



# Orleans County Natural Resources Conservation District

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## Lake Memphremagog and Stearns Brook Watershed Water Quality Monitoring 2019 Season Annual Report



Prepared for the

The LaRosa Volunteer Water Quality Monitoring Program  
Vermont Department of Environmental Conservation

by

Orleans County Natural Resources Conservation District  
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September 13th, 2020

## Introduction

The Orleans County NRC and other Memphremagog water monitoring partnership organizations have monitoring over 190 sites since 2005, including 36 sites in 2019 to continue our efforts to identify and assess threats to water quality in the Lake Memphremagog and Tomifobia Basins. This ongoing partnership program has received essential LaRosa program organizational support and analytical support funds to carry out monitoring, engage stakeholders, meet mitigation goals and deliver measurable water quality improvements.

Starting in 2016 the Orleans County NRC, the VT Department of Environmental Conservation, watershed partners and farmers came together to monitor non-point phosphorus and nitrogen in the impaired Lake Memphremagog watersheds and stressed Stearns Brook Watersheds. In 2019, we sampled water quality in streams flowing through nine farms. In 2019 we continue to monitor existing sites on these farms and added three new sites. These farmers are participating in the Orleans County NRC Memphremagog Long-term Water Quality Improvement Regional Conservation Partnership Program (RCPP) or state funded programs and have implemented or are identified to begin conservation practices such as farmstead stormwater diversion, livestock exclusion, permanent buffers, erosion reduction/elimination practices, flood plain restoration or larger barnyard installation projects. Our objectives for this ongoing water quality monitoring:

- 1) Identify phosphorus and nitrogen nutrient and sediment pollution sources, to inform our work and to engage with farmers about the water quality conditions scaled to their individual farm.
- 2) Identify source and cause of sediment and nutrient runoff to inform management changes and project development.
- 3) Track changes to water conditions to assess the effectiveness of agricultural water quality BMP remediation practices.
- 4) Inform the Lake Memphremagog TMDL by validating load reduction estimates associated with different BMP practices.

This report presents the data and analyses for each farm we work with including where possible an evaluation of the success of water quality improvement projects that farmers implemented since 2017.

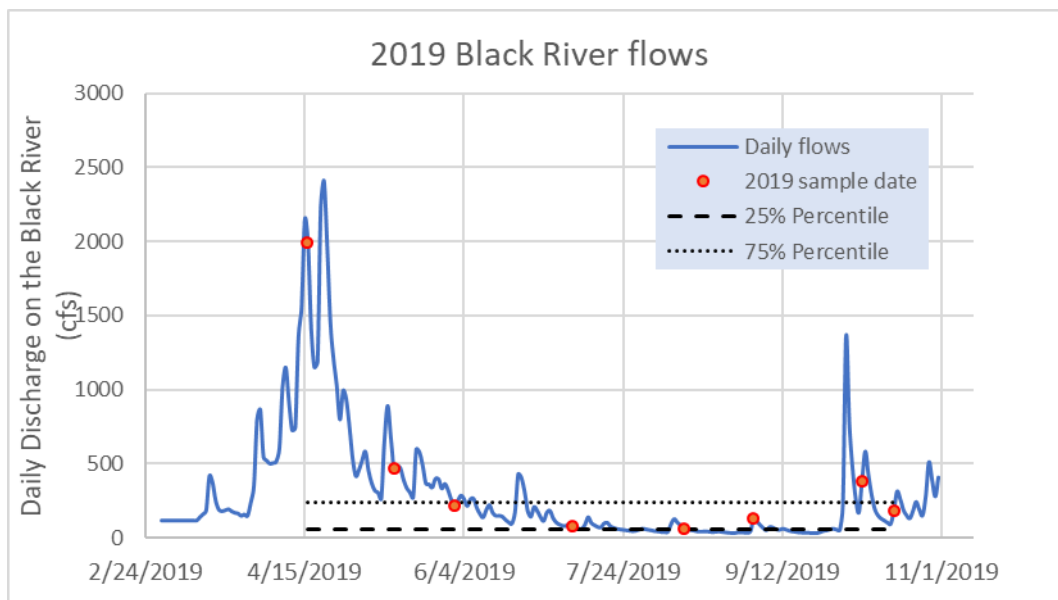
## Sampling Methods

Following our approved quality assurance project plan, we collected grab samples and analyzed total phosphorus and total nitrogen water quality at 36 sites on 8 dates including 6 regular scheduled sampling dates and 2 high flow events that occurred during spring snowmelt and during a fall rain event. Our sampling also includes 8 quality assurance samples per date. In total we collected 654 samples in 2019. This is 92% of the anticipated number of samples and 99% of the samples taken were determined to meet data quality objectives for the project to be considered successful.

Of the 36 sites 14 sites were located along tributaries and farm drainages in the Barton River watershed, 12 sites were located along tributaries and farm drainages in the Stearns Brook watershed in Holland VT, 6 sites were located along tributaries and farm drainages in the Willoughby River watershed, 2 sites were located in the Black River watershed in Craftsbury VT, and 2 sites were located along tributaries and farm drainages in the Clyde river watershed. A majority of these sites were sampled on farmlands to assess phosphorus reduction practices are planned to be install, had been installed or were being installed in 2019.

To relate the water quality data to stream flows, we relied on a single source of stream flow data. The U.S. Geologic Survey (USGS) maintains gage stations that measure water depths and stream flows on the Barton, Black, and Clyde Rivers. For this study, we used the daily stream flows measured at the Black River as a proxy for stream flows at all sites, although all our sites were located 2.5-18 mi away on streams that were smaller and generally steeper than the Black River. Three of the sample dates were on days with flow levels above the 75th percentile of flows and one of these, October 7th was also following a significant rain event. A second moderate rain event was captured on October 17th although runoff was less and flows remained below the 75th percentile. The remaining sample dates during the 2019 sampling season were considered moderate flows except for August 12th which was low flow.

Both field and laboratory data were entered into Microsoft Excel spreadsheets. All data sheets and analyses were archived by the author and VTDEC Basin 17 Basin Planner, and the electronic data were uploaded to the Vermont DEC for inclusion in their online databases. Statistical analyses to evaluate the effectiveness of the water quality improvement was done by the Basin 17 VTDEC Basin Planner.



2019 sampling season flows measured at USGS Stream Gauge BLACK RIVER AT COVENTRY, VT

## Results and Analysis

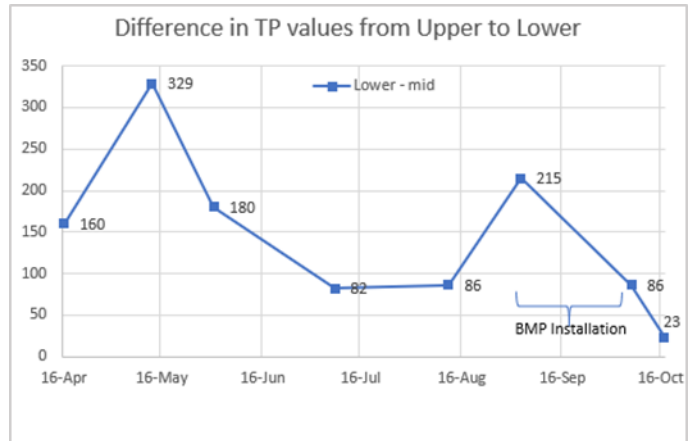
Results and analysis were summarized farm individualized reports and presented to the farmer for review during January and February 2020. At these meetings we revisit the program goals, remind farmer of our sampling methods, discuss the main points of the results analysis presented in graphs and in narratives, confirm implementation of practices and dates, notes any major and usual events that may have happened on the farm that would affect the results, explain loading compared to the nutrient the Vermont nutrient concentration criteria for aquatic biota in class B(2) streams and discuss next steps. We also share these results with the Memphremagog Agricultural work group which includes many local, federal and state partners who work in the watershed and in the region.

# Summary of Farm Sampling Results and Analysis by Watershed Location

## The Barton River Watershed

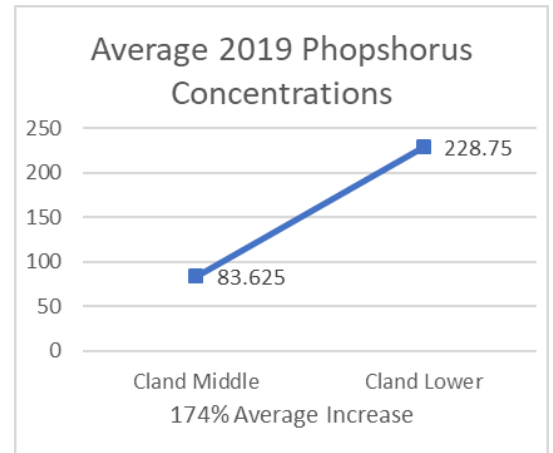
### FARM 1

2019 was the first sampling year at this farm. The farmer was working with VTAAF and CONRCD staff to address silage leachate runoff. We had four sampling sites from above to below the farmstead drainage area. The average lower site phosphorus sample results are 217.5 ug/l which is 18 times higher than the VT nutrient criteria for aquatic biota. The lower site sample results range from a low in August of 122 ug/l and a high of in 368 ug/l from the October 7th rain event sample. One of the sampling sites included the drainage area where the silage bunk run off was discharging before the fall 2019 BMP silage waste catchment project.



We sampled this drainage flow path just before it entered the stream twice. Dates sampled were April 16th and May 13th with an average of 71850 ug/l for the phosphorus results.

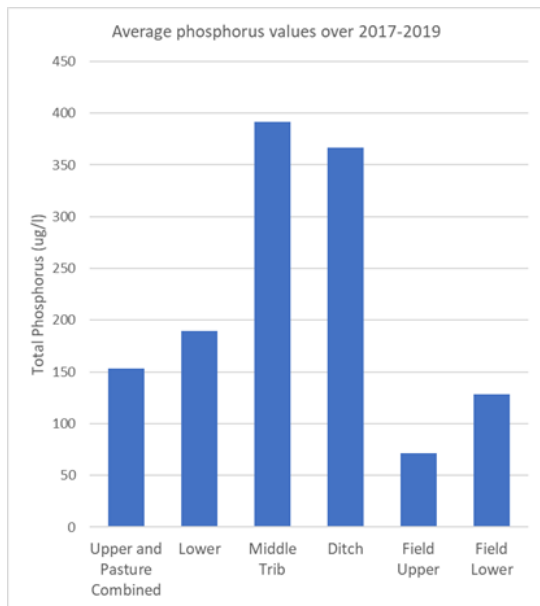
The middle and lower sampling sites had constant flow and tell the clearest picture of runoff from the farmstead in the sampling area. Looking at comparing the middle and lower sample sites, we see a 174% increase in phosphorus. We intend to monitor runoff by continuing to sample the lower and middle sites during our next sampling season to verify improvements from the installed silage catchment and animal exclusion project.



### FARM 2

Sampling on this farm was first done in 2017 and in 2018 we mapped all the drainage areas on the farmstead. We sample 6 sites through the farmstead and crop fields. The sum of the loading from the three drainage areas that drain the farmstead was estimated to be 88kg from 39 hectares which equates to loading of 2.25 kg/ha. While this is elevated it is lower than most farmstead areas we have sampled in the watershed. These levels have been variable over the last 3 years but there are no clear trends that are apparent with average annual concentrations for these sites ranging from 169 to 775 ug/l. Not surprisingly for all sample years the results are especially high in the spring and fall likely due to farmstead runoff.

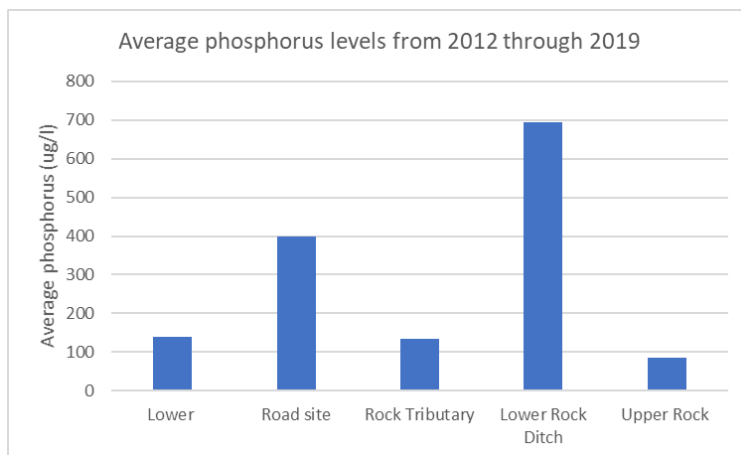
The increase in phosphorus concentration from above to below the corn field and hay fields was less in



2019 (65%) vs 2018 (80%) & 2017 (98%) suggesting field practices may have reduced phosphorus loading but there is a lot of uncertainty in this analysis. The sum of the annual loading from the two drainage areas that drain hay pasture and corn lands was estimated to be 81 kg from 96 hectares which equates to loading of .85 kg/ha. In modeling for Lake Memphremagog this is the average loading rate for pasture and hay land so given the presence of corn which has much higher loading rates this suggests lower loading rates and good management practices in general although additional improvements may still be possible. We intend to monitor runoff by continue to sample all the sites during our next sampling season. The farm is planning to install an improved silage leachate catchment project and a rook gutter to reduce sediment and nutrient runoff in the middle tributary.

### FARM 3

Sampling on this farm was first done in 2012 where the small tributary enters the Barton River. When elevated levels were observed and one site was added in 2013, two in 2014 and then three 2016 to try to locate the phosphorus source areas. In 2019 we sampled the small tributary where it enters the Barton River and four sites that drain the farmstead and farm crop fields. The site with the highest levels



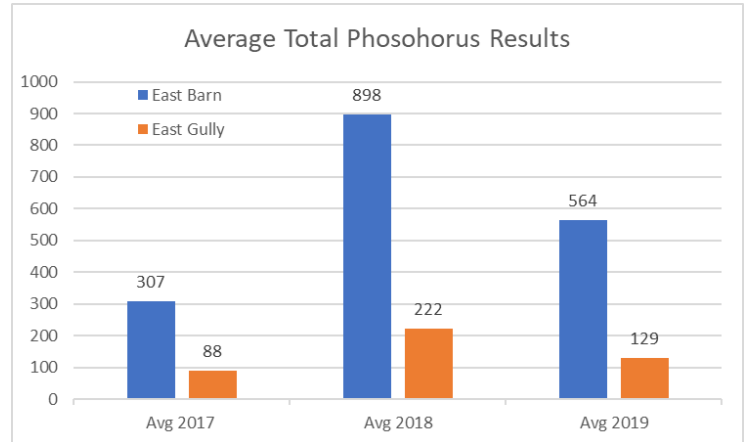
at 695 ug/l and tended to have high levels after rain events application suggesting direct flow from crop fields and suggests the need for an increased conservation measures. Significant work has taken place at the farm with the use of no till, cover crops, adding buffers along the ditch and stream, seeding down the upper portion of the field and replacing the manure pit in the fall of 2018 however we don't yet see improvements in the water quality results. The water quality data for these

sites are variable and so it may take several years before we can see improvements in water quality. We intend to continue to work with this farm to identify priority projects and implement conservation needs through the Orleans County NRCDC RCPP and we will continue to monitor for water quality improvements.

## The Stearns Brook Watershed

### FARM 4

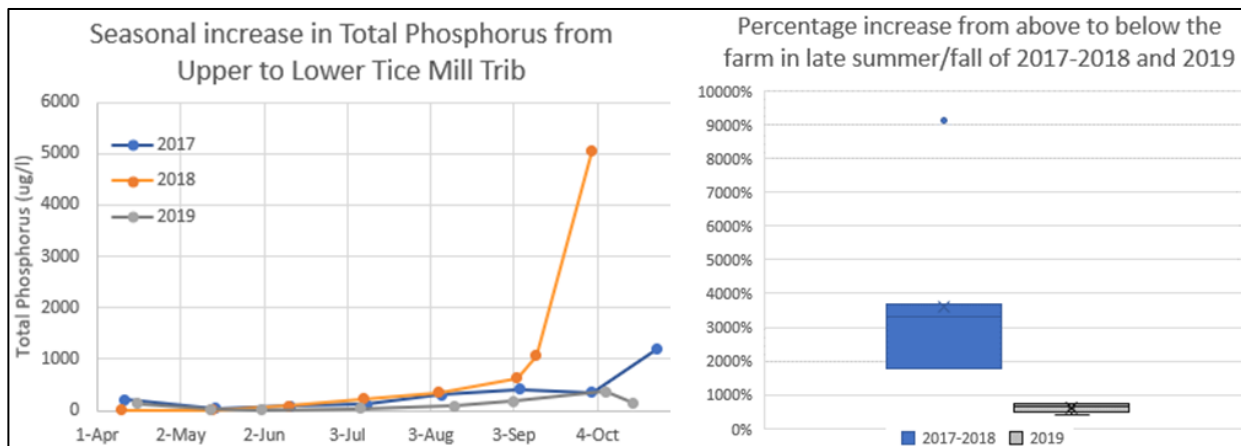
Water quality samples were first taken on the unnamed tributary to the brook near its mouth in 2016 and two additional sites were added further up this tributary, along with four sites on smaller drainages near the farm production area and two sites above and below a pasture. In 2018 and 2019 the sites that were sampled drained the area that the farmer agreed to complete a silage leachate catchment project. The leachate catchment project was complete in August of 2018. The two 2018 sample results



taken after VTAAFM funded project indicated a potential positive impact, but the 2019 results are back at pre-project levels with the highest level in April 2019 sample at 2000 ug/l. In the fall of 2019, the farmer completed a VTAAFM manure pit project. We intend to continue our sampling efforts at this farm to monitor improvements and make recommendations for continued installation of conservation projects as needed. We are also considering adding a above sampling site above the farmstead to bracket the area and potentially account for wetland flows coming in from upstream.

### FARM 5

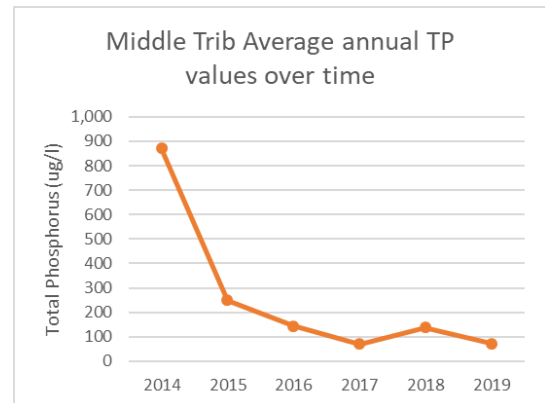
Water quality was first sampled near the mouth of this unnamed tributary to Stearns Brook in 2016 and two additional sites in this watershed were added along the small eastern tributary of this stream that flows through the farm in 2017. These two sites were bracket above and below the farmstead and pasture. In 2017 and 2018 the total phosphorus concentrations were 10 times higher on average at the lower than the upper site. In July of 2019 fencing around the stream, a new barn yard project, stream crossings and laneway projects were completed. After this work was completed the increase in total phosphorus from the upper to the lower sits dropped to 6 times higher. Analysis suggests that this was a real improvement in phosphorus levels in the fall (99.97% chance there was an improvement). This indicates that the projects installed in July significantly improved water quality and while we only have one sample date in October after the remaining work was completed this date has the lowest increase of any fall date sampled so this indicates additional improvements in water quality. Phosphorus levels in the brook downstream from the tributary in 2019 were about half that of the results from 2016-2018.



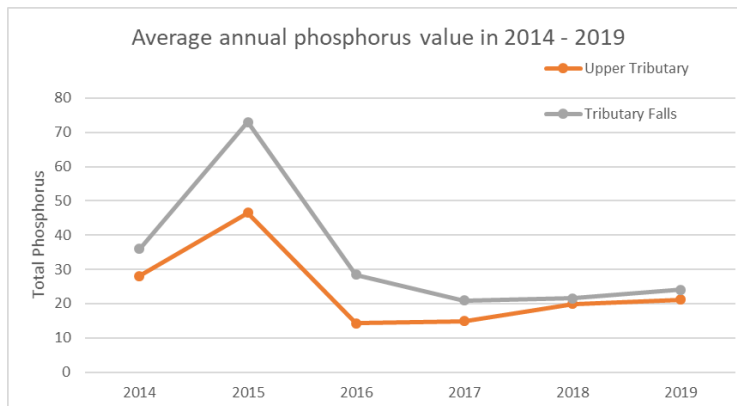
There is a transition on the farm, however if cows are brought onto the facility from another heard, sampling another season would allow us to confirm the magnitude of improvements. The farmer agreed to complete a success story with us to assist us in getting the word out about what farmers are doing in Orleans County to improve water quality and tell the great story that water quality data tells about real improvements due to these conservation efforts. See the appendix A the end of this report.

FARM 6

Water quality was first sampled on the tributary that drain the farm in 2014 to identify source areas in this watershed to help inform efforts to restore water quality of this brook. In 2017, 2018, and 2019 six sites were sampled including four on the tributary and two smaller tributaries. The graph below shows the trend of lower phosphorus values at the Middle Tributary site suggesting work done on fields and main farmstead have been effective and now show that these reductions are significant.



Water quality data shows that there has been a significant improvement between the upper site as compared at the falls site which drains a couple of the corn fields. This suggests that the no till, cover cropping practices and increased buffers have reduced phosphorus runoff. From 2014-2017 phosphorus levels increased by 50% between these two sites but this increase was reduced to an average of just 10% in 2018 and 2019. Water quality results at the lowest site a mile below the farm have remained



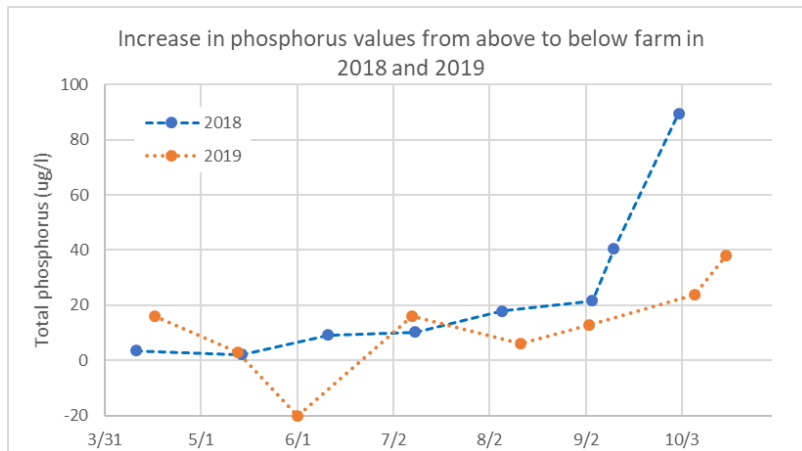
stable over the course of this study suggesting that there may be additional source areas or that there are large amounts of nutrients that still need to flush though this system. VTDEC has collected samples in 2019 for biological monitoring which indicate that conditions in the stream have not improved and thus we intend to continue these monitoring efforts. We will continue to work with this farm to address runoff.

**The Willoughby River Watershed**

FARM 7

In 2018 and 2019 we sampled at 3 sites along the stream that flows through the farm’s pastures and 3 smaller drainages that flow near or through the farmstead area and through culverts under the town road. For 2018 and 2019 average values approximately doubled from the upper to the lower site on the stream. The increase was largest between the middle site and lower site during rain events suggesting rain driven loading between these two sites likely related to runoff from the heavy use in the pasture, the town culvert and the barn ditch that drain that both drain the farmstead. This increase suggests this area generated around 10% of the phosphorus load to Lake Willoughby.

One of the drainage sample sites had elevated phosphorus levels – with extremely high levels on 7/8/19 and significant flow volume suggesting substantial phosphorus loading from this drainage as well. These high results were attributed to manure overflows from a wet 2018 fall and 2019 spring and early summer when the farmers were not able to get out on their fields to spread their manure storage. Data seen in the chart here highlights the fall of 2019 results provides some

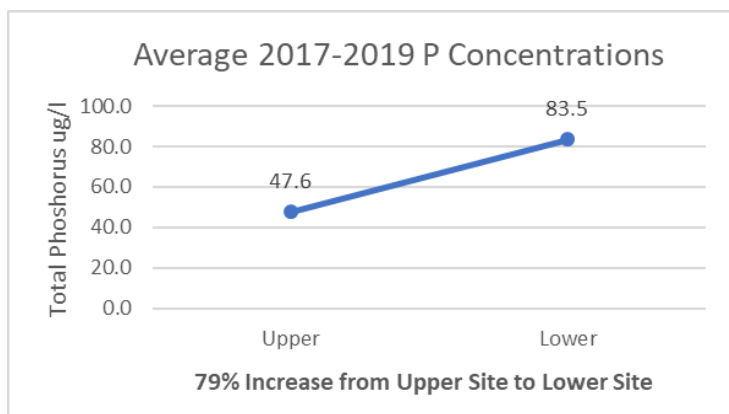


indications that nutrient loading was reduced after the September to October implementation of several pasture related conservation projects. Additional work is being done to address elevated levels. We intend to continue to assist the farm in implementing the additional work needed and continue to monitor for water quality improvements.

### The Black River Watershed

#### FARM 8

Water quality was first sampled along the brook that drains the farm near its mouth in 2010, and in 2017 two additional upper and lower farm bracketing sites were added along the small northern tributary that flows through the farm in 2017. The three years of sampling results have generally shown a consistent increase from the upper to lower sites. Like in 2017 & 2018 the 2019 total phosphorus concentrations had an increase from the upper to the lower site on all sample dates and were on average more than twice as high at the lower than the upper site. Phosphorus concentrations at the lower site were consistently high during snowmelt and following heavy rains. Average concentrations at the lower site during low to moderate flow conditions were at the most two times as high as the State of Vermont phosphorus criteria of 12 ug/l for Aquatic Biota.



Again, this year total nitrogen concentrations were generally low on all sample dates but consistently increased from the upper to the lower site. Even though we don't see an improvement in the sampling data over three years, the estimated average phosphorus loading is 1.2Kg/Ha which is relatively low for a farmstead area. We applaud the farmers daily and project work completed inside and outside the sampling watershed area

to protect the stream. High priority water quality protection work was completed but the runoff flows towards a drainage where we did not have a sampling site and so we would not have captured improvements in water quality that may have resulted from this work. Given the relatively low average loading estimates for this farm and that the large project has been completed we have decided not to continue sampling at this farm.

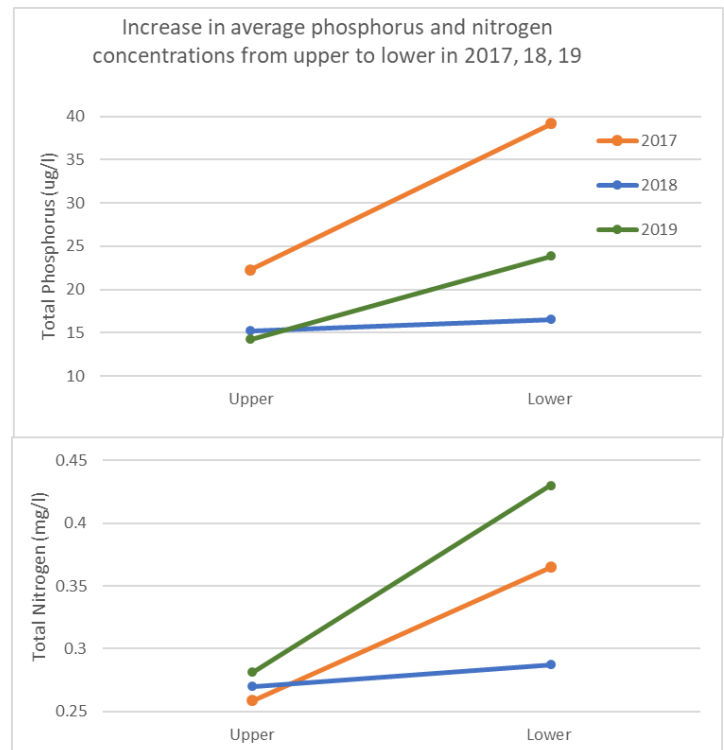


## The Clyde River Watershed

### FARM 9

Water quality was first sampled on this brook that runs through the farm near its mouth in 2006 and on two tributaries of the brook in 2008 and 2009. In 2017 sites were added on the east and west tributaries that flow through the farm, and just above and below the farm and the above and below sites were sampled again in 2018 and 2019. The increase in average phosphorus concentrations between the upper site and lower site dropped from 76% in 2017 to 9% in 2018. This drop is likely a result of no animals being in the pastures having uncontrolled access to the brook. The average increase between these two sites jumped back up to 60% in 2019 when there are animals in the farms pasture again. The increase in average nitrogen concentrations between the upper site and lower site dropped from 41% in 2017 to 6% in 2018. The average increase between these two sites jumped back up to 57% in 2019.

Based on 2017 concentrations we estimated a phosphorus loading of over 200 pounds per year between upper and lower sites which was reduced to less than 50 pounds per year in 2018 or a reduction of over 150 pounds per year. In 2019 the estimated phosphorus loading was intermediate, but these are very general estimates! An analysis of this data shows that the reduction in the increase in nitrogen and phosphorus between these two sites in 2017 and 2018 is statistically significant (97% chance this is real) and close to statistically significant increase between 2018 and 2019 (92% chance this is real). Comparing the 2017 and 2019 data does not show a statistically significant improvement between these years but lower values suggest that the smaller herd and diversion project may have improved water quality.



OCNRCD staff assisted this farmer in actualizing his interest to sell the farm. The farmer is currently working with VHCB through their farm retirement program, VTAAFM and VTFWD to sell the farm to VTFWD for long term protection, restoration and public access. If this is completed, we will continue monitoring these sites to evaluate the improvements in water quality with restoration efforts that are planned.

### Conclusion

The scope and magnitude of our efforts to provide quantifiable data related to monitoring the implementation of agricultural BMP projects on farms continues to improve water quality in the Lake Memphremagog Basin. Out of the 9 RCPP cooperating farms that we have been sampling at since 2017 3 farms have shown statically significant reductions total phosphorus results after BMP implementation. An additional 3 farms have water quality data that provides some indications of reductions in phosphorus but this is not statistically significant although in several cases BMP's were installed in late 2019 so there is limited post data to evaluate and additional data should allow for an evaluation of the impact of this work. Thus, requiring additional post BMP data collection to evaluate these improvement

projects and others that were installed in 2018, 2019 or 2020. Phosphorus levels in surface waters can change greatly based on the season, streamflow, runoff conditions and many other factors. The high levels of variability in phosphorus levels caused by these factors makes it challenging to show statistically significant changes in concentrations caused by BMP installation except in cases where the magnitude of water quality improvements is extremely large, so we are very pleased with the initial program post BMP data. A few of the farm results analysis have indicated BMPs did not address nutrient and runoff sources and so continued work to identify and address sources is ongoing.

Our efforts also continue to provide a meaningful experience for all our cooperating farmers all of which are interested in continuing the water quality monitoring. This was highlighted by one farmer who said to us "I thought the water sampling results wouldn't show any change, but I was pleased and shocked to learn that this on farm measured change shows that indeed farmers and conservationist are making progress." This statement underscores the incredible value this water sampling data provides to farmers. The results enhance the farmers understanding of water quality impacts and responsiveness to make management changes and decisions. This increased knowledge makes this a very impactful water sampling program because the farmers have a greater acceptance of the water quality impairment issues when it is directly related to them. Both offering a positive and affirming experience for farmers and knowing the local waters are improved by their work is very satisfying which leads to behavior change. Farmers also really like knowing that by participation in this program and the implementation of their practices and management changes will directly inform the states complicated efforts to meet the TMDL targets.

This program provides an opportunity to validate the TMDL load reduction estimates associated with different BMP practices which is essential for the credibility and long-term success of the Lake Memphremagog phosphorus TMDL implementation efforts. The TMDL was built using a scenario tool that used broad assumptions on BMP efficiencies, so on the ground analysis such as this allows us to check these assumptions since it will be many years before we will be able to demonstrate reductions in loading at the mouths of larger tributaries.

This successful water quality monitoring program can only happen by drawing on all available funding resources to support farmers to implement these BMP projects. An integral funding source has been the Memphremagog RCPP, 7 of the 9 farms have utilized this USDA NRCS funding source to make these measurable water quality improvements. We will be renewing the RCPP bringing in \$850,0000 with an equal amount of matching funds to support the technical and financial assistance to support farmer water quality improvement efforts over the next five years. We will be sharing a summary of these result and the success story when we make our public announcement about our RCPP renewal. This program makes available long-term technical support and financial resources to these cooperating farmers and future farm cooperators. This water sampling program is integral in guiding and evaluating this work. This RCPP and LaRosa funded water quality monitoring study has proven to be very successful at effectively engaging farmers and measuring the effectiveness of agricultural BMPs. This success paved the way for positive experiences for other farmers and has quantified phosphorus reductions from agriculture in our impaired watersheds. We very much look forward to continuing this valuable and important sampling work in 2021.



NONPOINT SOURCE  
POLLUTION SUCCESS STORY

## Installing Livestock Exclusion Best Management Practices Reduces Phosphorus

**PROBLEM:**

The Morin farm is in the town of Holland within the Stearns Brook watershed. Stearns Brook flows northeasterly and is listed on the VT Dept of Environmental Conservation 2016 stressed waters list for agricultural and gravel road runoff and morphological instability. Stearns Brook drains to Quebec’s Lake Massawippi which has elevated levels of phosphorus.

The coordination efforts of Orleans County Natural Resources Conservation District (NRCD) and other partners focused efforts have improved water quality conditions by implementing best management practices throughout the watershed.

Elevated levels of phosphorus in the unnamed waterway that runs through the Morin farm were discovered by the Orleans County Conservation District through the LaRosa Volunteer Water Quality Monitoring program. Samples were collected 8 times per year including 2 rain events in 2017, 2018 and 2019 at two locations, above and below the farm.

**PROJECT HIGHLIGHTS:**

Andre Morin bought his 116-acre home farm from his parents in 1992, who had purchased it in 1984. In 2016, he started working with the Vermont Land Trust and the Vermont Housing & Conservation Board to place a permanent conservation easement on his farm.

As part of the easement agreements Andre agreed to address all Required Agricultural Practices (RAPs) including addressing the herd management practices of a heavy use production area adjacent the waterway. With assistance from Orleans County NRCD staff he has discontinued the practice of feeding in paddocks adjacent to the waterway and allowing livestock access along the waterway.

In 2019 Andre completed a new heavy use area barn yard project with funding from the VT Agency of Agriculture, Food and Markets’ Best Management Practices program. He also installed exclusion fencing, alternative watering, stream crossings and laneway projects with funding from the Orleans County NRCD USDA Regional Conservation Partnership Program to bring the farm into compliance with the RAPs.

Andre said, “The project improved the farm because the cows are out of the mud, there is more room to feed in one place, it is easier to maintain, it helps my manure management, it looks a lot nicer and the work benefits the local waters because the cows are not going in the stream whenever they want.” He sold his cows in the winter of 2020 because of his personal health limitations but his brother John will continue to use the facilities, pastures and crop fields.



For additional information contact:

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Orleans County NRCD Manager, Sarah Damsell 802 334 6090 x 7008

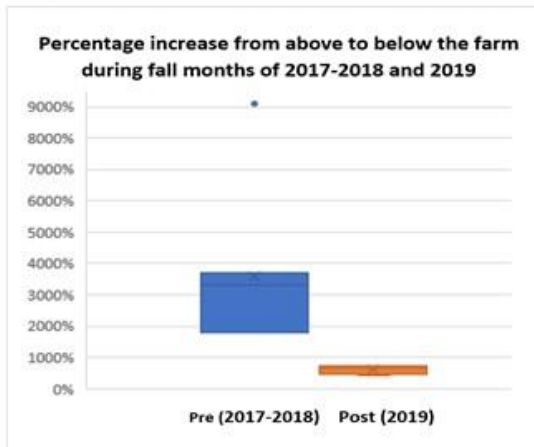
**WATER QUALITY RESULTS:**

Total phosphorus concentrations were considerably higher on average at the lower than the upper site in 2017 and 2018. This tended to increase in August through October where on average the lower site was 36 times as high as the above site in 2017 and 2018.

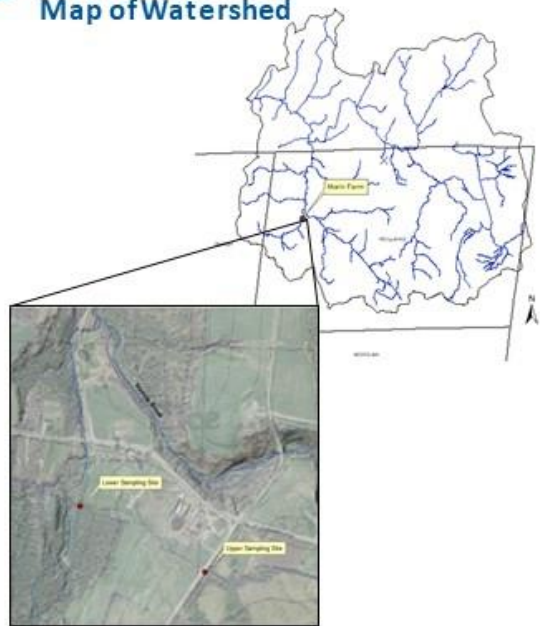
The installation of BMPs in 2019 appears to have dramatically reduced the phosphorus loading from the farmstead and pasture areas. After this work was completed the increase in total phosphorus from the upper to the lower sites dropped to 6 times higher.

Analysis suggests that this was a real improvement in phosphorus levels in the fall, with over a 99% chance of significant improvement. It is unusual to be able to document such a dramatic improvement with only one season of data. The box plot graph below shows the percent increase in phosphorus concentration during the fall season from above to below the farm in 2017-2018 and 2019 showing dramatic improvement after BMP's were installed in July of 2019.

**Water Quality Sampling Results**



**Map of Watershed**



**REQUEST FOR ACTION:**

Andre believes that farm conservation work that helps water quality "is good because everybody uses rivers and lakes and if we don't keep them clean then we will all pay the price. When one farm here and another farm there does a project like this it adds up to have a bigger effect and I am proud to be a part of that work". Andre said he would suggest to other farmers doing this work because "Working with the staff was real good, everyone listened to my suggestion and their openness was a big help. If you have time to work on the project, they will help you do it!"



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