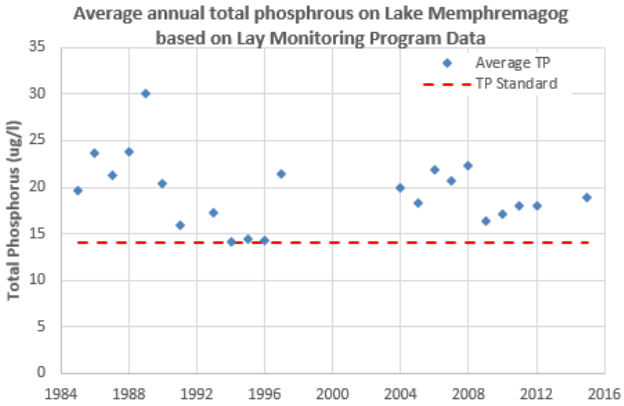
Lake Memphremagog TMDL Proposal Summary

Water Quality Challenge



Phosphorus levels in the Vermont portion of Lake Memphremagog are over 20% higher than the water quality standard set for the lake of 14 ug/l. Elevated levels of phosphorus contribute to occasional cyanobacteria (also called Blue Green Algae) blooms but also support excessive plant and algae growth that limits the quality of the lake for recreational use. A Total Maximum Daily Load (TMDL) is required by the Clean Water Act to set a limit of phosphorus that can enter the lake from its watershed and still meet this Water quality standard. Lake Memphremagog is an international waterbody with over 73% of its surface area in Quebec, while 27% is in Vermont. Currently Lake Memphremagog meets its phosphorus guideline in Quebec however, through the Quebec Vermont Steering Committee on Lake Memphremagog, collaborative efforts have supported modeling and efforts to reduce loading in both Vermont and Quebec and an international agreement on the implementation of this TMDL is being contemplated.

Cyanobacteria Bloom in Lake Memphremagog

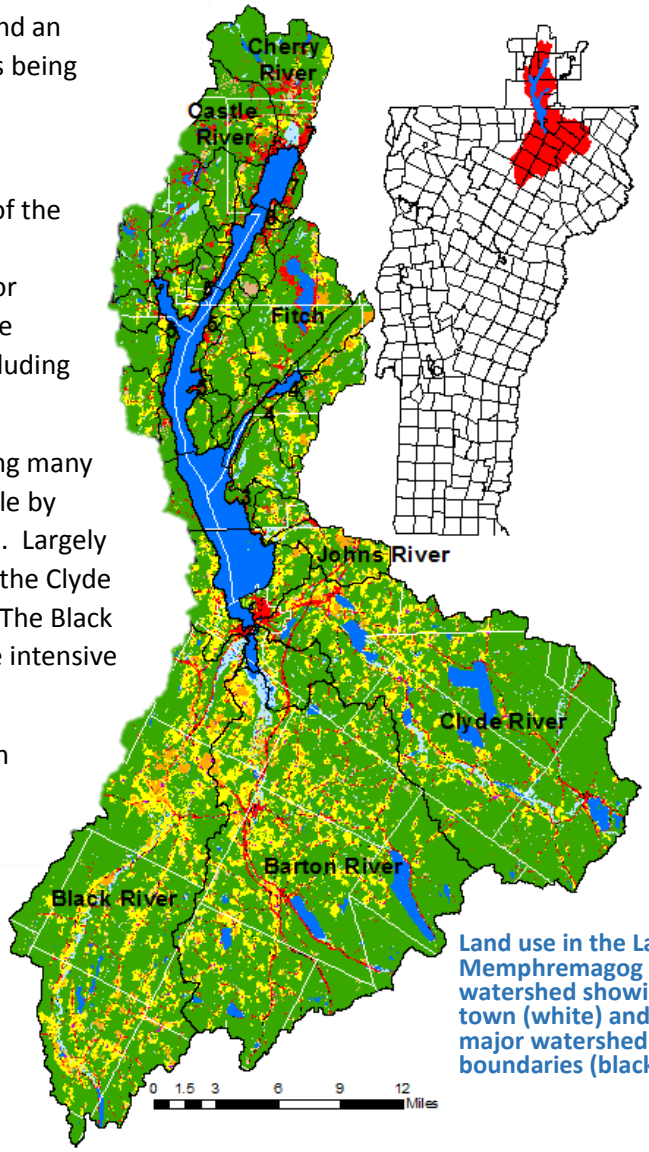
Watershed Description

While most of the lake surface area is in Quebec, the majority of the watershed (71%) lies in Vermont. The Vermont portion of the watershed covers most of Orleans County, including three major tributaries: The Black, Barton, and Clyde rivers in addition to the smaller Johns River. Smaller areas drain directly to the lake including portions of Newport City and Town and the Town of Derby.

The watershed includes a large number of upland lakes including many in the Clyde River watershed. These lakes play an important role by settling out a large amount of phosphorus from upland sources. Largely as a result of this attenuation, loading on a per acre basis from the Clyde River is much lower than that for the Barton and Johns Rivers. The Black River has the highest loading due to fewer ponds but also more intensive agricultural land use.

The table below identifies the approximate land use breakdown within the Vermont portion of the lake watershed

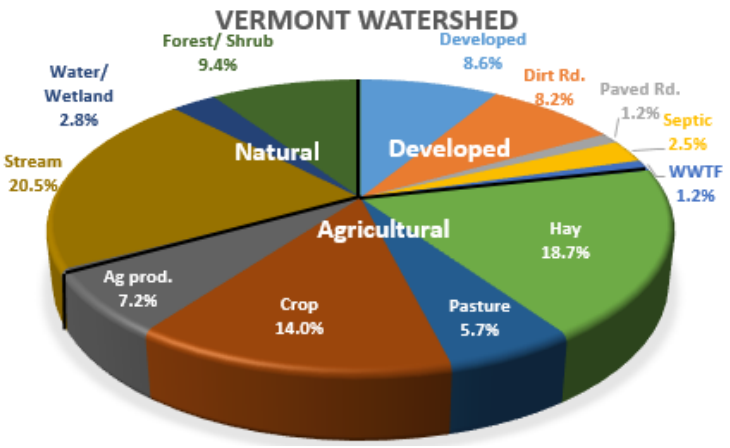
Land use	Percent of VT watershed
Developed	6%
Agricultural	17%
Forest/Wetland	77%



Land use in the Lake Memphremagog watershed showing town (white) and major watershed boundaries (black)

Modeling and the Draft TMDL

A land use phosphorus export model was developed for the watershed to estimate phosphorus loading from each of these land use sectors. The model estimates that much of the load is coming from agricultural lands (45.6%). Developed land (including septic) contribute 21.5%, with an additional 20.5% from stream channel instability and 12.2% from natural sources. WWTFs contribute 1.2% of the total load. A detailed breakdown of loads from various sectors is given in the adjacent pie chart.



Estimated phosphorus loading from different land use sectors from the Vermont portion of the Lake Memphremagog watershed

A lake model was developed using in-lake and tributary monitoring data to translate the watershed loading into resulting in-lake phosphorus concentrations. The lake was broken down into eight segments to describe the lake's unique characteristics. Exchange between these segments, and the loss of phosphorus from each segment to lake-bottom sediments was also estimated. After calibration, this model suggests that a 21% phosphorus load reduction for the Vermont portions of the Lake Memphremagog watershed is necessary to bring phosphorus concentrations in Vermont waters below 14 ug/l. This percent reduction represents the overall loading reduction needed, but the TMDL allocations determine how much reduction is necessary from each sector, and also include a margin of safety of 8%, which increases the total load reduction required to 29%, to ensure continued attainment of the standard.

Wastewater Treatment Facility (WWTF) Loading

The only source-sector of loading that is directly measured in the watershed is the loading that comes from wastewater treatment plants that are reflected in the TMDL based on annual permitted loading. The table below shows the current permitted daily flow, phosphorus concentration limit, and the resulting annual total permitted loading for the four facilities in the Lake Memphremagog watershed. The Brighton facility doesn't have a concentration limit, so 5 mg/l is used as a maximum concentration for this facility. This table also shows the average phosphorus load from 2009 to 2012, which indicates that all facilities are operating at less than 30% of the permitted load allowed. This is because the average concentration and flows were both substantially below the levels allowed by permit.

Permitted flow, concentration, loading, and measured loading from 2009-2012 for four wastewater treatment facilities in the Lake Memphremagog watershed.

	Permit Flow (MGD)	Permit Conc. (mg/l)	Permit Load (KG)	Average Load 2009-2012
Barton	0.265	1.0	368	112
Brighton	0.150	5.0*	1040	295
Newport	1.200	0.8	1332	391
Orleans	0.190	1.0	264	38
Total	**1.805**		**3003**	**836**

*Brighton does not have a permit concentration limit for phosphorus so 5 mg/l used to calculate annual loading

Several options for setting permit limits for phosphorus loading from WWTF were evaluated for facilities in the Lake Memphremagog watershed. Three of these shown in the following table are the current loading, current permitted loading, and the 2016 strict allocation approach for the Lake Champlain TMDL. The strict WLA approach was only applied in the Lake Champlain TMDL for lake segments where WWTF made up a large percentage of loading to the segment or where the overall load

reduction was extremely high neither of which applies to the Lake Memphremagog watershed and so Options 1-3 are being considered although some combination of these could be also be applied.

Permitting options that were evaluated are shown in the table below detail and included:

- Option 1 reduces concentration limits for Barton and Orleans to 0.8 mg/l and annual loading for the Newport facility to 999 kg/y (which represents 0.6mg/l times annual flow) while leaving Brighton facility permit unchanged.
- Option 2 is the same but reduces the annual loading for Brighton facility to 166 kg (which represents 0.8 mg/l times permitted flow.)
- Option 3 is to maintain current concentration limits but to apply stricter annual loading limits at a level that still allows for an increase in annual loading of at least a 70% over the average loading before reaching permit limits. There is uncertainty as to how this might impact facility operations far into the future as phosphorus treatment efficiency may be reduced as flows increase for facilities to levels closer to permit limits so costs associated with this option were not estimated.

The current proposed TMDL loading scenario was built using permitting Option 2.

Alternative approaches to setting wastewater treatment permit concentration with the resulting loading calculated concentration times permitted flow.

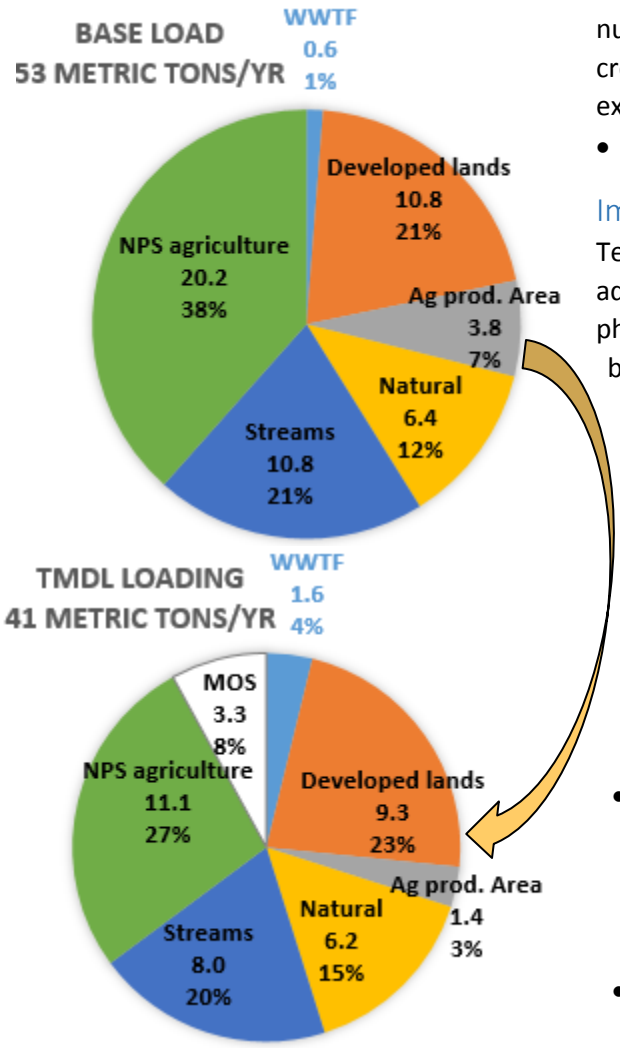
	2009-2012 average load (**kg**)	Current permit (mg/l)/**(kg)**	Option 1 (mg/l)/**(kg)**	Option 2 (mg/l)/**(kg)**	Option 3 (mg/l)/**(kg)**	2016 Lk. Champ. TMDL (mg/l)/**(kg)**
BARTON	**112**	1.0 / **368**	0.8 / **294**	0.8 / **294**	0.6 / **221**	0.2 / **74**
BRIGHTON	**295**	5 / **1040**	5 / **1040**	0.8 / **166**	2.5 / **520**	0.8 / **166**
NEWPORT	**391**	.8 / **1332**	0.6 / **999**	0.6 / **999**	0.4 / **666**	0.2/ **333**
ORLEANS	**37**	1.0 / **264**	0.8 / **211**	0.8 / **211**	0.6 / **158**	0.6 / **158**
Total Load (kg)	**836**	**3003**	**2544**	**1670**	**1565**	**731**
% of TMDL load (40820 kg)	1.6%	5.8%	4.6%	3.8%	3.0%	1.5%
Change from current permit load	-72%	0%	-20%	-33%	-47%	-73%
non WWTF load reduction required	NA	33.8%	32.3%	31.2%	30.4%	28.5%
Approximate cost estimate*	NA	$0	$0	$875,000	NA	$12,215,220

*Cost estimates were made based on 2014 Cost Estimate Analysis for Vermont Wastewater Treatment Facilities.

Setting the Phosphorus Load Reduction approach

Public meetings were held over the summer of 2016 to discuss the most effective way that TMDL load reductions can be achieved across different land use sectors for the development of the Draft TMDL allocations. These meetings included a meeting on June 30th for the general public, a meeting on August 11th that focused on agricultural load reductions and a meeting on August 31st that was focused on upland lake watersheds. Load reduction options were evaluated using the Lake Memphremagog scenario tool, which estimates the load reduction achieved by applying a combination of Best Management practices (BMPs) across a percentage of a land use for a portion of the basin which is shown in detail in the summary table on page 5. Many of the BMPs that are being contemplated are required through regulations passed with the Clean Water Act, Act 64. These include:

- A municipal road permit which will require towns to address runoff from roads over a 20-year period
- Stormwater regulations that will require stormwater treatment for parcels with over 3 acres of impervious surfaces



- Required agricultural practices that require buffers on ditches, nutrient management plans which limit erosion levels from croplands, and the certification and inspection of small farms to expand the inspection already required for medium and large farms.
- New acceptable management practices for forestry operations

Implementing the TMDL through Tactical Basin Planning

Technical and financial assistance will be necessary to speed up the adoption of BMPs and target BMPs that will maximize the potential phosphorus reduction achieved through these efforts. A tactical basin plan for the Lake Memphremagog Tomifobia and Coaticook watershed is being developed this winter with general strategies for the next 5 years to most effectively provide the technical and financial resources in addition to a list of specific projects identified through assessments as priorities for meeting phosphorus reduction targets in a new online database.

Strategic efforts being discussed as part of this plan include:

- Supporting the implementation of targeted stormwater practices identified through a stormwater master plan completed by the Memphremagog Watershed Association.
- Provide technical and financial support to towns completing road erosion inventories and applying for grants to implement water quality improvement practices through a rivers and roads group with members from V-trans, conservation districts and the Northeast Vermont Development Association.
- Targeting increased funds through a $674,000 regional conservation partnership program grant through USDA, and Clean Water Initiative funding to the Orleans County Natural Resources Conservation District that will provide technical and financial support for the implementation both required and voluntary of agricultural practices with another $674,000 in committed contributions from partners in the region. These practices are being targeted to areas which have been identified through water quality sampling as sources areas to maximize phosphorus reduction impacts of these projects and follow-up sampling is being done to demonstrate the impacts of these projects.

Proposed allocations for Lake Memphremagog TMDL and required reductions in comparison to the percentage load reductions in the Lake Champlain TMDL

	Waste Load Allocation (WLA) in Kg					Load Allocation (LA) in Kg			
	WWTF Permit to Lake	WWTF	Devel.	Future Growth	Ag prod. Area	Natural	Streams	Agric.	Total
Base Load	2338	647	10791		3801	6426	10776	20233	52674
Draft TMDL	1559		9077	222	1368	6198	8050	11080	37554
% Reduction	**33.3%**		**15.9%**		**64.0%**	**3.5%**	**25.3%**	**45.2%**	**28.7%**
Champ % red.	42.1%		20.9%		80.0%	18.7%	45.4%	53.6%	33.7%

Phosphorus load reductions achieved though project implementation will be tracked so progress in meeting TMDL loading reduction targets can be evaluated at the beginning of the next five-year planning cycle with a goal of meeting load reduction targets and in-lake water quality standards in 20 years.

Contact Ben Copans with the Vermont Watershed Management Division at 802-751-2610 or ben.copans@vermont.gov with any questions.

Table showing the current proposed set of BMPs to meet TMDL phosphorus load reduction targets across all land use sectors except WWTF.

% Total load reduction	Land use	Area in acres	Load to lake (lbs)	BMP	Percentage applied	Acres treated	BMP efficiency	Load reduction (lbs)
0.7%	Developed Pervious	9,166	3,978	Ban on P Fertilizer Use on Turf	12%	1,100	50.0%	239
0.4%	Developed Pervious	9,166	3,978	Riparian buffer	5%	458	67.0%	133
0.5%	Developed Impervious	3,618	5,781	Riparian buffer	5%	181	67.0%	194
1.0%	Developed Impervious	3,618	5,781	Surface Infiltration Practices .5"	8%	289	77.0%	356
0.7%	Forest	211,240	10,021	Stream Crossing Erosion/Sedimentation Control	100%	211,240	5.0%	501
0.0%	Road Paved	1,607	1,367	Mechanical Broom Sweeper (2/year)	25%	435	1.0%	4
0.0%	Road Paved	1,607	1,367	Catch Basin Cleaning	25%	435	2.0%	7
0.1%	Road Paved	1,607	1,367	Infiltration Trench.5"	5%	80	77.0%	53
8.5%	Dirt Road Combined	2,391	9,507	Roadside Erosion Control	53%	1,261	50.0%	3,055
14.9%	Farmstead	974	8,380	Barnyard Management	80%	779	80.0%	5363
10.4%	Hay	35,657	21,680	Ditch buffer or 10 ft Manure spreading setback	34%	12,123	51.0%	3759
10.1%	Hay	35,657	21,680	Riparian buffer or 25 ft Manure spreading setback	25%	8,914	67.0%	3631
4.4%	Hay	35,657	21,680	Gully stabilization and- 25 ft Riparian Buffer/setback	9%	3,101	84.0%	1598
2.5%	Pasture	10,880	6,616	Fencing/livestock exclusion with out riparian buffer	25%	2,720	55.0%	910
3.4%	Pasture	10,880	6,616	Fencing/livestock exclusion with riparian buffer	25%	2,720	73.5%	1215
1.1%	Pasture	10,880	6,616	Managed Intensive Grazing	25%	2,720	24.0%	397
12.1%	Cropland Combined	6,021	16,309	Cover crop - Conservation tillage - Grassed Waterways - Ditch Buffer	31%	1,859	84.0%	4,357
2.0%	Cropland Combined	6,021	16,309	Change in Crop Rotation - Grassed Waterways - Ditch Buffer	4%	238	74.0%	727
1.3%	Cropland Combined	6,021	16,309	Cover crop	10%	602	28.3%	462
0.8%	Cropland Combined	6,021	16,309	Conservation tillage - Manure injection	8%	507	20.0%	274
3.7%	Cropland Combined	6,021	16,309	25 ft Riparian buffer	13%	805	67.0%	1,318
2.8%	Cropland Combined	6,021	16,309	10 ft Ditch buffer	13%	805	51.0%	1,004
1.5%	Cropland Combined	6,021	16,309	Grassed Waterways	10%	602	40.0%	527
16.7%	Streambank	-	23,758	Restoration of Equilibrium Condition	46%	-	55.0%	6011
0.0%	Septic	-	2,951	Septic system - Strengthened regulations place holder	0%	-	20.0%	0
100.0%	total	272,654	106,842			260,657		36094