Caspian Lake - Lake and Watershed Action Plan - Final Report

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This final report has also been created online as a StoryMap – use this link to see the online Final Report as a StoryMap. It contains all the media that follows as well as live hyperlinks to the various summary reports (also as StoryMaps) for the Caspian Lake Lake and Watershed Action Plan (LWAP).

1 Project Goals

The **primary goal of the Caspian Lake and Watershed Action Plan was to protect and preserve water quality** in the Lake, in particular with respect to opportunities to reduce the amount of phosphorus entering the lake and potentially contribution to Harmful Algal Blooms (HABs). HABs can be dangerous to human health and harm aquatic ecosystems (algae can alter plant communities and, when they decompose, can cause mass fish die-offs).

The LWAP identified 34 priority projects and further selected five for 30% Concept Design.

If all 34 priority projects were implemented, a total of 67.4 kilograms phosphorus (148.59 pounds) would be prevented from entering the lake.

As one pound of phosphorus can produce up to 500 pounds of algae (or more), these projects would eliminate algae production in the lake by 74,295 pounds (more than 37 tons) each year.

If implemented as designed, **the five 30% Concept Design sites would eliminate 15.34 kilograms phosphorous (33.73 pounds) from entering the lake each year**, a potential reduction of 16,865 pounds of algae (8.4 tons).

Additional objectives of this project were to restore lake shoreline to more natural conditions, stabilize stream banks to prevent erosion, and to restore native riparian habitat to its natural function. The goals would be accomplished primarily through the re-establishment of riparian buffers on the lake shore, stream banks, as well as around wetlands. If all 34 priority projects are implemented a total of:

- **780 linear feet of shoreline would be restored** to at least a 50' deep native riparian buffer. This would remove over 350 cubic feet of sediment from entering the lake each year.
- **25 acres of streamside, lakeside, and wetland-associated riparian buffers would be created**. These acres of riparian buffer would also enhance habitat for native species of plants and animals.
- **8,694 linear feet (1.65 miles) of public roads** would be brought to Municipal Road General Permit (MRGP) water quality standards.

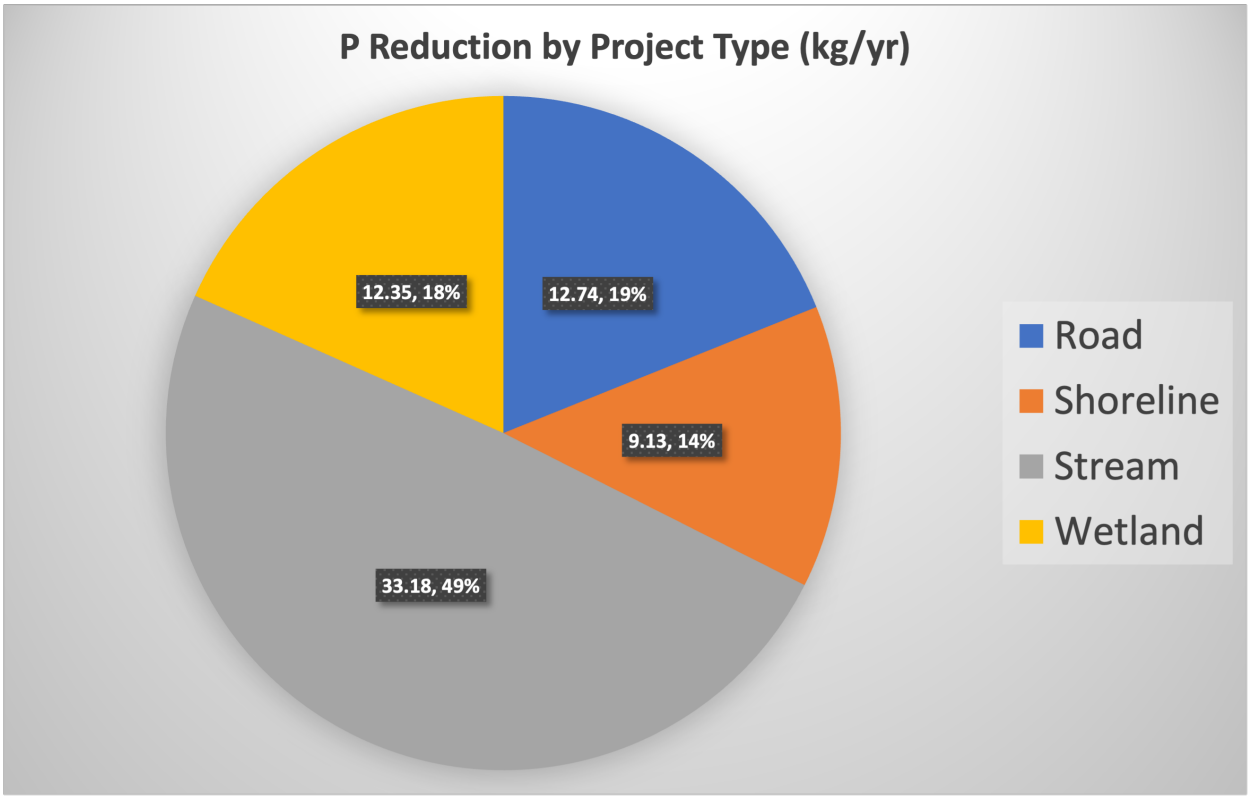

Figure 1: Phosphorus reduction by project type for the Caspian Lake LWAP 34 priority projects. Implementing all 34 projects would result in a reduction of 67.4 kilograms (148.59 pounds) of phosphorus from entering the Lake each, potentially reducing algae production in the Lake by more than 37 tons.

Projects can include stormwater treatment practices like rain gardens, level spreaders, or filter trenches, erosion stabilization, floodplain restoration, and vegetation/habitat restoration, in particular establishment of high-quality native vegetation riparian buffers. 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.

2 Introduction:

Caspian Lake is a 790-acre lake located in the Town of Greensboro, VT. The contributing watershed area is approximately 4,400 acres (6.88 square miles). Greensboro is a small town, with a population of 762 in the 2010 census (U.S. Census Bureau, 2011). Lake

The Caspian Lake watershed is predominantly forested with 2,399 acres of tree canopy (54%), followed by grass/shrubs comprising 1,123 acres (25%) with 80 acres of water, of which Caspian Lake is the majority at 790 acres (18%). Development makes up the minority of land use in the watershed with only 68 acres total split between roads, buildings, and other paved surfaces, with 'bare soil' accounting for 3.58 acres.

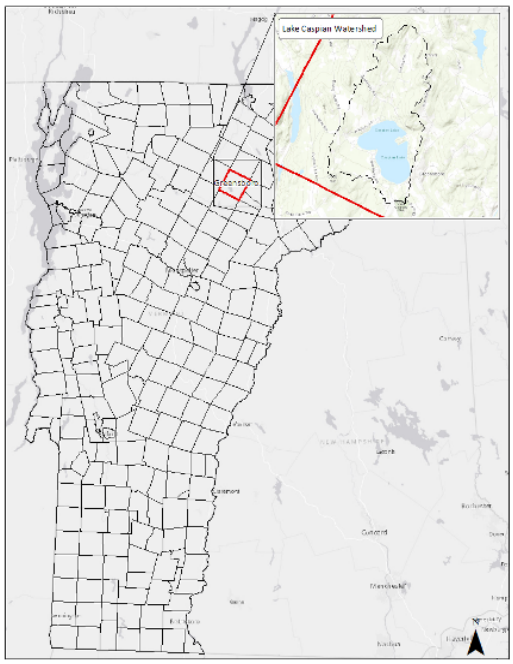

Figure 2: Caspian Lake in the upper Winooski River watershed.

There are five main tributary streams to Caspian Lake. They are:

- Porter Brook
- Tate Brook
- Cemetery Brook
- Bachelor Brook
- Baker Hill Brook

Based on 30 years of water quality monitoring data, Caspian Lake is experiencing a significant increase in both summer and spring total phosphorus concentrations. The VT DEC Lake Scorecard indicates that spring total phosphorus trends in Caspian Lake are significantly increasing ($p = 0.0182$), and summer total phosphorus trends are highly significantly increasing ($p = 0.0033$) (Vermont Lakes and Ponds Management and Protection Program, 2019). Because of this trend, and because Caspian Lake is one of only a few of Vermont's dwindling oligotrophic lakes, it is a priority for action by the Vermont Lakes and Ponds Protection Program. In addition, Caspian Lake is part of the Lamoille watershed, and the Lamoille watershed is Vermont's fourth highest contributor of phosphorus into Lake Champlain. There are still significant gaps in understanding the sources and impacts of nutrient loading in Caspian Lake. The 2019 Caspian Lake Tributary Monitoring Report recommends that the Tributary 6 watershed be assessed for sources of sedimentation that are causing erosion of the river channel or land surfaces resulting

in sediment and nutrient run-off into the tributary. In addition, the report recommends that shoreland properties conduct Lake Wise assessments, and that additional assessment is conducted to identify the type of agricultural land use (i.e. corn, rotational grazing, hay) in monitored watersheds to better understand potential contribution to nutrient loading. Private roads as well as lake tributary streams also need to be assessed. A Lake Watershed Action Plan will address these gaps in assessment.

Orleans County Natural Resources Conservation District (OCNRCD) applied for and received a grant from the Lake Champlain Basin Program to complete an LWAP for Caspian Lake. The Stewards of Greensboro Watershed were local partners in the project.

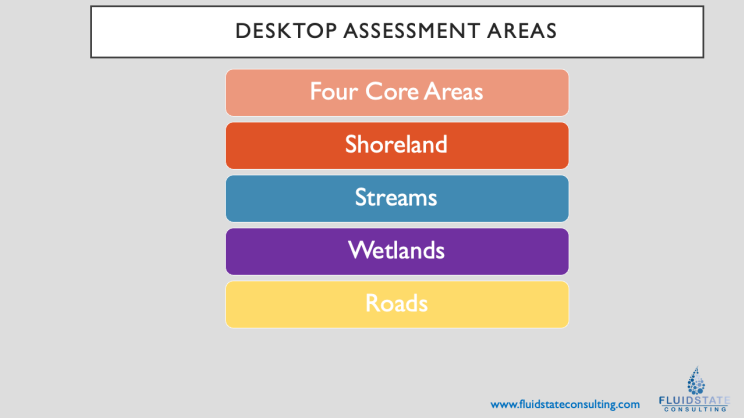

Figure 3: The Caspian LWAP focused on four core areas - shoreland, streams, wetlands, and roads.

The Stewards of Greensboro Watershed can be contacted via Stew Arnold (stewarnold@hotmail.com), JoAnn Hanowski (joannhanowski@gmail.com), or Jed Feffer (jedtfeffer@aol.com). The Greensboro Association is the overarching organization for the Stewards.

The Orleans County NRCD can be contacted either through Sarah Damsell (sarah.damsell@vt.nacdnet.net) or Ted Sedell (Edwin.sedell@vt.nacdnet.net).

This LWAP was developed over the course of 2022 and 2023 through field work as well as interacting with stakeholders from the Town of Greensboro, the Greensboro Association and OCNRCD to identify and prioritize projects that will help improve the health of Caspian Lake.

The resulting LWAP is the product of meetings with the stakeholder group, extensive data review of previous studies and planning efforts, desktop and field assessment of nearly 170 sites (including 18 stream reaches using the SGA Lite process and 11 road 'sites' comprised of 57 Municipal Roads General Permit (MRGP) segments). 17 Lake Wise Assessments were completed. Of this list, 34 sites were chosen for prioritization.

3 Methods

Creating the Lake and Watershed Action Plan started with the creation of a data library to assess existing information on water quality information associated with the lake. A 'desktop assessment' was then conducted using mapped layers such as landuse, streams and wetlands, slopes, soils, roads data, and satellite imagery to identify sites that could possibly benefit from improvements such as riparian buffer creation or erosion mitigation projects. Field assessment was then conducted for a selection of higher priority desktop assessed sites to gather information on conditions on the ground that would then inform project type selection (buffer creation versus stormwater practice implementation for example), as well as to inform further project prioritization. Prioritization was accomplished using criteria developed by VT DEC in other LWAPs as well as criteria used in Stormwater Master Plans (SWMPs), and agreed upon by the Caspian LWAP stakeholder group.

In selecting the five 30% Concept Design sites the results of the prioritization process were used, which evaluated many quantitative factors like buffer acres created, length of road improved, estimated potential cost of implementation, and potential phosphorus removed. However, landowner buy-in for future implementation was considered a key factor. Therefore, some sites that are quantitatively more valuable to lake health from a strict cost/benefit standpoint didn't necessarily get selected for Concept Design as landowner buy-in for implementation was uncertain or considered less likely in some cases.

Additionally, the stakeholder group's desire to select sites that would benefit from engineering design (i.e. some priority sites were primarily riparian buffer re-establishment sites needing relatively little evaluation and design) influence site selection as well.

As a result, the top five highest-scoring projects from the prioritization process aren't the ones that advanced to Concept Design, based on the input received from the stakeholder group.

4 Project Goals

The goal of this project was to evaluate the Caspian Lake watershed to identify sources of increased stormwater runoff and associated sediment and nutrients. Erosion and phosphorus mitigation 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, road erosion projects, and increasing natural shoreland vegetation to stem sediment and nutrient loading to the lake.

Stream and lakeshore projects can include stormwater treatment practices, erosion stabilization, floodplain restoration, and vegetation/habitat restoration, in particular establishment of high-quality native vegetation riparian buffers. 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 35 projects and to create 30% Concept Designs for five (5) projects. Key to this process was property owner buy-in for any sites prioritized and for which 30% Concept Design was pursued. The stakeholder group was essential in facilitating this process.

5 Data Library

In order to more fully understand the Caspian Lake watershed, a comprehensive review of existing data was conducted. Data included Road related data (MRGP Road Erosion Inventory data in particular), landuse patterns using the 2016 high-resolution landuse dataset developed by the University of Vermont's Spatial Analysis Lab (UVM SAL), Lake Wise assessments, topography and soils data, and water quality data, in particular data collected by the VT Lay Monitoring Program, as well as the results of several stream walks conducted by VT DEC. Local zoning regulations were also considered.

For in-depth information related to Data Library and Data Assessment process, here's a link to the online Data Library as a StoryMap for full details on that process.

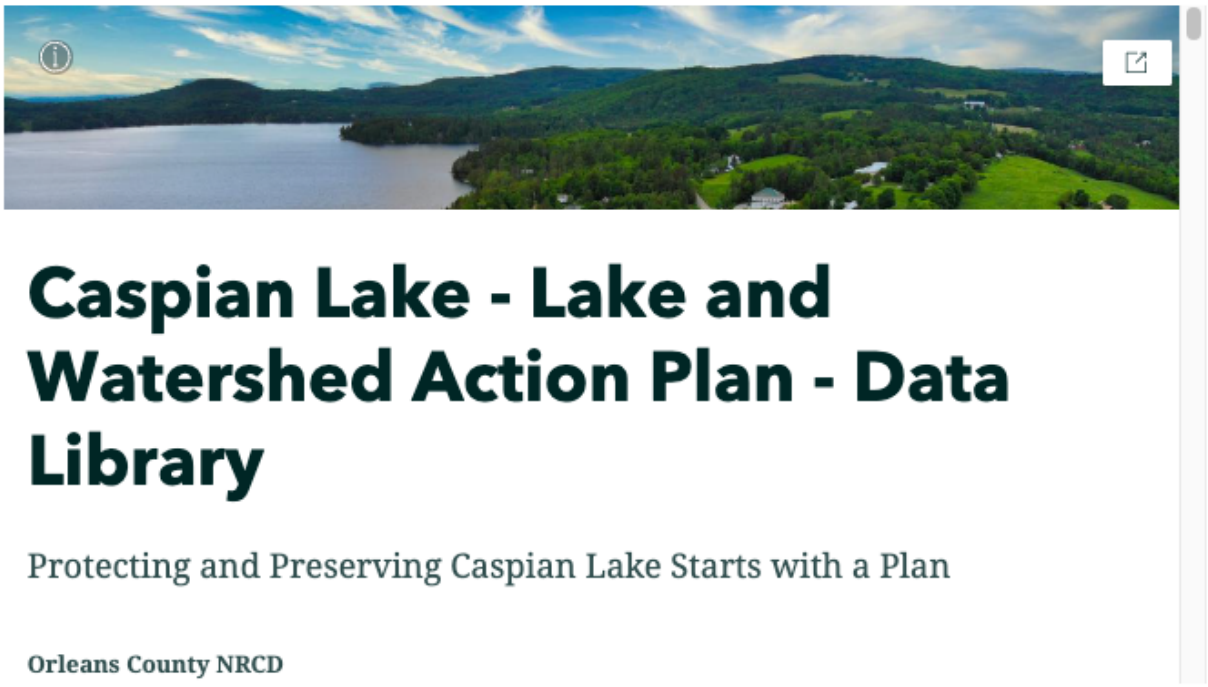

Figure 4: Caspian Lake - Lake and Watershed Action Plan - Data Library

6 Desktop Assessment

Following the creation of the Data Library and the assessment of existing data, a Desktop Assessment was conducted with the goal of identifying sites for Field Assessment. Four core areas were assessed - lakeshore, streams, wetlands, and roads (municipal). Generally, for lakeshore, streams, and wetlands, a combination of the most recent aerial imagery, landuse data, soils data, and slope information was used to inspect areas in proximity to the Lake and its tributaries for opportunities for improvement. For road sites, the Road Erosion Inventory (REI) conducted as part of the Municipal Roads General Permit process was used to identify and prioritize potential project sites.

For lakeshore, streams, and wetlands, a preliminary priority ranking was assigned to each point. These rankings were assigned based on the relative area by parcel not covered in forested land and how connected that area is to the nearest hydrologic features (the Lake, a tributary, or a wetland). For road sites, the Road Erosion Inventory (REI) conducted as part of the Municipal Roads General Permit process was used to identify and prioritize potential project sites. The REI divides roads into segments for assessment. Where possible, hydrologically connected segments were combined into a single project site for further assessment as any future road work will likely be conducted on multiple segments as part of one road work project.

During Desktop Assessment the following number of sites were identified for Field Assessment:

- Lakeshore: 87 sites
- Streams: 33 sites (18 SGA Lite reaches)
- Wetlands: 10 sites
- Roads: 11 sites (57 MRGP Segments - ~3.45 miles)

For a more detailed description of the Desktop Assessment process, here's a link to the online StoryMap for the Desktop Assessment, which further outlines specific methods and results.

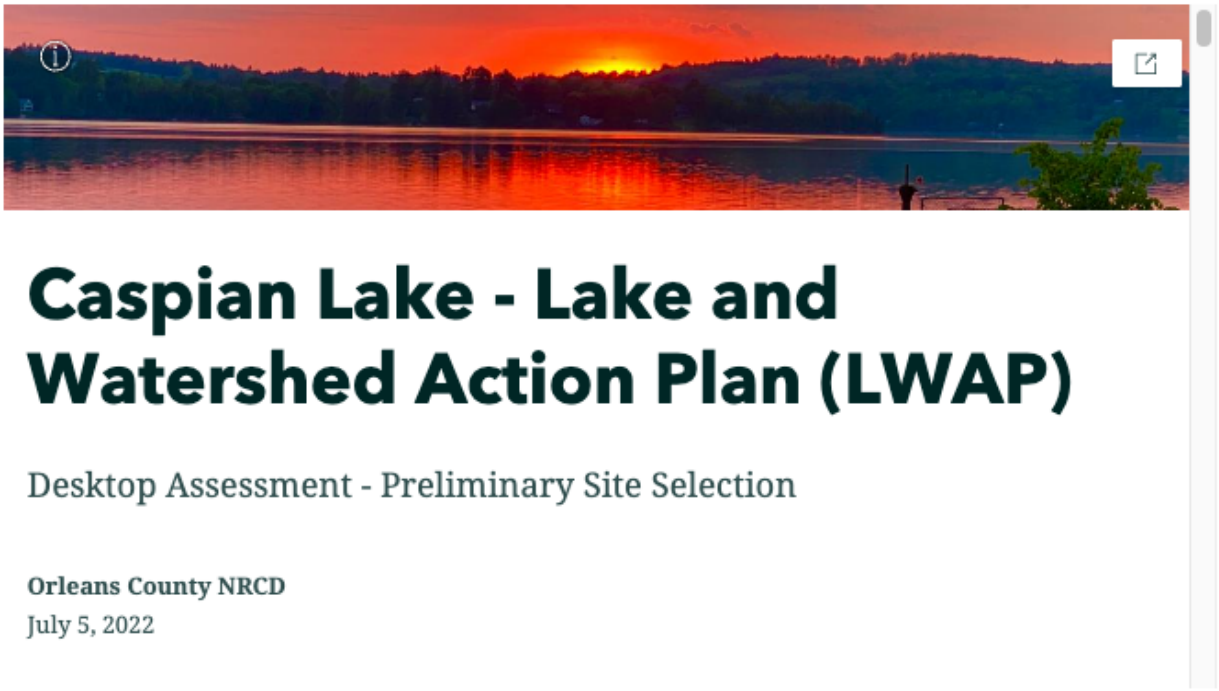

Figure 5: Caspian Lake - Lake and Watershed Action Plan (LWAP) - Desktop Assessment

7 Field Assessment and Prioritization Process

Following the Desktop Assessment process where sites were selected and preliminarily prioritized, the project team then conducted Field Assessments over the course of several days in the fall of 2022 and spring/summer of 2023. Thirty-three (33) Stream sites (along with 18 SGA Lite reaches), 11 Road sites, 10 Wetland sites and ~98 Lakeshore sites (all 88 Desktop Assessment ID'ed sites plus an additional 5-10 sites) were assessed.

From this group of assessments, a final total of 34 sites were selected for prioritization and ranking. One of the key criterion for inclusion in ranking, beyond field observed severity of the issue(s) present at the site, was landowner willingness. Representatives of the Stewards of Greensboro Watershed were highly proactive in reaching out to property owners identified during the Desktop Assessment process (based on ownership records from public parcel data) to gauge their potential willingness to have their property assessed and, if issues were found, to pursue remediation through implementation of Best Management Practices (BMPs).

Once assessed the project team reviewed prioritization criteria recommended by VT DEC as well as criteria used in stormwater master plans and other LWAPs. The results of this review were discussed with project stakeholders to gain their input on the selected criteria before ranking projects. See below for the criteria used.

LWAP Guidance	Unified Criteria for SWMP	Elmore LWAP - Non-Unified Criteria	Caspian Criteria
Sediment Loading	Sediment Reduction (lbs.)	Sediment Reduction	Sediment Reduction (lbs.) and/or Erosion Mitigation (volume)
Phosphorus Loading	P Reduction (lbs.)	P Reduction	P Reduction (lbs.)
Water Quality Benefits (sediment &nutrient reduction effectiveness)	Impervious managed (ac)	Drainage Area (size)	Drainage Area (size)
Costs, including BMP unit costs & adjustments	% WQv / CPv	Impervious Area (size)	Impervious managed (ac)
Landowner Support	% Rev met	Hydrologic Connection	Hydrologic Connection
Location (access)	Erosion Mitigation (volume)	Landowner Support	Landowner Support
Hydrological Connectivity	GI Opportunity	O&M Requirements	Cost
Enhances Natural Buffers	Landowner Support	Cost & Constructability	Efficiency ($ / lbs P removed)
Wildlife Benefits	Complexity (permit/project)	Additional Benefits (see codes)	O&M Requirements
Project Feasibility	Infrastructure conflicts		Geomorphic Benefits
Maintenance Requirements	Cost	**Additional Benefits**	**Additional Benefits**
Public Demonstration Site	Efficiency ($ / lbs P removed)	Chronic Problem	Chronic Problem
Protects Other Restoration Efforts	O&M / Access	Flooding	Flooding
Constructability	Educational / Recreational Benefits	Educational	Educational - Public Demonstration
	Habitat Creation	Infrastructure conflicts	Infrastructure conflicts
	Infrastructure improvement	Drains to connected stormwater infrastructure	Reduces thermal pollution
	Outfall erosion control	Improves existing BMP performance	Peak flow reduction
	Hydrologic connection	High visibility	Enhances/Creates natural habitat
	Flood mitigation	Reduces thermal pollution	Easy Access for Construction
	Local Concerns	Peak flow reduction	
		Enhances natural habitat	

Figure 6: Caspian Lake Prioritization Criteria (final criteria used at far right of image)

All Field Assessment and Prioritization Materials (Field Data Summary Sheets, SGA Lite Summary Sheets, as well as the Prioritization Table can be downloaded using this link. They are also included as an appendix to this report.

For a more detailed explanation of field methods and prioritization results, [use this link to the online StoryMap for details](#).

Figure 7: Caspian Lake - Field Assessment Story Map link.

8 30% Concept Designs

Following the Field Assessment and Prioritization processes of the Lake and Watershed Action Plan and with the input of the project's stakeholder group including members of the Stewards of Greensboro Watershed, Orleans County Natural Resources Conservation District, VT DEC, and representatives from the Town of Greensboro, five projects were chosen to advance to 30% Concept Design. 30% Concept Designs can be thought of as 'proof of concept' designs where features are approximately sized, sited, and modeled to ensure that they will work given site opportunities and constraints such as topography, soils, or ownership boundaries.

The five 30% Concept Design sites were chosen based on both a quantitative process where estimated phosphorus reductions were calculated, preliminary costs were developed, and a variety of other criteria were considered, resulting in a score (details of this process can be seen in the Field Assessments StoryMap linked above). The stakeholder group reviewed the scoring table and then selected the final five Concept Design sites based on the scores as well as landowner buy-in (i.e. likelihood that a given landowner for a project site would actually implement a project) as well as complexity of design (the stakeholder group wanted to choose sites that would benefit from engineering evaluation and design as some projects, while valuable, are relatively simple to implement like establishment of riparian buffers).

The sites chosen by the stakeholder group are:

- Wet005 & ST-3
- ST-7
- LS-25
- LS-32
- LS-29

For more information on the 30% Concept Design process and to see the 30% Concept Designs Developed, use this link to the online StoryMap for additional details.

Caspian Lake and Watershed Action Plan - 30% Concept Designs

Five concept designs to help improve water quality in the Lake

Figure 8: Caspian Lake and Watershed Action Plan - 30% Concept Designs

9 Next Steps and Possible Funding Sources

Next steps for the Caspian Lake LWAP are:

9.1 Five 30% Concept Design Sites:

- Wet005/ST-3: Seek funding for final design of this project site. As the most complex site plan in the LWAP that may require additional permits (Stream Alteration, Shoreland Protection, US Army Corps of Engineers), additional design may be required to ensure this project is implemented correctly. Interface with the Town of Greensboro regarding the road-related stormwater BMP.
- LS-25: Work with the owners to ensure that implementation of the recommended project at their site (creation of infiltration stairs, better drainage control of hillside seepage, stabilization and control of runoff associated with access paths to the residence, infiltration trenches) moves forward as planned in the spring of 2024.
- LS-32 & LS-29: Communicate with the owners of these two properties regarding the 30% Concept Designs on their properties. It is likely that some aspects of those designs can, with the help of a competent contractor, be implemented as designed if the property owner and contractor feel that there is sufficient detail (the project team would, however, assume no liability for these decisions or implementation resulting from use of these plans). If owners feel that there is adequate direction to proceed and are inclined to do so, they could then proceed on their own using their own funding. If they do not feel that they have adequate direction or would like to leverage outside funding to help accomplish the work, then funding and assistance for final design should be pursued. Funding can then be sought from a variety of public sources (see the Funding Options section for additional information).
- ST-7: Conduct outreach to owner of property and neighbors about stream's expected course and the benefits of creating floodplain access in segment 2 of the stream. It may be beneficial to explain that as the lower section of stream was relocated to its current position, it is still moving towards a condition of equilibrium. Currently it is incising (eroding the channel bed) and will continue to expand laterally as it tries to provide itself more space. The result may lead to damage to driveway and telephone pole on south side. Although these could be moved, or the stream bank hardened, it may be cheaper and more permanent solution to allow for floodplain access to relieve the erosive power in the channel. The field just to the east of the cemetery includes a lower area that could provide area for floodwater expansion. A future design could include estimation for extent of floodwaters moving towards houses. In addition, the

future design may want to consider additional areas upstream projects that enhance floodplain connection.

9.2 Additional Priority Sites:

- **LS-5:** Conduct outreach to the property owners of **LS-5**. This was the 30% Concept Design backup site as chosen by project stakeholders and represents a good opportunity to pursue 30% design for a high-value lakeshore site.
- **Wet001/Wet010/ST-32/ST-33:** The landowner at this site has expressed a willingness to work with project stakeholders on numerous occasions and this suite of projects has by far the largest potential phosphorus reduction benefit for the Lake. Seeking funding for 30% design would be the immediate next step.
- **LS-103, LS-101, LS-82, LS-35, LS-102, & LS-20:** Communicate with the owners of these properties about their willingness to pursue both riparian buffering and shoreline stabilization using bioengineering practices as all of these sites are experiencing some level of lakeshore erosion. As these are more complex design sites, obtaining buy-in prior to pursuing funding for 30% design is wise. Once obtained, pursue funding.
- **ST-31:** Continue working these property owners to ensure that a robust, native vegetation riparian buffer is implemented along the entirety of the stream reach at that property. 50' is the minimum for water quality but if owners are willing, up to 250' would provide additional protection and habitat benefits.
- **ST-2 & ST-6:** Communicate with the owner of this property about increasing the width of the riparian buffer to a full 50' minimum (or more depending on willingness - as stated above up to 250' has additional benefits). The owner of this property has repeatedly expressed willingness to participate.
- **LS-2, LS-42, LS-48, LS-6, LS-86, & LS-44:** Conduct outreach to these property owners as these properties represent large areas of 'lawn-to-lake' that could be easy to eliminate, even without a 30% design plan. These properties could be priorities for Lake Wise assessments.
- **RD-1, RD-11, RD-3 & RD-8:** Collaborate with **Town of Greensboro** officials to ensure that road work following the July 10, 2023 rain event is done to MRGP standards, in particular the area around site **RD-1**. The road segments associated with RD-1 could be routed via existing ditches to a stormwater BMP on the Wet005/ST-3 property. This collection of MRGP road segments is one of the largest and most connected within the watershed and represents a large potential reduction in phosphorus to the Lake if

done to MRGP standards. RD-11, RD-3, and RD-8 also represent relatively large road areas that are directly connected to the lake or its tributaries. The stakeholder group needs to connect directly with Town official regarding work performed on these road segments.

- **Town Beach:** The Caspian Lake Town Beach was not specifically evaluated during this LWAP process. However, stakeholders have expressed that they believe this site merits additional assessment and engineering design. As such, the project stakeholders should assess the funding sources below to determine which source might be most appropriate to fund design and potential implementation. Given that it is a non-regulatory (i.e. not permit associated) project that could potentially reduce phosphorus loading to the Lake, a VT DEC grant would likely be most appropriate, followed by funding from the Clean Water Service Provided program.

9.3 Funding Options

If property owners are interested in pursuing projects, funding through a variety of sources is available and the various programs can be seen below. Property owners should work with with Orleans County NRCD and/or the Stewards of the Greensboro Watershed to apply for funding.

9.3.1 VT DEC - Block Grants

VT DEC has a variety of block grants, the focus of which is primarily phosphorus removal. The primary contact for these program is Karen Bates, Watershed Coordinator for VT DEC. Her email is karen.bates@vermont.gov.

The most pertinent program to fund projects associated with the LWAP would be the **Design/Implementation Block Grant** which is intended to "Support design and implementation of clean water projects that reduce sediment and nutrient pollution, including phosphorus from runoff and soil erosion that discharge into Vermont's rivers, streams, lakes, ponds, and wetlands. ***This block grant is projected to sunset by 2024."***

It is currently administered by Watersheds United Vermont, Natural Resource Conservation Council, and the Mount Ascutney Regional Commission.

The **Project Development Block Grant** may also be appropriate. It is intended to "Help project implementers line up high priority clean water projects that Clean Water Service Providers and their associated Basin Water Quality Councils (BWQCs) can consider advancing through Water Quality Restoration Formula grant funding, or that can be pursued through the Water Quality Enhancement Grant Program or other water quality grants. Learn more about Project Development . ***This block grant is projected to sunset by 2024."***

Additional the **Water Quality Enhancement Development, Design, and Implementation Block Grant** may be of use but this is a grant program that prioritizes work outside the Lake Champlain Basin (Caspian Lake is within the Basin). This grant is intended to "To support the development, design, and implementation of priority water quality enhancement projects. View the Water Quality Enhancement Grants Summary document to learn more."

Finally of interest is the **Woody Riparian Buffer Planting Block Grant** which seeks to "To support projects that establish, and steward forested riparian buffers." This grant is administered by the Natural Resource Conservation Council and Watersheds United Vermont.

9.3.2 Clean Water Service Provider Funding

Vermont's Clean Water Service Delivery Act (also known as Act 76) . Act 76 provides funding to CWSPs for "boots on the ground" project delivery for non-regulatory clean water projects. These projects could include small scale stormwater management practices and natural resource restoration projects (floodplain reconnections, wetlands restoration, vegetated buffer planting). They are focused on accomplishing the goals of the Lake Champlain Total Maximum Daily Load (TMDL) policy which seeks to reduce phosphorus flowing to Lake Champlain. Any project within the Lake Champlain Basin that reduces phosphorus is eligible for this funding (provided it is not a project required by permitting).

The Northwest Regional Planning Commission is the CWSP for the Lamoille River Basin of which Caspian Lake is a part. The funding mechanisms provided through Act 76 and the Clean Water Fund as administered by the CWSPs are potentially very appropriate for the type of small-scale non-regulatory projects associated with this LWAP (notably any road-related MRGP projects would not necessarily be eligible for this program as those are regulatory in nature). NRPC has put together a comprehensive Clean Water Service Provider page that outlines the general process of applying for these funds.

9.3.3 VT Fish and Wildlife Watershed Grant Program

Since its creation in 1998, the Vermont Watershed Grant Program has supported the protection, restoration, enhancement, and public appreciation of Vermont's lakes, ponds, rivers, and streams.

The grant program also supports efforts to improve surface water quality in keeping with stated habitat improvement objectives. The program provides grants to towns, nonprofit organizations and community groups with specific watershed projects.

The program funds projects aimed at a variety of terrestrial and aquatic habitat protection and restoration, as well as water quality focused projects. Any of the projects within the LWAP,

with the possible exception of MRGP road-related projects, would be eligible for this funding source as the goal is habitat creation and not specifically phosphorus reduction as with VT DEC grants.

9.3.4 LCBP Grants

The Lake Champlain Basin Program administers a variety of grant programs in Vermont and the greater Lake Champlain Basin (LCBP funded this LWAP). Their Grants and Requests for Proposals page outlines these programs.

LCBP's **Clean Water and Healthy Ecosystems Planning and Implementation Projects** grant would be an appropriate funding source for both design and implementation projects associated with this LWAP.

Stream Wise is also a program that could be used to conduct additional outreach and education around stream riparian buffering in the Caspian watershed. Stream Wise does not have funding to implement projects but is rather focused on highlighting properties with good riparian buffers and helping landowners find ways to improve their buffers.

Finally, the **Education and Outreach** grant could be appropriate for spreading the word regarding the results of the LWAP, as well as conducting outreach to engage property owners for additional design and implementation projects.

10 Overall Recommendations

The following are general recommendations to both preserve and promote water quality and overall ecological health of Caspian Lake focusing on preserving natural resources and their associated functions and that also encourage the use of Low Impact Development (LID) and Green Stormwater Infrastructure (GSI) where possible.

10.1 Programmatic Actions

Figure 9: The above image is from a presentation given to Caspian stakeholders during a public meeting in August, 2023.

Programmatic Actions are those that organizations within the Caspian watershed can undertake.

10.2 Lake Wise & Stream Wise

Increasing the use of social marketing using the Lake Wise and Stream Wise programs is one way to encourage residents to adopt better buffers via the Awards, as well as the marketing and outreach materials developed by each of those programs. It's also a proven way for neighbors to encourage other neighbors.

10.3 Storm Smart

Storm Smart is another program specifically targeting residential stormwater (runoff from developed lands like driveways, rooftops, and parking areas, among other things). A Storm Smart assessment can help properties not immediately adjacent to the Lake or a stream tributary reduce runoff leaving the property - runoff that may ultimately have an impact on the Lake or its tributaries via town ditches or other conveyances. The Friends of the Winooski River is one administrator of this program.

10.4 Water Quality Related Zoning Bylaws

The Town of Greensboro has a lakeshore protection bylaw written into town zoning. The Town and the Planning Commission could consider expanding this zone to include mapped tributaries to the Lake to further protect water quality and habitat as the vegetated buffer on streams is equally important as that on the Lake. Additionally, VT DEC has created model River Corridor Protection Bylaws that may be of interest and serve the Town well in drafting and creating a zoning regulation to protect tributaries in the watershed.

Another bylaw that the Town could consider adopting is the VT League of Cities and Towns Model Stormwater Bylaw which would help regulate stormwater runoff from all development within the watershed. This would help in reducing runoff from properties to Town infrastructure, like ditches, and could reduce runoff to the Lake and its tributaries.

10.5 Septic Systems

During the public meeting held in August of 2023, the public expressed numerous concerns about septic systems within the watershed and their possible impact on water quality in the Lake. The Lake Wise program has a structure for Wastewater Workshops, formerly called Septic Socials, where residents can attend to learn about and discuss onsite wastewater treatment systems, their issues and potential problems, and can learn about how to maintain them for optimal function. While it was beyond the scope of this project to investigate the potential impact to water quality from septic systems within the watershed, efforts should be made to conduct outreach to homeowners within the watershed to assess the health of individual systems.

10.6 Municipal Road Work

The Town of Greensboro, like all municipalities in Vermont, is undertaking a comprehensive update of road infrastructure related to water quality under the Municipal Roads General Permit or MRGP. This permit will help roads reduce their runoff to streams, wetlands, lakes, and ponds.

Greensboro, following the flooding of July 2023 and the washouts that occurred then, is actively working to bring roads up to MRGP standards which should have a positive impact on Lake health overall. Residents can support this work by ensuring that the Town's road crew is adequately funded and supported for these tasks.

10.7 Lake Level

During the public meeting held in August 2023, several residents expressed interest and concern regarding the level of the Lake. The outlet of the Lake has a dam that is owned and controlled by Hardwick Electric. As such, the level of the lake is controlled by that entity and is responsive to their needs.

VT DEC's Basin Planner for the Winooski Basin, Karen Bates, corresponded with the project team. VT DEC acknowledges that *"the lake surface level management practices and resulting ice scour is potentially a second source of erosion."*

She further elaborated that *"Regarding solutions, DEC's Dam Safety Program has suggested that Hardwick Electric conduct a hydraulic and hydrologic study as a next step. Ultimately the electric company is responsible for the dam and water levels and DEC has no authority to direct Hardwick to manage flows to maintain a specific surface water level. I (ed. Karen Bates) understand that Hardwick Electric may be concerned about the expense."*

Further she notes *"Another idea could be to tour the lakeshore after ice scouring has taken place to understand extent of damage and the types of shoreline prone to damage. Danielle Owczarski, the previous watershed planner had provided that suggestion to me."*

Regarding other issues associated with lake level, Karen Bates and Alison Marchione, Lake Wise Coordinator, explained *"Many Vermont lakes have a dam on the outlet which has raised the water level of a natural lake between 3 and 10 feet. In some cases, the water level may be drawn down, for varying reasons, in the fall and possibly through the winter. This creates an area of littoral zone exposed to freezing and results in change to the habitat and biota in that area. The consequences of unnatural water level fluctuations in lakes and reservoirs on the ecosystem can be significant. Most immediate is the exposure and stress or death of animals that lack the mobility to move down with the water: mussels, macroinvertebrates, small fish and fish eggs. Any species that have already hibernated may be unable to move. Aquatic plant communities in the dewatered zone can also be degraded, as can wetlands associated with the lake. When native plant communities are killed by drawdowns, often the first species to recolonize those areas are invasive ones. The end result can be a zone bordering the lake that lacks healthy littoral (shallow water), riparian and wetland communities."*

For these reasons, a recommended next step is to reach out to Hardwick Electric and encourage them to conduct a hydrologic and hydraulic study to gauge the impact of lake level draw down. Ben Green of Vermont's Dam Safety Program (Benjamin.Green@vermont.gov) is the preferred point of contact for further questions regarding the dam and the State's role with respect to it, though it should be noted that the dam is privately owned and not controlled by the State, other than via standard dam safety regulations.

In the meantime, adopting robust vegetated buffers along the lakeshore will ensure that even with lake level fluctuations, and the associated difference in level of wave action and ice scour, that the shoreline will be more resilient to these impacts and less likely to erode.

10.8 Greensboro Land Trust - Land Conservation

Though not specifically aimed at improving water quality, land conservation can be a good strategy for residents of a watershed to adopt to protect water resources, as well as protect and improve habitat. The Greensboro Land Trust produced a Phase 1 Natural Resource Inventory that outlines many of the natural resources in Greensboro. The inventory should be used to guide conservation decisions.

10.9 Individual Actions

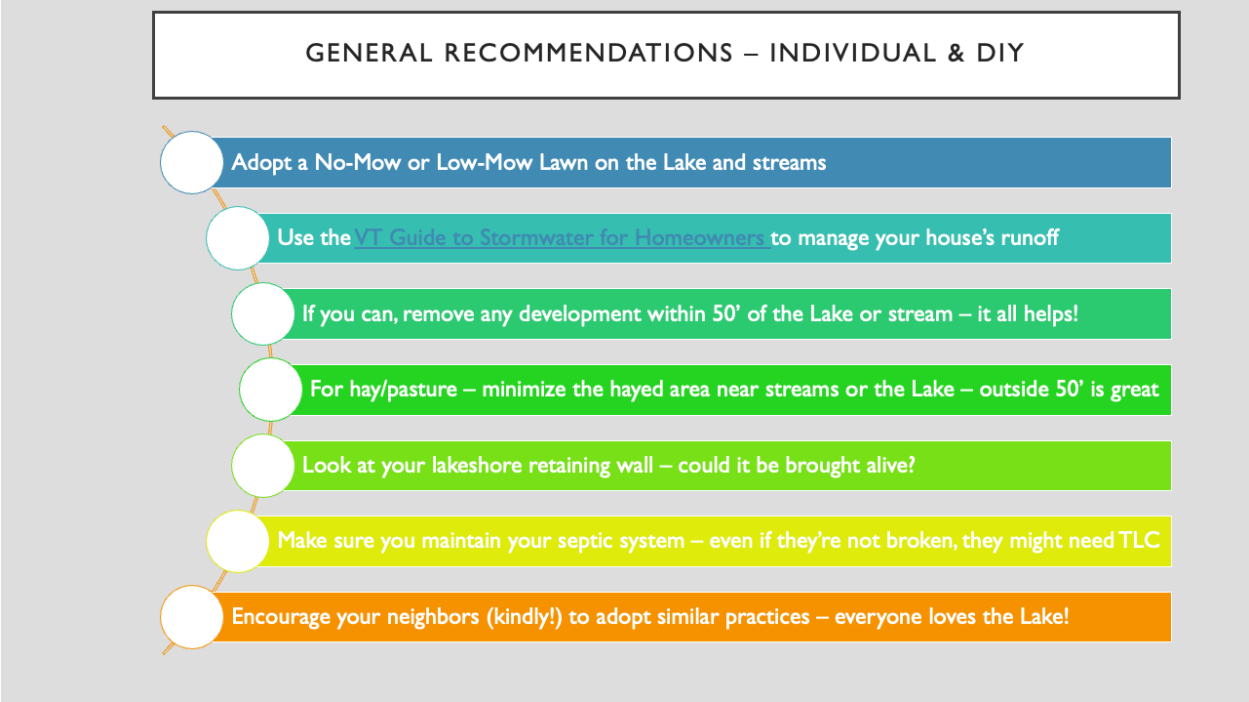

Figure 10: The above image is from a presentation given to Caspian stakeholders during a public meeting in August, 2023.

Individual Actions are those homeowners and small businesses can undertake relatively easily on their own and don't require large inputs of time or money.

10.9.1 No- or Low-Mow

Adopting a No-Mow or Low-Mow practice on lawns adjacent to streams, wetlands, and the Lake will have a positive impact on water quality. Taller vegetation has deeper roots, typically. These roots hold soils better (better for mitigating stream erosion) and allow more water to infiltrate into the ground via the roots (especially important in the Caspian watershed where soils are very clayey and don't allow for much infiltration naturally). The Lake Wise program has guidance on establishing a No-Mow zone but it can be as easy just not mowing within 50 (or more) feet of the stream or Lake.

10.9.2 Stormwater Management

VT DEC has put together a great resource specifically aimed at homeowners and small businesses to help them evaluate and manage runoff from developed surfaces like driveways, patios, rooftops, and parking areas. The Vermont Guide to Stormwater for Homeowners and Small Businesses is user friendly and robust. Managing runoff near lakes and streams can be really important in reducing runoff that transports pollutants to these bodies. Managing runoff on properties not directly adjacent to streams or lakes can also be important in that many times this runoff is transported to ditches (or catch basins and pipes) where it then can be transported to local water bodies. Reducing this can be helpful to water quality and also protect local infrastructure from getting overwhelmed during large rain events.

One relatively easy way to help water quality is to remove development within 50' of streams, wetlands, and lakes (and make sure that there are no ditches or pipes taking runoff to those water bodies). 50' is usually considered a good minimum width to help protect water quality.

This 50' minimum width goes for hay/pasture land. Much of the acreage within the Caspian watershed near the Lake and its tributaries is hay or pasture. While this landuse doesn't generate as much runoff as truly developed like land driveways and houses, it does have an impact. Returning land to its natural native community, like diverse native forest, is generally best in the 50' near water.

10.9.3 Lakeshore (or other) Retaining Walls

Many properties along the Lake (and potentially some on streams as well) have retaining walls made of stone or concrete to help reduce erosion from waves or ice action. While this can be a good solution for that issue temporarily, ultimately these structures may fail. There are many

'living' alternatives that mix engineered structures or means with vegetation in a process called bioengineering. This type of engineering integrates the power of living vegetation roots, which hold soils very well and will strengthen over time, with retaining walls that allow for this vegetation to establish. The Vermont Bioengineering Manual outlines many of these practices. While some of the practices detailed in the manual may require the assistance of a skilled practitioner, some may be installed by a homeowner. Adopting 'living' retaining walls is an excellent way to promote water quality in the Lake.

10.9.4 Septic System Maintenance

Septic systems can be a source of water quality stress to the Lake and its tributaries, even if it's not apparent that anything is wrong. Septic leachate can contain a lot of nutrients, including phosphorus, as well as other pollutants. Even if a system isn't technically 'failed' (meaning that untreated septage is evident on the ground's surface), the system may not be fully treating leachate, allowing it to flow to surface water bodies in shallow groundwater. Flows such as these can be hard to detect. The best course of action is to ensure property owners are maintaining their systems regularly as recommended by their septic system designer or hire a licensed system designer to help them better understand their system in order to ensure that they are conducting the proper maintenance on it.

11 Climate Change Implications

Research has shown that climate is changing in Vermont and within the Lake Champlain Basin. Temperature and precipitation have increased and models predict this will continue. Average temperature in Vermont has increased by 2.7 degrees F since 1941 and are further expected to rise by 3-6 degrees F by mid-21st century. Lake water temperatures in the Basin are increasing and winter ice coverage days are declining. Precipitation events are predicted to become more intense (more precipitation in shorter time periods). These events are predicted to deliver increasing amounts of nutrients, such as phosphorus, sediments, and potential pathogens to streams, lakes, and wetlands. Nutrient transport coupled with increasing water temperatures are expected to lead to an increase in activity by primary producers in the water column, one of which is toxic cyanobacteria, also known as blue-green algae.

While there is potentially little that the Caspian LWAP can do to mitigate these larger system changes, increasing resiliency within the Lake is possible. In order to guard against the increased potential for blue-green algae blooms, it will be critical to increase the absorption rate of soils and vegetation within the watershed in order to soak up the expected increase in precipitation. This precipitation is expected to increase in volume but also in intensity - that is, the rate at which it falls and therefore potentially causes erosion, which has the potential to transport nutrients, in particular phosphorus, at an increased rate.

Increasing streambank and lakeshore vegetation will help reduce erosion at these specific locations, but attention also needs to be paid to erosion anywhere that is directly hydrologically connected, i.e. where water can flow directly to a stream, lake, or wetland. These include ditches (public or private), driveways, lawns, patios - really any development that is outside of the natural native vegetative community. Any opportunity to return developed land, even if it is pasture or hay land, to native forest will increase absorption of water to soils and vegetation and decrease runoff that can cause erosion. Additionally, any opportunity to slow, spread, or sink water into the ground from developed surfaces, such us by using green stormwater infrastructure practices like rain gardens, infiltration swales, dry wells, or other depressions in the ground that can temporarily pond water and allow it to enter the soil column should be encouraged.

Increasing the ability of the various watersheds around the Lake to absorb precipitation will help certain streams in the watershed to stabilize their channels in the face of increased precipitation amount and intensity, notably some of the smaller tributaries. Bachelor Brook, which is one of the smallest streams feeding the Lake, experienced some channel erosion during the summer of 2023 when flooding occurred during July. As a small stream, it's very 'flashy' meaning water levels can rise quickly and intensely. It also appears to have been channelized at some point

in the past to its current location which means that the channel is still adjusting to its new location. For these reasons Bachelor Brook should be considered a priority for remediation and protection.

Shading can also help with mitigating increased global temperatures - another reason to encourage the profusion of forest land within the Caspian watershed. Trees along the Lake shore and its associated stream tributary banks and adjacent to wetlands is very important. It has also been demonstrated that trees in general provide ambient cooling regionally - so returning as much developed land to forest will have some localized impact on temperatures as well. This will in turn reduce the temperature of any runoff that does enter the aquatic ecosystems and help keep the Lake temperature lower - thereby mitigating the potential for algae blooms.

12 Conclusions

If the priority projects that have been identified as a result of this Lake and Watershed Action Plan are pursued and implemented as envisioned, there is the potential to eliminate over 148 pounds of phosphorus from entering Caspian Lake which would in turn prevent the growth of up to 37 tons of algae – each year. This is not an insignificant amount of potential improvement at an initially estimated cost of approximately $417,000 (just over $2,800 / pound of phosphorus removed) for all 34 prioritized projects.

In addition to eliminating phosphorus from entering the Lake, there are co-benefits to this work such as the creation of over 25 acres of riparian buffer habitat for plant and animal species, 780 linear feet of lake shoreline restored to more natural, natively vegetated conditions, and 1.65 miles of public roads brought up to MRGP standards to protect against sediment erosion into local water ways.

These 34 prioritized projects are certainly not the only water quality related projects to pursue within the Caspian watershed as, in addition to these 34, there are well over 100 sites which were remotely assessed and preliminarily prioritized for their potential to improve the health of the Lake and its tributaries. The recommendations of this action plan contain clear next steps for local stakeholder groups to pursue. The results of the desktop and field assessment process clearly outline priorities to pursue for additional investigation, design, and implementation opportunities. One of the most important things for local stakeholder groups to pursue in implementing this plan is to conduct outreach, both generally to the public within the watershed and to the property owners identified with priority sites, to ensure that there will be a level of cooperation when the time comes to pursue additional work. While this action plan clearly identifies quantifiable improvements, it will be necessary to do the outreach to ensure that this work can occur. Without that work, the potential for improvement will be much reduced.

13 Appendix – Field Assessments and Prioritization Tables