study Area Description

Lake Eden is a 198-acre lake located in the Town of Eden, VT (Figure 3). The contributing watershed area is approximately 7.2 square miles located in the Towns of Eden and Lowell. Eden and Lowell are small towns, with 1,323 and 879 residents respectively in the 2010 census (U.S. Census Bureau, 2011). The Lake Eden watershed is the headwaters of the Gihon River, which drains to the Lamoille River.

There are 9.8 miles of roads in the Lake Eden Watershed (Table 1), made up of private roads (37.8%), town highways (33.7%) and state highways (28.4%). Road distances are based on road centerline data from VTrans (2017). Land cover data based on imagery from 2011 National Land Cover Database (Homer et al., 2015) are summarized in Table 2. The Lake Eden watershed is predominantly forested. Residential development is concentrated along the Route 100 corridor and along East Hill Road in Eden.

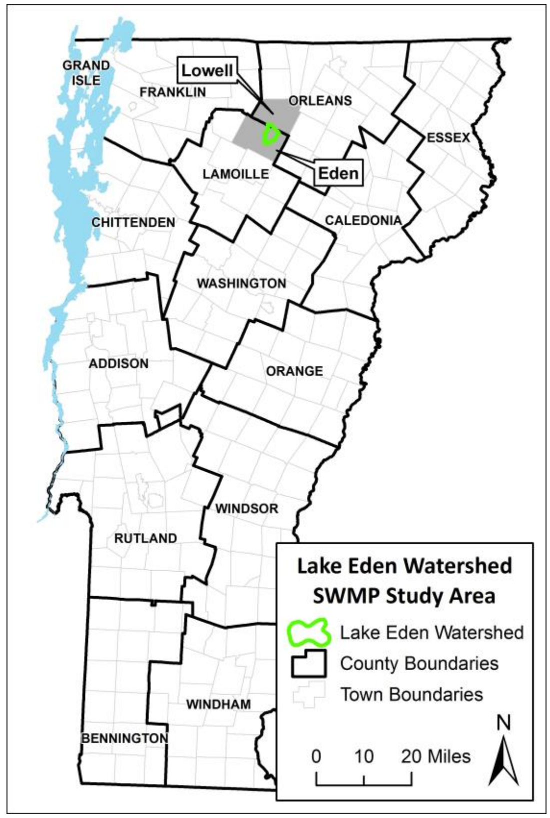

Figure 3: Lake Eden watershed study area location map.

Table 1: Road length by AOT class in the Lake Eden Watershed (VTrans, 2017)

AOT Class	Description	Length (miles)	% of Watershed Road Length
2	Class 2 Town Highway	1.54	15.7
3	Class 3 Town Highway	1.53	15.6
4	Class 4 Town Highway	0.24	2.4
8	Private Road	3.7	37.8
30	Vermont State Highway	2.78	28.4

Table 2: Land cover in the Lake Eden Watershed.

Land Cover/Land Use Type	% of Watershed
Agriculture	0.6
Barren	0.1
Developed	4.4
Forest	87.2
Open Water	4.4
Shrub/Scrub	1.6
Grassland/Herbaceous	0.5
Wetland	1.2

3.0 Watershed Data Library

We began our assessment efforts by gathering and reviewing information and documentation related to information and documentation related to lake and shoreline conditions, stormwater runoff, and watershed management within the Lake Eden Watershed. Below is a summary of available data, mapping, and documentation at the local and state level. The planning library is included in Appendix A. Sources for this information include:

- **Town and Regional Plans and Datasets**
  - Town of Eden Town Plan - 2018
  - Lamoille County Road Erosion Assessment - 2014
  - LCPC & TNC Bridge and Culvert Assessments 2011-2012
- **State Data and Plans**
  - Lamoille Tactical Basin Plan - 2015
  - Lake Eden Shoreline and Watershed Survey - 2004
  - Lake Eden Score Card - 2017
  - VTDEC Town of Eden Stormwater Infrastructure Mapping Project - 2017
  - VTDEC Hydrologically Collected Road Segment Data
  - Light Detection and Ranging (LiDAR) Topography Data - 2015
  - VT ANR Clean Water Roadmap
  - NRCS Soils Survey

4.0 Water Quality Problem Areas

One of the primary objectives of the watershed assessment is to "investigate a broad sweep of environmental concerns and land use impacts that may be reducing the water quality of Lake Eden". FEA conducted a total of six (6) field tours of the project area including a lakeshore assessment, stream walks on selected tributaries to the lake, and assessments of public and private roads and other impervious surfaces. Lake and stream assessments were conducted with representatives from VTANR and LCCD.

4.1 Identification of Problem Areas

The initial round of water quality problem area identification began with a desktop exercise to scan 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.

Field tours of the priority areas identified and assessed 36 problem areas. The problem areas are shown on the map included in Appendix B. We grouped the problem areas into five (5) project categories described below. **However, many projects have benefits and components that could be attributed to the other categories listed.**

- **Green Stormwater Infrastructure (GSI) BMP Installation/Retrofit** – Opportunity to reduce sediment and nutrient loads through the installation of a new stormwater best management practice (BMP). Sites where nutrient and sediment reductions could be improved through the retrofit of existing stormwater BMPs.

- **Stormwater (Road Drainage Improvement/Stabilization) –** Areas of high sediment and nutrient loading due to road, embankment, and ditch erosion.
- **Stream Culvert –** Locations of undersized culverts and culverts with active erosion.
- **Lakeshore –** Problem areas where lakeshore erosion or stormwater inputs are a significant nutrient and sediment source, or where improved lakeshore natural communities could reduce sediment and nutrient loads to receiving waters.
- **Stream or Wetland Restoration** – Problem areas where stream bank erosion is a significant nutrient and sediment source, or where improved stream/wetland function could reduce sediment and nutrient loads to receiving waters.

The stream walk assessment focused on four (4) blue-line tributaries and one unmapped tributary to the lake. The stream walks were a pared down version of the stream geomorphic assessment focusing on evaluating:

- Erosion of channel and embankments (bank erosion, mass failures, and headcuts)
- Additional linear features of interest (buffers < 25')
- Point features of interest (stormwater inputs, beaver impoundments, debris jams)
- Stream crossings
- Channel characteristics (dominant bed and bank material, basic cross-section, bar features)

Stressors identified in the stream walks included undersized culverts, bank and gully erosion, a headcut, bank armor, and the absence of a vegetated buffer. The majority of these stressors were concentrated in the lower portions of the tributaries near the lake rather than the headwaters.

A paddle of the lake was conducted to identify potential water quality impacts along the lakeshore, including:

- Erosion of lakeshore and lakeshore stabilization practices (e.g. hard armor)
- Additional linear features of interest (buffers < 25')
- Point features of interest (e.g. stormwater inputs)
- Invasive vegetation

Overall lakeshore erosion and invasive vegetation were low. A notable patch of Phragmites was observed along the shoreline at the Eden Recreation Area. Lakeshore areas of lawn and hardscaping tended to be concentrated within some "neighborhoods" (e.g. the west side of Peninsula Drive and parts of Howe Drive) suggesting a cultural component to lakeshore landscaping practices.

4.2 Evaluation and Prioritization of Problem Areas

4.2.1 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 project prioritization table (Appendix C).

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

- **Subwatershed Mapping –** The contributing drainage area to each problem area was mapped based on field observations and 2-foot contours derived from the 0.7 2014/2015 LiDAR elevation surface.
- **Aerial Photography** – We used the 0.3 m imagery collected for Northern Vermont in 2018 to review the site land cover characteristics (i.e., forest, grass, impervious).
- **Impervious Surfaces Data** – We manually measured total impervious area in acres for GSI projects from the aerial photography. For non-GSI projects, we estimated impervious area using the aerial imagery.
- **NRCS Soils** – We used the Lamoille 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 runoff characteristics of the drainage area based on hydrologic soil group (HSG).
- **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 Hydrologically Collected Road Segment Data –** We used a statewide inventory of road erosion risk and hydrologic connectivity of road segments to prioritize areas of potential sediment loading to visit for field surveys.

4.2.2 GSI Evaluation and Prioritization of Problem Areas

The 8 GSI projects described in the master project table (Appendix C) were prioritized based on the potential for each project to improve water quality, reduce environmental impact, project feasibility, and co-benefits. Estimated project cost and the phosphorus removal efficiency ($/lb of P) were included. We followed the Unified Scoring Prioritization for Stormwater Master Plans document developed by VTDEC, with an adjustment to the phosphorus loading and phosphorus reduction criteria (VTDEC, 2018). This method includes a total of 19 criteria divided into 3 categories. The final score is expressed as a percent of the total score, with slightly different criteria applied to road drainage projects.

<u>Phosphorus Loads from Sediment</u>

Land cover-based phosphorus loading estimates account for generalized assumptions of sediment mobilization; however, we believe that phosphorus loading from active erosion areas may be underestimated for some of the problem areas. Other project types such as stream bank restoration or gully stabilization do not fit into the VTDEC Unified Scoring framework. We developed a simple adjustment to the overall phosphorus loading and phosphorus reduction criteria to account for excess sediment mobilization. Our proposed adjustment is based on a best professional estimate of annual soil loss (in cubic feet) and an estimate of soil phosphorus content.

Two studies of streambank soils in Chittenden County have found an approximate total phosphorus concentration of 615-620 mg TP/kg soil (DeWolfe et al., 2004 and Ishee et al., 2015). These numbers align closely with the US average of 600mg/kg (Abrams and Jarrell, 1995). Based on these numbers we assumed that soils are 0.06% phosphorus by weight. The Ishee study found local streambank soil bulk density to range from 62 to 75 lbs/ft^3 (2015). Based on these findings in local watersheds, we estimate that a ft^3/year of soil erosion is equivalent to 0.04lb/year of increased phosphorus load.

<u>BMP Unit Costs and Adjustment Factors</u>

BMP unit costs (2016 $) and adjustment factors were derived from recent stormwater master plans completed by Watershed Consulting Associates (2018). These numbers were primarily based on research completed by the Charles River Watershed Association and the Center for Watershed Protection (EPA, 2016), as well as updates based on actual construction costs in Vermont (Table 3). The unit cost estimates include a 6% inflation adjustment based on the 3-year Consumer Price Indicator Inflation Calculator. Unit construction costs for road drainage projects were based on the estimates provided in the Road Erosion Site Prioritization and Remediation Project Summary (Fitzgerald Environmental Associates and Milone and MacBroom, Inc., 2017). Additional multipliers for site type (Table 4) and level of permitting and engineering required (Table 5) are also shown below.

Table 3: BMP Unit Costs

BMP Type	Cost/ft^3 Treatment Volume
Grass conveyance swale	6.61
Surface infiltration basin	6.61
Subsurface infiltration	6.63
Rain garden/bioretention	16.39
Wet pond	7.21

Table 4: Site Type Cost Adjustment

Site Type	Cost Multiplier
Existing BMP retrofit	0.25
New BMP in undeveloped area	1.00
New BMP in partially developed area	1.50
New BMP in developed area	2.00

Table 5: Permitting and Engineer (P&E) Cost Adjustment

Level of P&E Required	Cost Multiplier
None	1.00
Low	1.20
Moderate	1.25
High	1.35

4.2.3 Non-GSI Evaluation and Prioritization of Problem Areas

The 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 10 to 17. Each category is described below and includes a description of the scoring for each criterion. Final evaluation criteria summarized in the table in Appendix C 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 significantly 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 4: A culvert on the Gihon River with poor channel alignment had the lowest problem area score (left photo, Project SC-3). Erosion and transport of sediment from Lake Shore Road directly to the Lake was the highest problem area score (right photo, Project SW-11).

4.2.4 Problem Area Summary Sheets

Problem area summary sheets were developed for 20 of the high and moderate-priority project sites, and are provided in Appendix E. These sites were selected based on the prioritization categories shown in the Problem Area Table in Appendix C, and from input from project stakeholders during several meetings and field tours. Problem areas and prioritization strategies were discussed and refined with input from representatives of the Town of Eden, LCCD, and VTANR during various meetings. The one-page summary sheets found in Appendix E include a site map and description, site photographs, and prioritization categories.

4.3 Sediment and Nutrient Loads to Lake Eden

Based on the distribution of project types, as well as each project's watershed location, size, and existing nutrient/sediment load, we estimated the relative load from each of the primary "sectors" of the Lake Eden watershed. Given the high degree of development along much the lake's shoreline, as well as the extensive network of private gravel roads and driveways near the lakeshore, it is our opinion that the lakeshore represents the largest contribution of sediment and nutrients to the Lake. Municipal roadways and associated drainage from roadways likely represents greater than ¼ of the load, while stream bed and bank erosion appears to represent less than ¼ of the load (Figure 5).

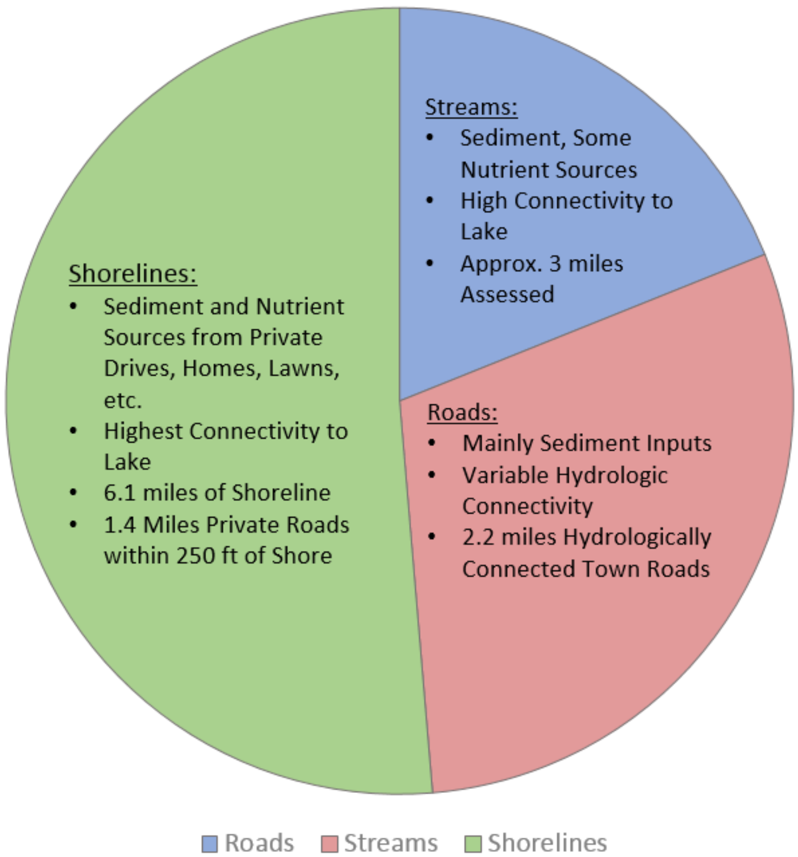

Figure 5: Relative contribution of sediment/nutrients to Lake Eden from various sources.

4.4 Project Prioritization and Conceptual Designs

The Lake Eden Watershed Action Plan partners reviewed and commented on the list of preliminary projects during various meetings and email correspondences. From the list of 36 projects described in the plan, a subset of high-priority projects was discussed for further development. Based on stakeholder input and the prioritization categories shown in the Problem Area Table in Appendix C, five (5) projects were chosen for conceptual design development (30% design). The projects focus on the priorities outlined in Figure 5, with 4 of the 5 designs addressing lakeshore runoff from impervious surfaces including private and municipal roads.

Figure 6: Part of a large paved parking lot at the Boy Scout Camp.

30% Concept Designs

Five (5) of the highest priority projects were selected for the development of 30% concept designs (Appendix F). Concept designs include:

- A site plan with contours, existing stormwater infrastructure, and proposed design elements
- 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 SW-4: Vermont Fish and Wildlife Boat Launch** – Concentrated runoff from Route 100 is causing rill erosion near the cross-culvert inlet conveying water to the adjacent wetland, and directly to the lake. The recent addition of water bars has helped intercept flow from Route 100, but opportunities remain to improve infiltration and sediment retention on-site. The sediment load at the site may be exacerbated by accumulation of gravel in the winter from plowing.
2. **Project SW-5: Boy Scout Camp Parking Lot** – An eroded channel and gully where the channel enters the stream is forming from stormwater runoff concentrated along the western side of the

parking area at the Boy Scout Camp. Total impervious area at the Camp exceeds 1 acre, and significant drainage problems around the facility have been noted by Camp staff. The location of snow storage for the parking lot may be contributing extra runoff to the channel.

3. **Project SW-8: Eden Recreation Area –** Runoff from the gravel road and parking area is concentrated near the canoe/kayak rack and eroding a channel underneath the rack toward the lakeshore.
4. **Project SW-11/17: Lake Shore Road –** This Class 4 Town Road lacks a lakeshore buffer and is concentrating runoff. A seasonal gully may form on the eroded embankment, that directly inputs sediment into the lake. A steep stretch of road lacks drainage ditches, causing severe rill erosion for approximately 150 feet near the eastern bend in the road. This runoff continues to the lakeshore, exacerbating the gully erosion on the stretch of road without a lakeshore buffer.
5. **Project SW-14: Griggs Road Near #187** – This channel takes runoff from the stone-lined ditch on the south side of Griggs Road. Runoff from the roadway comes down the ditch, under the road via culvert, and wraps around the east side of the house. The channel outlet west of Griggs Road is very incised.

Figure 7: Erosion at the VT Fish and Wildlife Boat access observed during a storm event in June 2019. The concept design for this area (SW-4) describes a BMP that would treat this runoff.

5.0 Next Steps

This watershed action plan represents an extensive effort to identify, describe, and evaluate water quality problem areas affecting the Lake Eden watershed. For each project recommendation, we provided a preliminary cost estimate and a site rating to aid the LCCD, LEA, and Town representatives in planning and prioritizing restoration efforts. The problem area descriptions for Town roads (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 LCCD continues to work with the Town, LEA, and VTDEC to secure funding for the high priority projects described in Appendices C, E, and F. 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.

- Project SW-4: Vermont Fish and Wildlife Boat Launch (30% design already complete)
- Project SW-5: Boy Scout Camp Parking Lot (30% design already complete)
- Project SW-8: Eden Recreation Area (30% design already complete)
- Project SW-11/17: Lake Shore Road (30% design already complete)
- Project SW-14: Griggs Road Near #187 (30% design already complete)

Additionally, we recommend that VT DEC and LCCD reach out to a selection of landowners with properties appearing likely to receive a LakeWise designation and assisting them as needed to obtain the designation for their properties. The lakeshore signage and interpersonal discussion of the program could steer the future culture of landscape management toward one incorporating more native vegetation and habitat enhancement.

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.

6.0 References

Abrams, M. M., and W. M. Jarrell. 1995. Soil Phosphorus as a Potential Nonpoint Source for Elevated Stream Phosphorus Levels. Journal of Environmental Quality. 24: 132-138.

Dewolfe, M. N., W.C. Hession, and M.C. Watzin. 2004. Sediment and Phosphorus Loads from Streambank Erosion in Vermont, USA. In: G. Sehlke, et al., editors, Critical transactions in water and environmental resources management. American Society of Civil Engineers.

EPA. 2016. Methodology for Developing Cost Estimates for Opti-Tool. Memorandum to Opti-Tool TAC prepared by Karen Mateleska, EPA Region 1.

Fitzgerald Environmental Associates and Milone and MacBroom. 2017. Road Erosion Site Prioritization and Remediation Project Summary. Memo prepared for the Chittenden County Regional Planning Commission. Dated December 27, 2017.

Homer, C.G., Dewitz, J.A., Yang, L., Jin, S., Danielson, P., Xian, G., Coulston, J., Herold, N.D., Wickham, J.D., and Megown, K., 2015, Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. *Photogrammetric Engineering and Remote Sensing*, v. 81, no. 5, p. 345-354

Ishee, E. R., D. S. Ross, K. M. Garvey, R. R. Bourgault, and C. R. Ford. 2015. Phosphorus Characterization and Contribution from Eroding Streambank Soils of Vermont's Lake Champlain Basin. Journal of Environmental Quality. 44: 1745-1753.

U.S. Census Bureau, 2011. U.S. Census Bureau American FactFinder web page. Accessed in March, 2017 at: http://factfinder.census.gov

VTANR (Vermont Agency of Natural Resources), 2016, Lamoille Tactical Basin Plan. Watershed Management Division, Montpelier, Vermont. Accessed in October 2018 at: https://dec.vermont.gov/sites/dec/files/wsm/mapp/docs/2016-12-30_Lamoille_Tactical_Plan_FINAL.pdf

Vermont Department of Environmental Conservation (VTDEC). 2018. Unified Scoring Prioritization for Stormwater Master Plans

Watershed Consulting Associates, LLC. 2018. Stormwater Master Plan for the Town of Berlin, Vermont. Prepared for the Central Vermont Regional Planning Commission. Final Report, January 17, 2018.