Fitzgerald Environmental Associates, LLC.

Applied Watershed Science & Ecology

MEMORANDUM

To: Lamoille County Conservation District
From: Evelyn Boardman and Evan P. Fitzgerald, CPESC, CFM
Re: Lake Eden Watershed Data Library
Date: October 31, 2018

As a first step in the development of a Watershed Action Plan for Lake Eden, we gathered and reviewed information and documentation related to lake and shoreline conditions, stormwater runoff, and watershed management. This document summarizes available documentation and other potential sources of information we explored. Much of this information is from previously completed studies in the lake's watershed, but also includes data sources discussed during a project steering committee meeting on August 15th, 2018. Other potential sources of data and data gaps are also addressed. A series of maps with relevant data are attached for reference.

Study Area Description

Lake Eden is a 198-acre lake located in the Town of Eden, VT (Figure 1). 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.

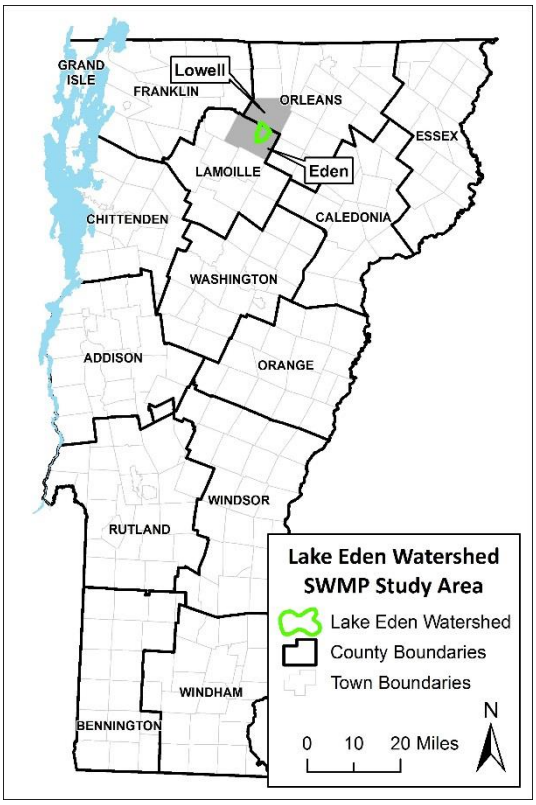

Figure 1: Lake Eden watershed location map.

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

Mapping Data

VTDEC Hydrologically Connected Road Segment Data

VTDEC created a statewide inventory of roads that are likely to be hydrologically connected to surface waters (link). 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 rankings 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 East Hill Road where they are relatively far from perennial stream and waterbodies; moderate and high-risk segments become more prevalent along gravel roads in close proximity to Lake Eden and its tributaries such as Lake Shore Road (see attached map). There are 63 town road segments mapped as hydrologically connected road segments in the Lake Eden watershed in the 2018 dataset.

Light Detection and Ranging (LiDAR)

LiDAR returns for Lamoille County were collected in a series of flights conducted between November 2014 and November 2015 as part of the VT LiDAR Initiative. The data meet the National Digital Elevation Program Quality Level 2 specifications for accuracy satisfactory for generation of a 0.7-meter Digital Elevation Model (DEM) and 1-foot contours. 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 will assist in culvert watershed delineation and the design of stormwater management projects (link). Terrain models will assist in remote identification of erosion features, such as stormwater gullies.

Town of Eden Stormwater Infrastructure Mapping Project

The VT Agency of Natural Resources completed infrastructure mapping for the Town of Eden (VTDEC 2017; link). The mapping products include drainage maps for 6 subwatersheds, stormwater infrastructure, and a potential location for stormwater BMP installation. The highest priority area in the report is a potential infiltration basin and bioretention area located between Route 100 and Lake Eden to treat road and campground runoff. Fitzgerald Environmental Associates (FEA) will explore this potential project and other stormwater BMPs in detail during our field assessments.

Bridge and Culvert Data

Lamoille County Planning Commission (LCPC) uploaded bridge and culvert inventories for Town roads to the Statewide database in September 2011 (https://vtculverts.org/). There are no bridge records and 23 culvert records for the Lake Eden watershed. The inventory included the structure dimensions and overall conditions but is missing some attributes such as the presence/absence of erosion. We will review the culvert data for overall condition characteristics to refine the selection of non-stream culverts we focus on during field surveys. We will also coordinate with the Town of Eden Highway Department to understand which culverts have been upgraded or replace since the 2011 inventory. Structure data for Route 100 is available from VTrans.

Additionally, three (3) culverts in the Lake Eden watershed were assessed by The Nature Conservancy in 2012 as part of a Lamoille River watershed assessment. Two (2) of the culverts had a geomorphic rating of mostly incompatible and the third was partially compatible.

Clean Water Roadmap

The Clean Water Roadmap tool apportions Total Phosphorus (TP) loads to land cover classifications (anrweb.vt.gov/DEC/CWR/cwr-tool.vbhtml). While the largest share of the TP load is attributed to forested areas in the Lake Eden watershed, nutrients associated with roads, developed areas, and agricultural activities contribute disproportionately to TP loads. Roads cover less than 2% of the watershed but contribute approximately 30% of the TP load.

NRCS Soils Survey

The NRCS soils survey dataset is also valuable for stormwater master planning (websoilsurvey.sc.egov.usda.gov). As part of our initial problem area scoping, we will screen areas based on the NRCS hydrologic soil groupings (HSG). The HSGs indicate the infiltration potential of the native soil type, which is useful for identifying areas of excessive runoff potential (e.g., HSG D-type) or good infiltration (e.g., HSG A-type) where stormwater infiltration practices should be explored.

Watershed Planning

Lamoille Tactical Basin Plan

The basin plan discusses the current condition of surface waters in the Lamoille River watershed, recommended actions to preserve and restore water quality, and relevant permit requirements (VTDEC, 2016). A top objective of the report includes improving lakeshore zone habitat along Lake Eden. The plan recommends outreach, watershed planning, VT LakeWise Program participation, and BMP implementation.

Water Quality Stressors & Ecological Condition

Lake assessments have found increasing TP levels, indicating a negative trend in water quality. Lake Eden has no confirmed problems with aquatic invasive species. The Lake Eden sub-basin is described as a priority due to "excessive sedimentation from land erosion and increasing nutrient trends". In addition to stormwater management and LakeWise participation, logging AMPs are recommended to reduce sediment loads.

Eden has no existing stormwater ordinance and no surface waters listed for water quality problems due to developed land. The Hutchins Brook watershed northwest of the Lake Eden watershed is impaired for sediment and asbestos. The recommended stormwater master planning template is 3b (a regional approach with a rural road focus).

Lake Eden Shoreline and Watershed Survey

These boat and road surveys were conducted in 2004 by VTDEC (Durrett, Ryan, & Warren, 2004). Signs of upstream erosion at lake inlets were observed as well as shoreline sources of nutrients and sediment. A list of recommendations includes further erosion assessments, investigating undersized culverts for replacement, and shoreline BMP implementation.

Lake Eden Score Card

Lake Eden is listed as stressed based on water quality standards and exhibited some negative water quality trends (fair condition). Summer annual total phosphorus mean concentration has significantly increased during the monitoring period of 1992 - 2018 (VT DEC, 2017). Secchi depth and chlorophyll *a* concentration have not significantly increased or decreased since 1988. Water quality stressors in Lake Eden include nutrients, organic enrichment / dissolved oxygen, and phosphorus. No known aquatic species are present in the lake. The lakeshore disturbance metric indicates the shoreline is moderately stressed (fair condition) and the lake development intensity index (LDI) indicates the watershed is moderately disturbed. The mercury fish contamination score is fair, indicating contamination in fish tissue is likely.

Town Planning and Permitting

Town of Eden Town Plan

The Town of Eden completed a Town Plan in 2018. The Town Plan discusses priorities around the protection of natural resources, including water quality in the Town's watersheds, lakes and rivers (Town of Eden, 2018). The plan mentions the need to protect water quality by treating stormwater runoff. Suggested approaches include low impact development (LID) strategies and residential-scale stormwater management. Other recommendations include upgrading undersized State and Town structures.

Lamoille County Road Erosion Assessment

LCPC and Watershed Consulting Associates conducted erosion assessments of Class 3 and 4 roads in 2014. Forty-five (45) erosion sites in Eden were mapped and prioritized. A total of 16 sites were included in a high-priority short-list, with seven chosen for design-repairs. Two medium-priority road erosion sites were in the Lake Eden watershed, one on Boy Scout Camp Road and one on East Hill Road. These sites will be revisited during stormwater problem area identification.

Data Gaps

The watershed library describes the available documents, reports, and datasets that characterize water quality, shoreline, stormwater, and flooding concerns within the Lake Eden watershed. No Phase 1 or Phase 2 stream geomorphic assessments (SGA) have been conducted in the watershed. Conducting Phase 1 or 2 SGA would better characterize the condition of the river system; however, data collection targeted toward stormwater concerns would also be beneficial. An alternative "stream walk" approach has been discussed with ANR to identify and evaluate areas of channel instability that may be contributing to sediment and phosphorus loading to the lake. This is described below.

In addition to the Gihon River mainstem, four tributaries to Lake Eden are mapped in the Vermont Hydrography Dataset (VHD). As part of the "stream walk" assessment, four tributaries and two unmapped tributaries visible in the LiDAR hillshade is proposed. The minimum extent of the walk is shown in the attached map. The stream walks are envisioned to be a pared down version of the stream geomorphic assessment focusing on:

- 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)

Literature Cited

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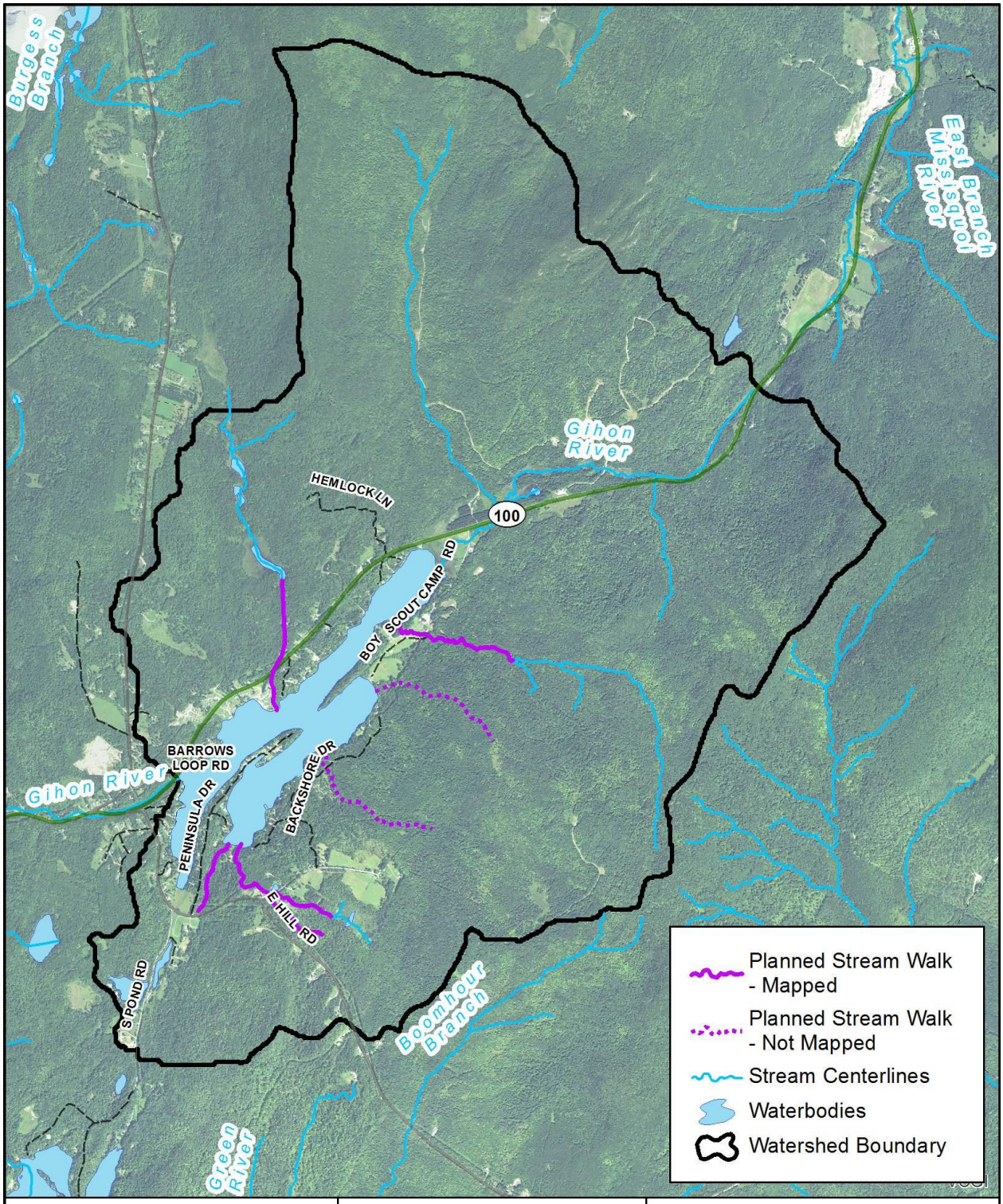

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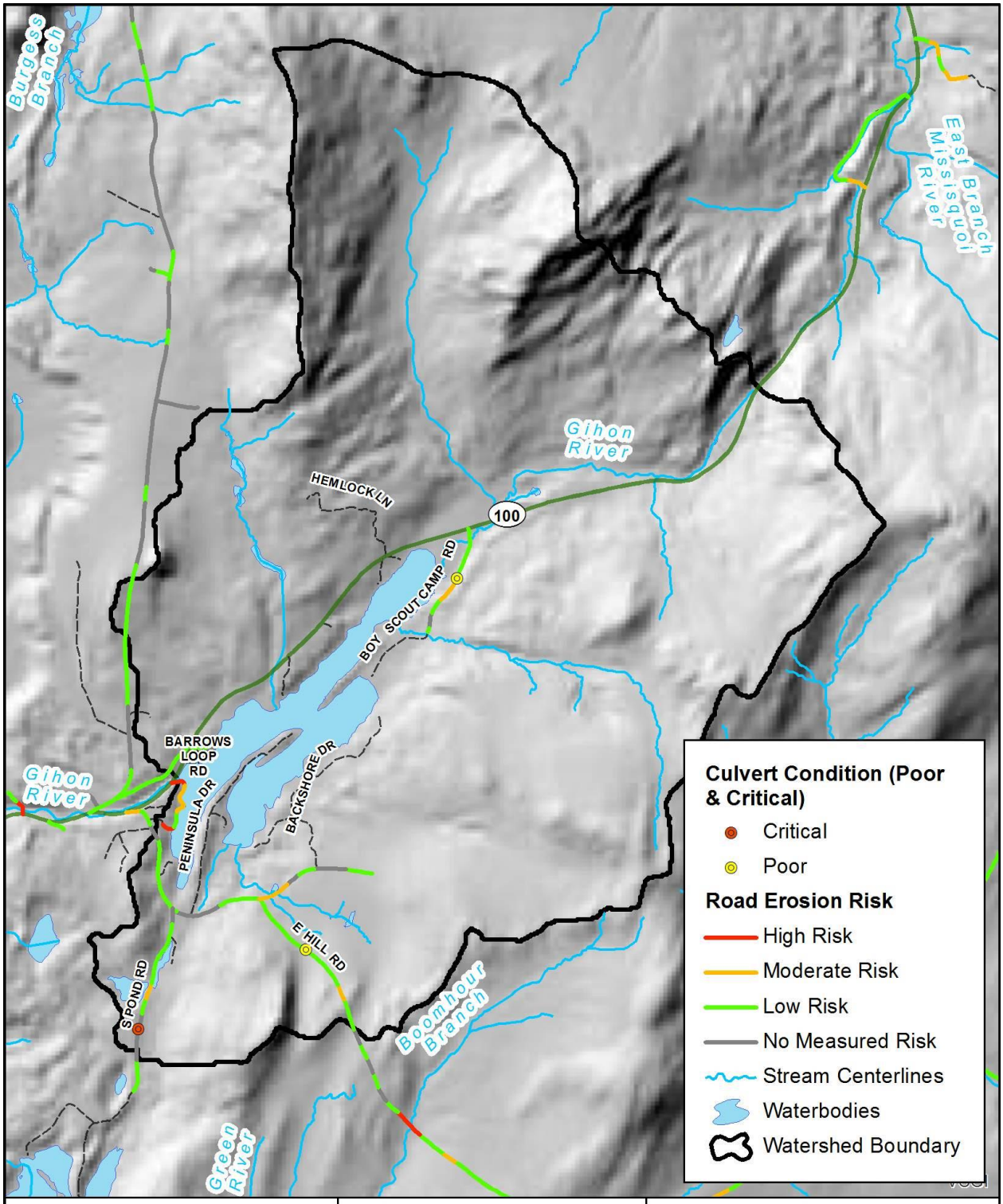
Lake Eden Watershed

0 0.3 0.6 Miles

Notes: NAIP imagery from 2016.
Map By: EHB
Date: October 30, 2018



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Road Erosion Risk Lake Eden Watershed

0 0.3 0.6 Miles

Notes: LiDAR hillshade from VCGI.
Map By: EHB
Date: October 30, 2018