Memphremagog Watershed Association

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MEMORANDUM

To: Orleans County Natural Resources Conservation District & Westmore Lake Association

From: Memphremagog Watershed Association

Re: Willoughby Lake Watershed Action Plan Data Library

Date: August 23, 2022

According to Technical Guidelines developed by Vermont Department of Environmental Conservation (VTDEC), an LWAP is "an assessment to identify the greatest threats to the lake ecosystem, including impacts on water quality and wildlife habitat from stormwater runoff and from altered, cleared, or converted shorelands…designed to answer specific concerns about each lake". The creation of a localized information clearinghouse in the form of a data library is the initial step in the development of the Willoughby Lake Watershed Action Plan (LWAP). As such, MWA initiated the LWAP process by gathering and reviewing available data, reports, and documentation related to water quality monitoring, stream geomorphic conditions, land use/land cover, lake shorelands, stormwater runoff, road networks, and watershed management in the Lake Willoughby watershed. This memo serves as a summary of the available data and information identified and explored through this process. Information was sourced from publicly available reports, town archives, databases, and previously completed studies. These findings were summarized in a presentation to the Town of Westmore and Westmore Association members at a steering committee meeting on July 27, 2022.

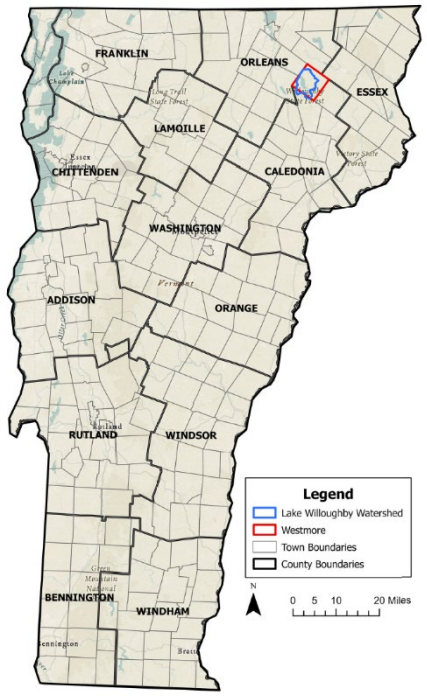

Figure 1. Overview map of the Lake Willoughby watershed in relation to Vermont towns and counties.

WATERSHED STUDY AREA DESCRIPTION

Lake Willoughby is a 1,687-acre glacial lake located in the Town of Westmore, Orleans County, VT (Figure 1). The lake reaches a depth of 320 feet and is the deepest lake entirely within Vermont. The contributing drainage area under this study is approximately 17.8 miles^2 (11,387 acres) located predominately in the Town of Westmore, with small portions of the headwaters in Sutton, VT. According

to the 2020 census, the Town of Westmore has 357 residents, however, many seasonal residents and visitors result in large increases in summer populations around the unincorporated village area (US Census Bureau, 2021). Lake Willoughby drains into the Willoughby River, which flows 11.6 miles to its confluence with the Barton River in Orleans Village. From there, the Barton River flows approximately 15 miles to its terminus in South Bay, Lake Memphremagog.

Within the lake's contributing drainage area is 37.6 linear miles of roads, based on the VT Agency of Transportation's (AOT) Road Centerline dataset (Figure 2). Of these, the majority are Town roads (57%, 21.48 miles), followed by Private roads (24%, 8.9 miles), State Highways (16%, 6.16 miles) and forest roads (3%, 1.07 miles).

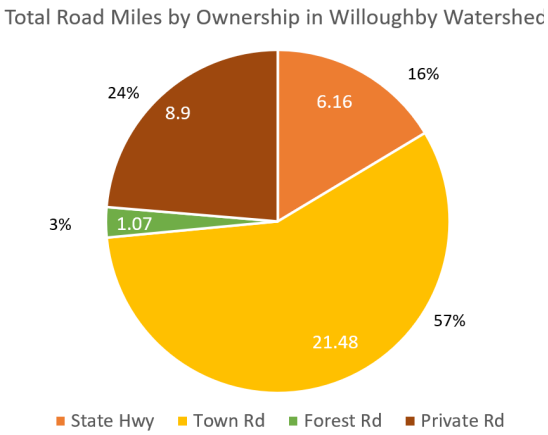

Figure 2. Breakdown of road length by ownership in the Lake Willoughby watershed.

Analyses performed by VTDEC and reported in the Lake Land Cover Maps indicate more than 80% of the watershed is forested (VTDEC, 2022a). Other dominant land cover types include hay (6%), grass/shrubs (6%), and wetlands (5%). While impervious surfaces such as buildings, roads, paved areas, and bare soil collectively amount to less than 2% of the total land cover in the watershed, these land cover types are most concentrated along the periphery of the lake. Residential and commercial development are densest along Route 5A, Old Cottage Lane, Hinton Hill Road, and Peene Hill Road.

Land Cover	Acres	% of Watershed Area
Forest	9,171.7	80.5%
Agriculture (Hay)	685.5	6.0%
Grass/Shrubs	682.1	6.0%
Bare Soil	27	0.2%
Open Water (not Lake)	129.2	1.1%
Buildings	19	0.2%
Roads	54.7	0.5%
Other Paved	48.9	0.4%
Railroads	0	0.0%
Wetlands	568.3	5.0%
Lake Willoughby	1,687	N/A

Figure 3. Land cover in the Lake Willoughby watershed based on the 11,387-acre contributing upland drainage area (VT DEC Lake Land Cover Maps).

AVAILABLE DATA

Water Quality Monitoring

Long-term water quality monitoring in Lake Willoughby indicates a highly significant increasing trend in springtime total phosphorus concentrations since data collection began in 1979, as depicted in the Lake Score Card (VTDEC 2022a, 2022b). Fortunately, there are no significant increases in summer total phosphorus or chlorophyll-α, and similarly, no significant decrease in secchi disk readings (water clarity).

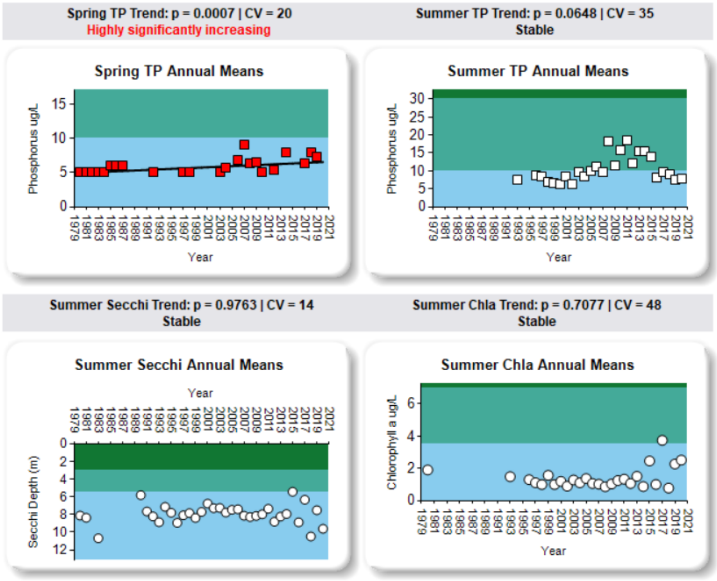

Figure 4. Lake Score Card for Willoughby Lake.

In 2021, the Westmore Lake Association performed routine water quality monitoring of select tributaries of the lake through the LaRosa volunteer monitoring program (VTDEC, 2022c). Monitoring focused on evaluating concentrations of chloride and total phosphorus (TP) in relation to qualitative flow conditions (e.g., high, moderate, low). Of the 6 tributaries sampled, all regularly demonstrated TP concentrations greater than the 14 µg/L typical of oligotrophic lakes in Vermont. During high flows, all tributaries except for the South Beach tributary had phosphorus concentrations exceeding 50 µg/L. At least once throughout the monitoring period, Mill Brook, Stoney Brook, Roaring Brook, and Church Brook exceeded 100 µg/L, with the latter three tributaries exceeding 200 µg/L. Chloride monitoring demonstrated tributary levels are well below the Vermont water quality standards for both chronic (230 mg/L) and acute (860 mg/L) exposure. These data shall be used to determine priority waterways for field assessment and project identification efforts.

Streams & Stream Crossings

Unstable stream channels, eroding streambanks, and incompatible crossing structures can act as significant sources of sediment, phosphorus, and fluvial erosion hazards. There are 43.3 miles of mapped perennial streams within the Lake Willoughby watershed; of these, 36.5 stream miles have undergone Phase 1 Stream Geomorphic Assessments. Phase 2 SGAs have not been performed anywhere within the watershed boundary (VTDEC, 2022d). In addition to mapped perennial streams, numerous intermittent streams drain higher elevation basins, sub-watersheds less than 0.5 miles^2, and direct drainages to the lake. Unmapped intermittent streams delineated by VTDEC staff using digital elevation models were reviewed to identify areas of interest (AOIs) for clean water project identification. Hydrography data, coupled with tributary water quality monitoring data, informed stream reach selection and assessment prioritization.

Between 2006 and 2016, 200 assessments were conducted for culvert crossings within the Lake Willoughby watershed. Assessment results and culvert location data are available through VT Culverts (VAPDA, 2022). One bridge assessment was completed for the North Beach Road crossing, but due to its location at the outlet of the lake, was not included in this review.

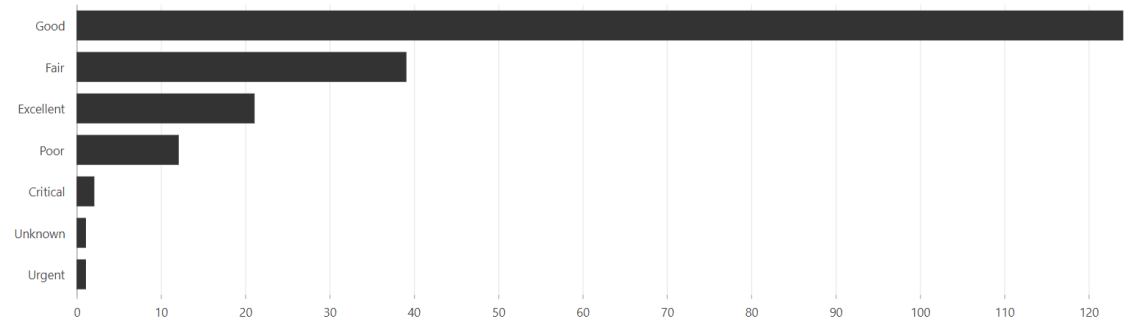

Figure 5. Summary of culvert conditions in the Lake Willoughby Watershed.

Of the 200 inventoried crossings, 31 were evaluated for geomorphic compatibility and aquatic organism passage between 2016 and 2019. Of these, only 1 structure was found to be fully geomorphically compatible, while 7 were mostly compatible, 14 were partially compatible, 8 were mostly incompatible, and 1 was fully incompatible.

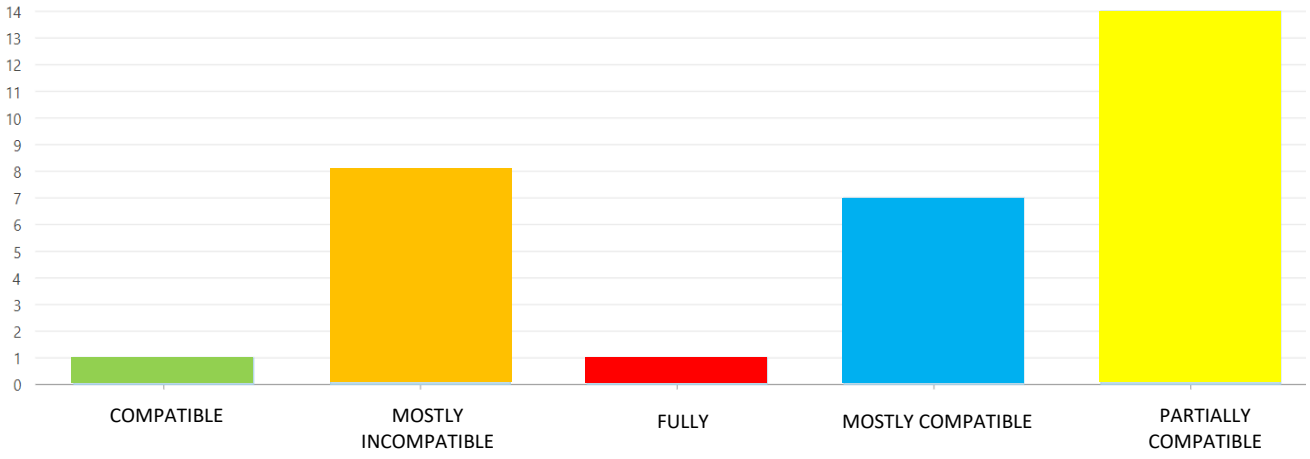

Figure 6. Geomorphic compatibility of 31 stream crossings in the Lake Willoughby watershed.

The same 31 stream crossings were evaluated for aquatic organism passage (AOP). AOP assessments identified only 1 crossing with full AOP, 12 crossings with reduced AOP, and 16 crossings with no AOP for all aquatic organisms including adult salmonids. The remaining 2 crossings of the 31 evaluated did not have enough data to determine AOP compatibility.

Hydrologically Connected Road Segment Data

Roadways can act as efficient conveyors of stormwater runoff and associated pollutants when hydrologically connected to waterways. VTDEC maintains a statewide database of hydrologically connected road segments to support watershed and transportation stormwater planning. From this database, MWA extracted road segments located within the Lake Willoughby watershed. Of the 312 road segments within the watershed, 141 are listed as hydrologically connected, while 171 are not. These data differ slightly from those provided in the *Town of Westmore Road Erosion Inventory 2020 Final Report* (OCNRCD, 2020). According to this report, "Westmore has 206 hydrologically connected segments, 12.8 hydrologically connected road miles which equals 48% of the town roads. During field inventory 15 segments were added to the hydrologically connected list and 9 were removed. These results include class 4 roads but while completing the inventory it was noted that some of the class 4 roads are not in fact class 4 roads but trails. It is recommended that the town consider reclassifying some of these class 4 roads.

These road segments were screened for proximity to mapped surface waters and river corridors, and evaluated based on road slope, adjacent hill slope, and soil erodibility to produce a preliminary road erosion risk ranking (Low, Moderate, High). Preliminary road erosion risk rankings identified 6 'High Risk' road segments, 28 'Moderate Risk' road segments, and 188 'Low Risk' road segments. Ranking was not performed on 90 road segments and were reported as 'No Measured Risk'. The majority of the high and moderate risk segments are located on Long Pond Road, Perkins Lane, Lakeview Road, and at the intersection of Peene Hill Rd and North Beach Road. These data will be used to identify target road segments for follow-up assessments, project identification, and development efforts.

Major take-aways from the 2020 Final Report indicate a need for additional town roads funding, upgrading driveway culverts to address stormwater runoff, and training roads crew members on MRGP best management practices. Lastly, recommendations emphasized the need for bringing 8 segments into MRGP compliance each year to meet permit requirements, and that a tracking tool should be employed by the Town for recordkeeping to permit requirements are met and progress is documented.

There are no data available for hydrologically connected road segments for privately owned roads. These data will be developed during the prioritization of core assessment areas, covered further in a separate memo.

Road Erosion Inventory Data

A Road Erosion Inventory (REI) is conducted by municipalities for all road segments as they work to fulfill the requirements of the Municipal General Roads Permit (MRGP). REI's are performed to establish baseline conditions and evaluate progress of implementation efforts related to transportation stormwater management. REI data are used to evaluate road segment conditions and classify them

according to whether or not they meet MRGP requirements. There are 302 road segments within the Lake Willoughby watershed which have been evaluated through the REI process. Of these, 156 are classed as hydrologically 'Not Connected'; 10 segments are classed as 'Incomplete Data'; 64 segments meet standards, 36 segments partially meet standards, and another 36 segments do not meet standards. Road segments that do not meet MRGP requirements are widely dispersed and tend to be located on steeper roads in the headwaters of the watershed. For instance, strings of several non-compliant road segments can be found on upper Lakeview Road, Perkins Lane/Hinton Hill Road, and Long Pond Road. These data will be used alongside hydrologically connected road segment data to identify target road segments for follow-up assessments, project identification, and development efforts. Priority road segments are listed in the following table and were sourced from the 2020 Final Report (OCNRCD, 2020).

Westmore Very High Priority Segments >10% Slope		
SegmentID	**RoadName**	**Slope**
8690	BIG VALLEY LN	11
8688	BIG VALLEY LN	10
143137	OLD COTTAGE LN	10
48664.1	PEENE HILL RD	14
48640.1	PEENE HILL RD	14
126469	LONG POND RD	11
28684.1	HINTON HILL RD	10
28685.1	HINTON HILL RD	11
28686.1	HINTON HILL RD	11
28687.1	HINTON HILL RD	11
24848	COLES RD	8
24847	COLES RD	14
140372	NEWARK RD	11
140371	NEWARK RD	10

Figure 7. Very high priority road segments with slopes >10% from the Westmore REI Final Report.

Potentially Erosive Features Data

High-resolution LiDAR data was used by the UVM Spatial Analysis Lab and Watershed Consulting Associates to identify potentially erosive features on forested landscapes in the Champlain and Memphremagog basins (UVMSAL & Watershed Consulting Assoc., 2021). Potentially erosive features were remotely sensed using DEM raster data while considering distance to mapped streams, soils, contributing drainage areas, gully morphology, stream power index, and other physical characteristics. MWA extracted potentially erosive features located within the Lake Willoughby watershed, amounting to 1,980 individual features. Many of these are natural erosion features such as the steep gullies on the western face of Mt. Pisgah and the eastern face of Mt. Hor. However, other potential erosive features appear to stem from roadside ditches, incised stream channels, forest road gullies, and other non-natural sources. Many of these potentially erosive features align with intermittent streams (<0.5 mi^2 drainage areas) and may be acting as erosion gullies. These data will be used to identify areas of interest (AOIs) for follow-up assessments, project identification, and development efforts.

Stormwater & Wastewater Infrastructure

MWA did not identify any existing stormwater or wastewater infrastructure within the Lake Willoughby watershed based on available data from the State. It is assumed these data have either 1) not been collected and incorporated into the statewide stormwater infrastructure dataset, or 2) the residences and businesses within the Lake Willoughby watershed are all on septic systems with no centralized storm or wastewater treatment facilities. Discussions with community members identified at least 1

known stormwater line on Hinton Hill Rd. This storm drain will be evaluated as part of the field assessment components of the LWAP.

Significant Natural Communities | Rare, Threatened, & Uncommon Species

MWA communicated with the Vermont Natural Heritage Coordinator at ANR to fulfill a Data Usage Agreement and discuss significant natural communities and known rare, threatened, or uncommon species in the Willoughby watershed. The Vermont Atlas BioFinder allows a user to view all mapped significant natural communities that occur within the watershed, as well as identify coarse areas of rare, threatened, or uncommon species.

There are 10 significant natural communities in the Willoughby watershed. These include the following:

1. Northern White Cedar Swamp
2. Dwarf Shrub Bog
3. Montane Spruce-Fir Forest
4. Red Spruce-Northern Hardwood Forest
5. Open Talus
6. Boreal Acidic Cliff
7. Northern Hardwood Forest
8. Boreal Calcareous Cliff
9. Lowland Spruce-Fir Forest
10. Montane Yellow Birch-Red Spruce Forest

Natural communities are used to better understand and prioritize conservation initiatives at local, state, and regional levels. The Willoughby LWAP may utilize significant natural community data to provide context for potential natural resource project development and prioritization.

Due to privacy and conservation policy requirements, locations and names of rare, threatened, or uncommon plants and animals cannot be shared publicly through this document or planning process (E. Marshall, *personal communication*). However, MWA and OCNRCD shall use this information in manners that are permitted by the data use agreement to better inform project identification, prioritization, and development. These data are useful in designing and implementing water quality and habitat restoration projects that give consideration to vulnerable species and may also provide co-benefits and funding incentives if habitat restoration benefits the species of concern.

WATERSHED PLANNING

Tactical Basin Plan

The 2017 Basin 17 Lake Memphremagog, Tomifobia, and Coaticook Tactical Basin Plan (TBP) summarizes existing conditions for surface waters throughout the Memphremagog watershed and nearby basins (VTDEC, 2017b). The TBP provides an assessment of the health of the basin through the lens of the phosphorus Total Maximum Daily Load (TMDL) for Lake Memphremagog, and "defines ongoing and future strategies to address high-priority surface water stressors". In this plan, Lake Willoughby is identified as a high-quality surface water in the top 10% of Vermont's healthiest lakes. However, Willoughby is subject to several stressors that threaten its status as an oligotrophic waterbody. The Lake Score Card for Willoughby, summarized in Table 2 of the TBP and Figure 4 above, identifies nutrient trends and aquatic invasive species as the primary water quality concerns. In addition, mercury (Hg) and shoreland development are listed as secondary stressors to Willoughby.

The TBP provides several strategies to address water quality stressors in Lake Willoughby. In the regulatory realm, reclassification of the Lake Willoughby Tributary as B(1) high-quality or A(1) excellent surface water would protect the watershed by prohibiting direct discharge of untreated wastes, development of new septic systems >1,000 gallons per day, and solid waste management facilities or application of biosolids or septage. Going one step further, the TBP expressed a willingness on behalf of VTDEC to explore Outstanding Resource Waters (ORW) designation for Lake Willoughby and the Willoughby River. Another strategy recommends chemical monitoring and watershed surveys to locate substantial sources of the increasing nutrient trends – this effort is underway through the LaRosa Volunteer Monitoring Program.

Beyond monitoring and regulatory protections, the TBP recommends addressing water quality stressors by assessing, identifying, and implementing water quality projects in several works sectors. This includes agricultural BMPs, gravel road BMPs, developed lands BMPs, LakeWise master planning, shoreland restoration, riparian buffer plantings, and limiting development and encroachments. As of 2017, Lake Willoughby had 3 Lake Wise awards, 0 certifications, and only 2 completed projects. These numbers likely underestimate the work performed as of 2022, but not by much. Overall, implementation table Strategies focused on Lake Wise master planning (#9), implementing Lake Wise practices (#12), scoping potential treatment practices for runoff from Route 5A (#23), and bridge & culvert assessments on tributaries (#78).

In addition to nutrients, other watershed health stressors include invasive species and aquatic organism passage (AOP). Populations of Rainbow Smelt, Rainbow Trout, and White Sucker in Lake Willoughby would benefit from AOP improvements on Dorin Brook, Myers Brook, Wells Brook, and Schoolhouse Brook, listed in Table 11 of the TBP. Moreover, invasive Eurasian watermilfoil is an ongoing issue in the littoral zones of the lake and are being addressed through diver-assisted removal efforts (see Willoughby Final Report 2020).

Total Maximum Daily Load

The 2017 Lake Memphremagog Phosphorus Total Maximum Daily Load provides a quantitative approach for modeling phosphorus loading from the Memphremagog basin which includes all sub-catchments of the Lake Willoughby watershed(VTDEC, 2017a). This model used literature-based phosphorus export values to calculate loading rates for different land uses and septic systems while estimating retention in lakes larger than 4 hectares. Modeled data were calibrated to measured loads delivered to Lake Memphremagog from the four contributing river basins and smaller direct drainages. While the TMDL report did not specifically address P export dynamics in the Lake Willoughby watershed, output data from the model runs are available for these sub-catchments and are discussed further below.

Retention of phosphorus inputs to Lake Willoughby was estimated to be between 70.6 – 74.6%, likely due to the relatively long residence time of 8.6 years for surface water passing through the lake. Long residence times are a result of the large area and significant depth of the lake compared to the relatively small tributaries that feed it. Model output data for the Willoughby watershed indicate the greatest areal P export rates are located in sub-catchments draining Beavers Brook, Church Brook, Roaring Brook, an unnamed tributary of Route 5A, and Stoney Brook. Listed from largest export rates to smallest, these five brooks all contribute more than 0.24 kg P per hectare. These five watersheds also demonstrate the greatest proportions of developed (4 – 7%) and agricultural (6 – 22.5%; hay/pasture) lands. “Other” land

uses contributed the majority of P export in 9 of the 11 sub-catchments, conflicting with conventional wisdom that developed and agricultural lands are the predominant sources of P. Farmsteads were not the primary modeled P contributor in any of the sub-catchments; however, pasture/hayfields were the largest contributors in 4 of 11 sub-catchments (Stoney, Roaring, Beavers, and Church Brooks). Roads contributed 20 – 55% of P export loads in 4 sub-catchments (Mud Pond, Long Pond, Stoney Brook, & Route 5A). Lastly, septic systems played a varied but meaningful role in the most developed sub-catchments. Over 19% of the Stoney Brook sub-catchment TP export was estimated to be derived from septic systems; this was similar to the rates modeled for Church, Mill, Beavers, and Route 5A sub-catchments.

It is worth noting that the TMDL provides a very coarse evaluation of phosphorus export dynamics in the Willoughby watershed. According to VTDEC, "the streams in [the Willoughby watershed] were too small to estimate stream loading, so there is no estimated loading" available. In addition, it is believed that the "load estimate for septic systems may be high, as the methodology for estimating septic loading may use a higher export than is appropriate". Moreover, the "land use [data] used in this model may underestimate the amount of developed lands around the lake and may not accurately reflect the higher intensity of shoreland development and proximity to surface waters, [meaning the] model [may] underestimate the level of loading from shoreland development and private roads to some degree" (B. Copans, *personal communications*). Thus, it is important to be conservative when interpreting the TMDL output results for the Willoughby watershed and instead focus on overall trends rather that empirical phosphorus export rates.

International Joint Commission

The Study of Nutrient Loading and Impacts in Lake Memphremagog, produced for the International Join Commission, outlined current conditions in the watershed, reviewed ongoing management efforts, and recommended initiatives and policy efforts to address nutrient loading and algae blooms in Lake Memphremagog (IJC, 2019). This report did not specifically address the dynamics controlling phosphorus export in the Lake Willoughby watershed. However, it does provide general recommendations that can be applied to the Willoughby basin, including:

- Adopt widespread on-farm BMPs supported by resources for implementation and direct service providers
- Adopt BMPs and stormwater regulations for new development projects and increased implementation of retrofit projects for existing development
- Identify priority conservation areas that protect essential ecological services provided by natural lands in the watershed and implement programs and provide incentives to conserve and restore these lands
- Incorporate climate change impacts into all decision-making in order to ensure nutrient loading targets are met and investments in BMPs are long-term and that finite resources are used effectively

TOWN PLANNING & PERMITTING

Westmore Town Plan

The Westmore Town Plan, last amended on October 21, 2020, is a non-regulatory planning document that outlines the general vision, direction for future development, and local needs and desires of the community. The document is intended to provide actions and priorities to be addressed in the Town implementation plan. Arguably the most important section of the document, Section 3, lists the Policy Statements that will steer decision-making in Westmore. Policy statements include limiting land use regulations to a minimum, protecting water quality and environmental health, promoting agrarian, forestry, and tourism industries, and preserving the cultural resources of the Town. This document will play an important role in discussions focused on future policies related to private land uses, development/redevelopment restrictions, and long-range planning.

Vegetative Buffer Disturbance Permit

The Town of Westmore requires all projects with anticipated vegetative buffer disturbances to acquire permit approvals from the Zoning Administrator and Planning Commission prior to any work being performed. Permit approvals are contingent upon submittal of a $50 filing fee; appeals to permit denials must be accompanied by a $75 filing fee.

Water Quality Protection Bylaws

The Town of Westmore bylaws include specific requirements for water quality protection as it relates to land-based development and related activities alongside lake shorelines, streams, and wetlands. Section 317 of the Westmore Bylaws include requirements for shoreline protection areas – dependent on slope and presence of bedrock ledge or high-water tables – that limit allowable uses, waterfront pathways, development/redevelopment, parking areas, docks, landings, fences, and other activities. Shoreline protection bylaws also provide guidance for managing and protecting natural sand beaches, streambanks, and wetlands. Additional bylaws reiterate mandatory erosion control practices during construction, logging, and agricultural activities, although Town bylaws do not go beyond the minimum standards set by State statute.

LWAP Kick-Off Meeting

OCNRCD & MWA led a public kick-off meeting on July 27, 2022 as part of the LWAP process. The meeting began with members of the Westmore Association and greater community sharing their personal sentiments about Lake Willoughby and their vision for the future of the watershed. OCNRCD provided an overview of the intent and purpose of an LWAP, the process by which the LWAP will be developed, opportunities for public engagement and assistance, and a tentative schedule. MWA presented on current available data highlighted in this report and briefed the attendees about priority assessment areas. Each participant was given an 11x17 map printout of the watershed and asked to mark and label areas they know of that may be contributing to water quality and habitat degradation. These maps were collected and used to developed a plan for the proposed field assessments.

DATA GAPS

MWA was not able to identify significant water, sewer, or stormwater infrastructure for the town of Westmore. Moreover, there is a lack of data for the tributary streams flowing into the Lake. Other data

limitations were the land use P export rates from TMDL, which are probably too coarse and outdated to provide meaningful data at this scale. MWA encourages the Westmore Association to continue and perhaps expand tributary water quality monitoring to better characterize P loading trends from select tributaries. Lastly, there are no data available for hydrologically connected road segments or road erosion inventories for privately owned roads. These data will be developed during the prioritization of core assessment areas, covered further in a separate memo.

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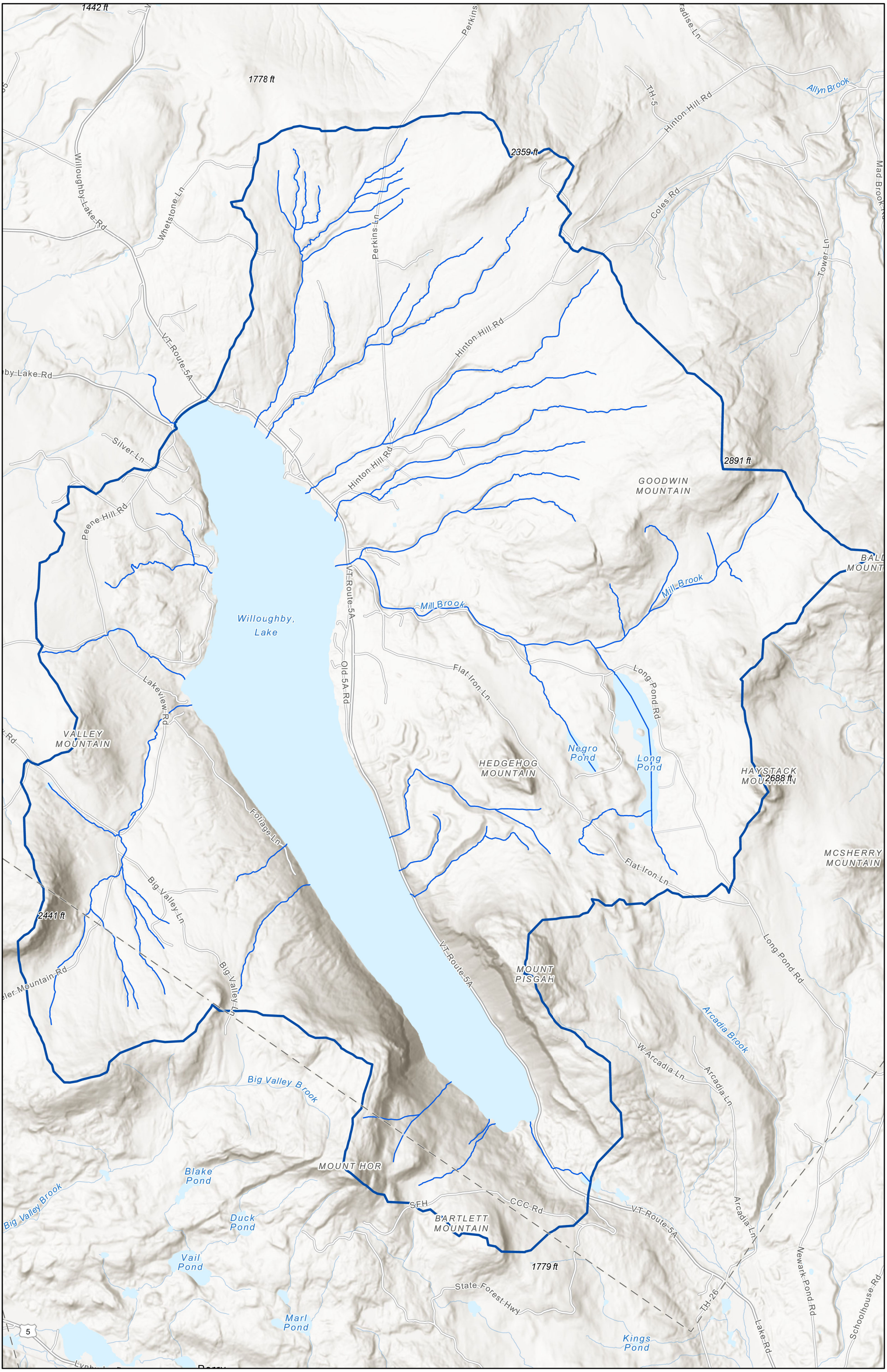
PLEASE MARK AND LABEL AREAS WHERE YOU SUSPECT EROSION, SEDIMENT, OR OTHER WATER QUALITY ISSUES



Memphremagog Watershed Association

www.mwavt.org

MEMORANDUM

To: Orleans County Natural Resources Conservation District & Westmore Lake Association

From: Memphremagog Watershed Association

Re: Proposed Core Assessment Areas for Water Quality & Habitat Restoration Project Screening

Date: August 23, 2022

Overview

The *Technical Guidelines for Developing a LWAP*, produced by Vermont Department of Environmental Conservation (VTDEC), suggest three core areas (shoreland, roadways, and tributaries) for field assessments to identify potential water quality and habitat improvement projects. In addition to the three core areas, MWA and OCNRCD propose to screen other potential sources of water quality and habitat degradation in the Lake Willoughby watershed. Other areas to be considered during field assessments shall include 1) screening AOP or geomorphically incompatible culverts, 2) evaluating potential forestland erosion and sediment sources, and 3) identifying opportunities for developed lands and agricultural best management practices. The additional field assessment components shall be performed in conjunction with roadway screening, stream walks, and landowner site visits. Additional funding sources beyond the Willoughby LWAP contract will be leveraged to support supplemental assessments described below.

Based on the areal extent of potential assessment areas, MWA and OCNRCD shall perform rapid screening for each of the core assessment areas. For roadways and culverts, rapid screening shall involve drive-bys, walks, and targeted site visits to identify potential improvement projects. For tributaries, rapid screening shall involve stream walks and assessments focused on stream channel or bank erosion and riparian buffer quality. For shoreland areas, OCNRCD shall initiate screening with boat-

based lake shoreland assessments to identify priority areas for follow-up landowner outreach and subsequent site-specific Lake Wise assessments. Screening for agricultural and/or developed lands BMPs shall be performed on a site-specific basis using appropriate assessment means determined by best professional judgements.

The purpose of a Lake Watershed Action Plan is to identify and prioritize clean water projects to protect and enhance the water quality and ecological health of a watershed. While this includes a vast spectrum of potential project types, not all potential projects are economically or socially feasible within the scope of an LWAP. For instance, regulatory projects related to major highways, farm infrastructure, and public storm- or wastewater systems are expensive and highly technical. As such, these project types will not be thoroughly assessed in the Willoughby LWAP due to the extensive planning and design phase requirements that pose an economic infeasibility. Similarly, socially infeasible projects are not a focus of this LWAP. Examples of socially infeasible projects include town-wide septic upgrades, bylaws restricting certain land uses, and publicly funded projects on private property without landowner support. While these potential project types may be identified during LWAP assessments and perhaps prioritized in the final report, they will not be a focus of BMP planning or conceptual design development.

Public Roads, Private Roads, & Stream Crossings

Based on the Road Erosion Risk Scoring from the hydrologically connected road segments data layer, 82 road segments do not meet MRGP requirements (Figure 1). The vast majority of these 82 segments are located on Long Pond Rd (27), Lakeview Rd (13), Perkins Ln (10), and Hinton Hill Rd (7). As these data are from 2019 and may be outdated, OCNRCD shall work with the Westmore Roads Commissioner and Foreman to narrow down the list of road segments to be evaluated during field assessments. The only known storm drain lines on Hinton Hill Rd will be evaluated as part of the roadway and culvert screening.

Private roads were not included in the state Road Erosion Inventory database, so additional efforts were taken to identify priority segments for field assessments. Of the 9.2 miles (145 segments) of private road within the Willoughby watershed, 3.3 miles (54 segments) were identified as having potential need for field assessments (Figure 2). These segments were selected using protocols akin to the Hydrologically Connected Road Segments. Private road centerlines were segmented into 100-meter lengths and all segments within 100 feet of a stream (intermittent and perennial), wetland or waterbody were selected for field assessment. Slopes greater than 10% were explored as additional filters for Private Road segments, but most private road segments in the watershed have average slopes approaching or greater than 10%.

In addition to roadways, this effort identified 39 individual stream crossings that are not geomorphic and/or AOP compatible. Of these, 23 were identified as having potential need for sediment and erosion screening (Figures 3). MWA shall perform sediment and erosion screening at all stream crossings encountered during stream walks. In addition, OCNRCD and MWA shall work with the Orleans County AOP Work Group to identify up to 10 crossings to assess for opportunities to improve fish passage and

geomorphic compatibility. *(This AOP assessment work will not be funded under the current LWAP grant but rather will be supported through other secured funds from VT Department of Fish and Wildlife).*

Tributaries

There are 43.3 miles of mapped perennial streams in the Willoughby watershed. Based on water quality data and community feedback, MWA and OCNRCD shall perform stream walks along 15.3 miles of tributaries (Figure 4). These include all the major tributaries draining the most heavily developed areas of the watershed. Priorities include Roaring Brook, Mill Brook, Minsters Brook, Stoney Brook, and Church Brook (all unofficial, 'local' names). Stream walks shall evaluate the condition of the stream as it relates to channel and bank erosion, riparian buffer, water quality issues, sediment transport, and fish & wildlife habitat.

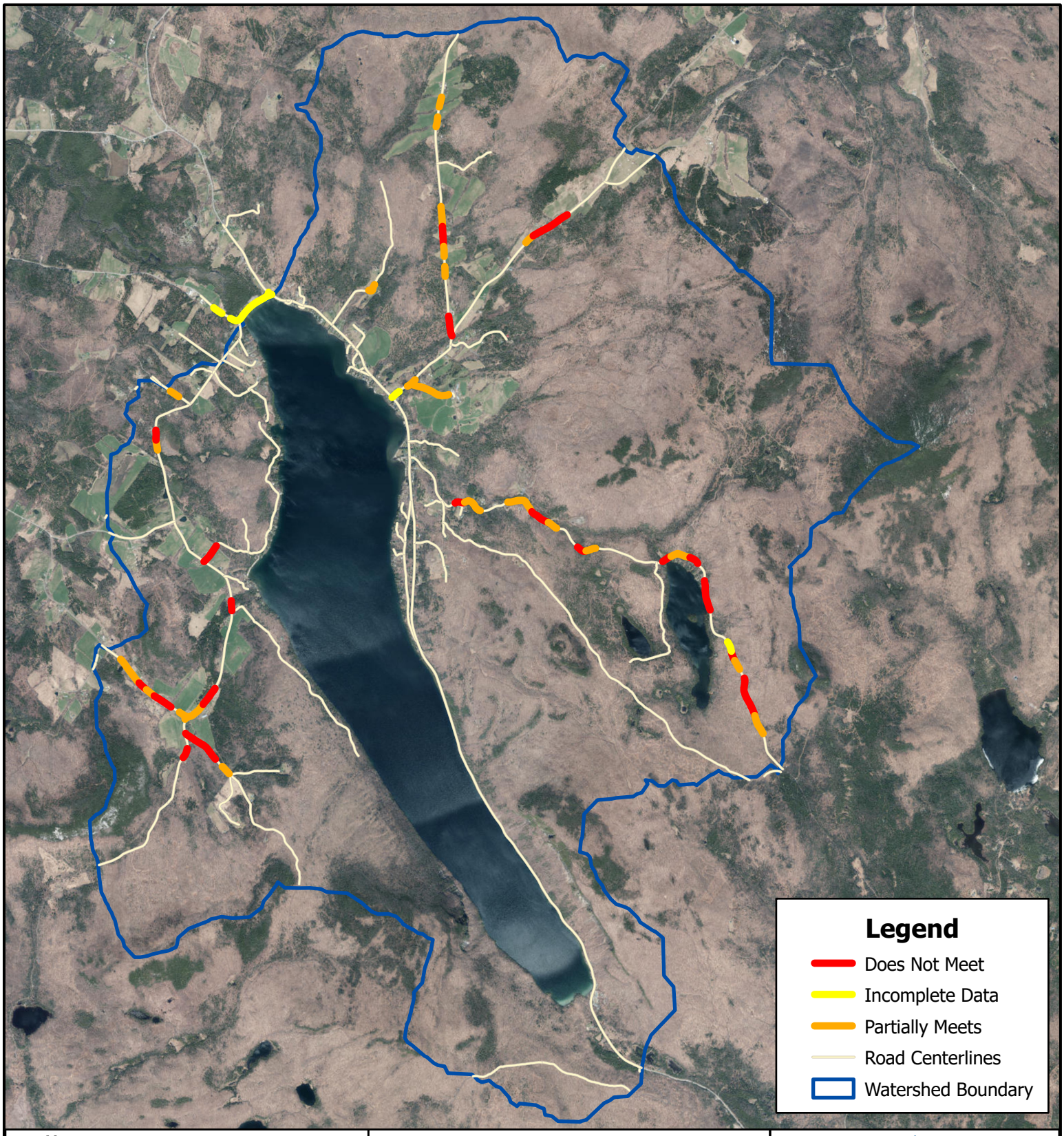
Shoreland

Based on land use/land cover data, the northern half of the lake is subject to the greatest proportion of impervious surface and lakeshore development (Figure 5). Thus, lake shoreland and Lake Wise assessments shall be focused in these areas. It is recommended that lake shoreland assessments be performed by boat along approximately 3.9 miles of the northern periphery of the lake, from south of the Beavers Brook outlet (Old Cottage Ln) clockwise to North Beach and south to Old 5A Rd. The south-west quarter of the lake is fully forested and does not warrant water quality or habitat enhancement project prioritization. If shoreland habitat restoration is a goal along the south-east (Route 5A) shore, this area can be included in the boat-based screening. Based on the outcomes of the shoreland assessments, OCRNCD shall perform targeted landowner outreach and formal Lake Wise assessments on an individual and site-specific basis, dictated by landowner interest and permission.

Forestlands & Agriculture

There are several large parcels in the watershed with historic or contemporary logging or farming activities (Figure 6). Analysis of land use/land cover and potentially erosive feature datasets indicate several areas within these parcels that may be subject to gullying or other accelerated erosion related to forest roads, skid paths, ditches, and pasture/farmyard drainage. MWA and OCNRCD shall perform outreach to these landowners to request site visits and discuss opportunities to address runoff or erosion issues as they are identified. It is anticipated that site visits will take place on 5 developed or forest land parcels.

FIGURE 1



N

0 0.25 0.5 1 Miles

Notes: Map depicting proposed road segments for drive-by screening and project identification assessments.

Drawn By: Patrick Hurley, MWA

Date: August 8, 2022

Potential Public Road Assessments

Willoughby Lake
Watershed Action Plan

MWA
MEMPHREMAGOG WATERSHED ASSOCIATION

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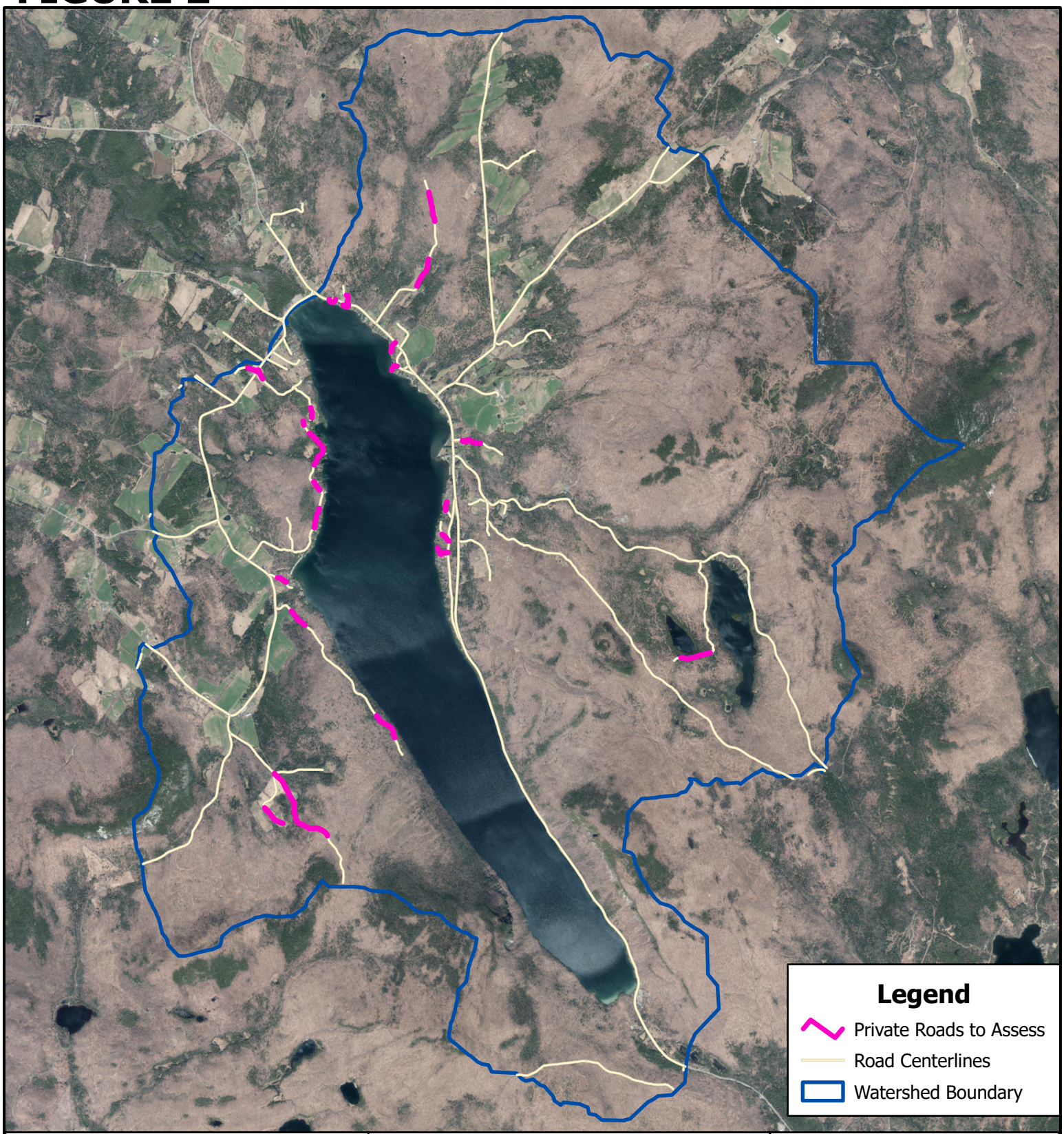
FIGURE 2



N

0 0.25 0.5 1 Miles

Notes: Map depicting proposed private road segments for field assessments.

Drawn By: Patrick Hurley, MWA

Date: August 8, 2022

Proposed Private Road Assessments

Willoughby Lake
Watershed Action Plan

MWA
MEMPHREMAGOG WATERSHED ASSOCIATION
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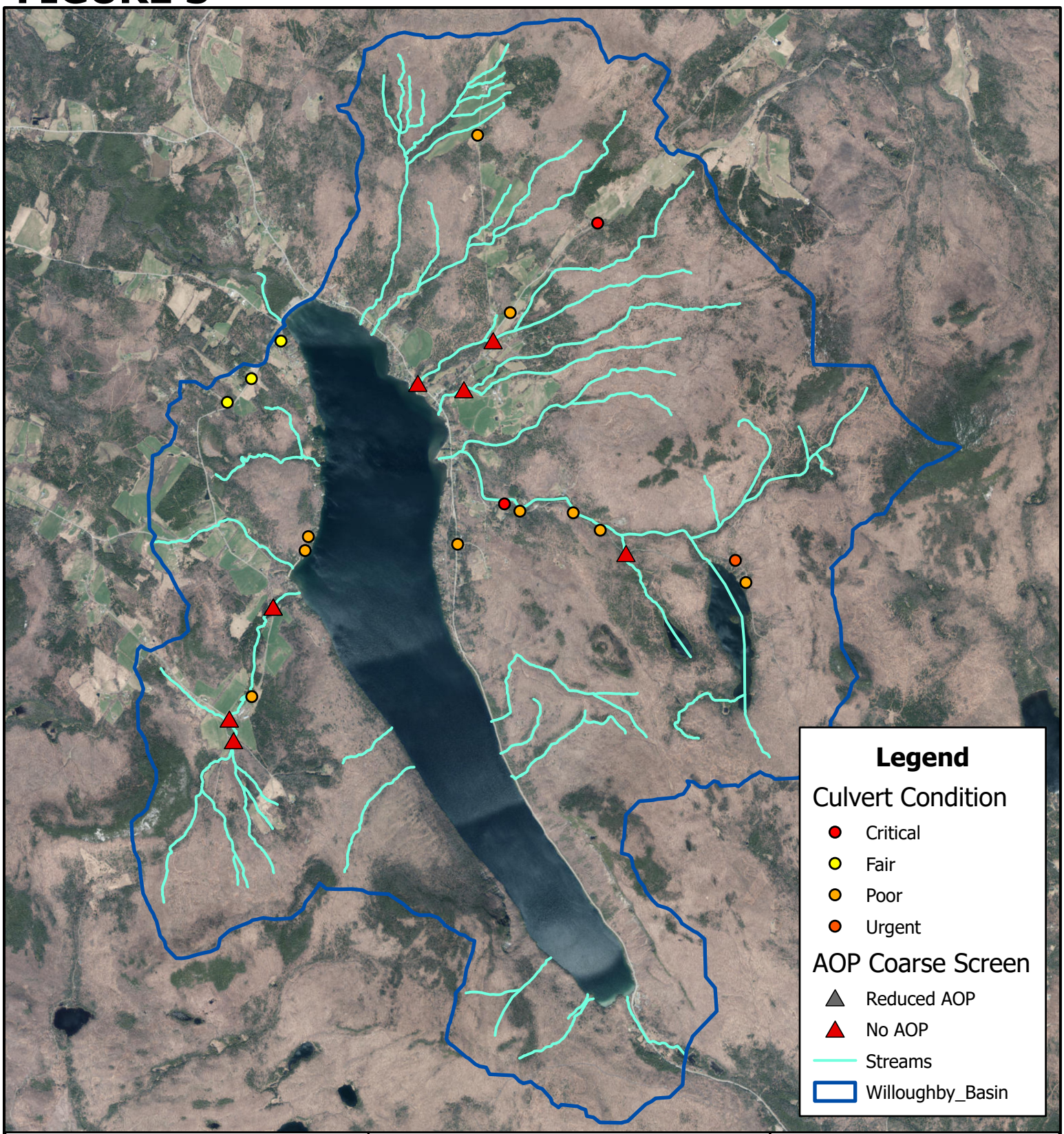
FIGURE 3



N

0 0.25 0.5 1 Miles

Notes: Map depicting proposed culverts for sediment and erosion screening.

Drawn By: Patrick Hurley, MWA

Date: August 8, 2022

Proposed Culvert & Erosion Screening

Willoughby Lake
Watershed Action Plan

MWA
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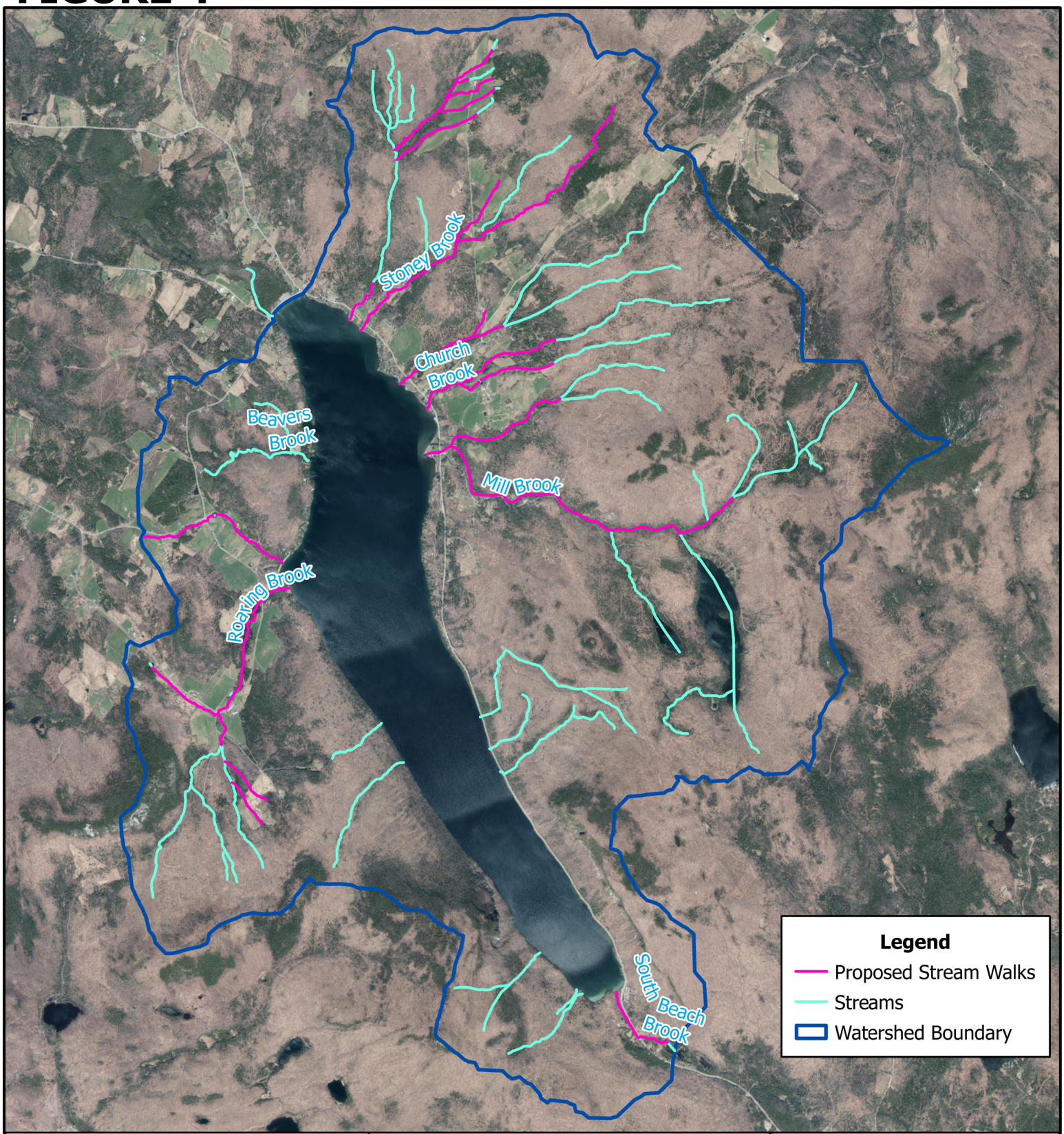
FIGURE 4



N

0 0.25 0.5 1 Miles

Notes: Map depicting proposed reaches for stream walks and streambank assessments.

Drawn By: Patrick Hurley, MWA

Date: July 25, 2022

Proposed Stream Walks

Willoughby Lake
Watershed Action Plan

MWA
MEMPHREMAGOG WATERSHED ASSOCIATION

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FIGURE 5

N

0 0.25 0.5 1 Miles

Notes: Map depicting proposed lake shoreland areas for boat-based assessment and screening.

Drawn By: Patrick Hurley, MWA

Date: August 8, 2022

Proposed Lake Shoreland Assessments

Willoughby Lake
Watershed Action Plan

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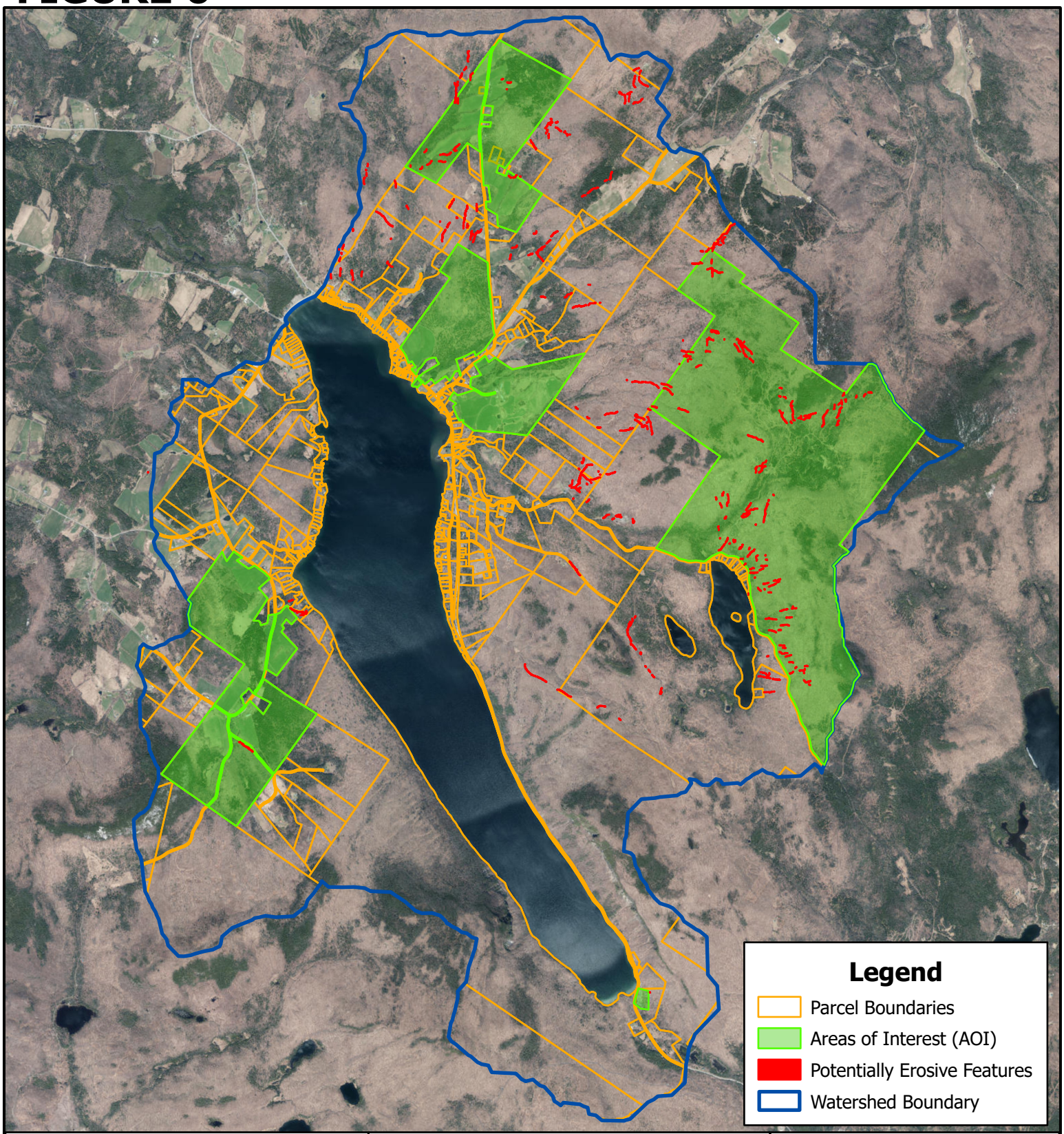
FIGURE 6



N

0 0.25 0.5 1 Miles

Notes: Map depicting areas of interest for proposed forest and developed lands assessments.

Drawn By: Patrick Hurley, MWA

Date: August 8, 2022

Potential Forest & Developed Lands Assessment

Willoughby Lake
Watershed Action Plan

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