Summary Report: 2019 Sampling Results
Addison County River Watch Collaborative

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Executive Summary

This report summarizes the 2019 water quality results for six rivers monitored by the Addison County River Watch Collaborative (ACRWC). Sediment, phosphorus, nitrogen, and *E. coli* were monitored at 34 stations in the Lemon Fair, Lewis Creek, Little Otter Creek, Middlebury River, New Haven River and the lower Otter Creek watersheds. Sampling events occurred on Wednesdays early in the month for two spring dates (April and May) and four summer dates (June, July, August and September). The year, overall, was characterized by above-normal precipitation. In some watersheds, flow conditions never dropped to low-flow levels during the sampling season. For the ACRWC, 2019 also marked a year of transitions. The State agricultural lab transferred to a new location and a new ordering system, and the ACRWC transitioned between technical coordinators. These changes resulted in some disruptions that should smooth out over time.

Due to a request from the La Rosa Volunteer Monitoring Program to conserve analytical expenses, *E. coli* was sampled in only three of the six rivers in 2019. Samples were limited to recreational sites in the Lewis Creek and the New Haven and Middlebury Rivers, as well as at a bracket monitoring project in the Lewis Creek. Counts at all five recreational sites exceeded the health-based standard of 235 organisms/ 100mL during at least one summer sampling event. Generally, elevated *E. coli* detections are associated with developed land uses including nearby agriculture and livestock with direct access to the river. Human sources (e.g., failed septic systems) and wildlife sources of *E. coli* also exist in these rivers, including beaver, deer, and waterfowl. For example, a beaver dam that failed in April in the New Haven River may have contributed to higher *E. coli* levels in that watershed.

Two to three sentinel stations in each watershed are monitored every year to track long-term trends in water quality. Segments of the Little Otter Creek, Lewis Creek, Middlebury River, and Otter Creek are listed as impaired and included in a state-wide Total Maximum Daily Load plan for Bacteria. Each of the watersheds contributes phosphorus and sediment to Lake Champlain, either directly (Lewis Creek, Little Otter Creek) or via Otter Creek (Middlebury River, New Haven River, Lemon Fair).

Comparison to phosphorus standards can be made only when flow is at or below the Low Median Monthly flow, which occurred only in the Otter Creek, Little Otter Creek, and the Lemon Fair River and only in the month of August. During this single low-flow event, total phosphorus concentrations exceeded the respective Vermont water quality standards at sentinel stations in all three watersheds. High phosphorus concentrations at high flow events can suggest watershed areas that are significant loaders of phosphorus to Lake Champlain, as the most substantial loading occurs at high flow. While there is no standard against which to compare these events, phosphorus exceeded 100 ug/L at stations along the Lemon Fair River, Little Otter Creek, and Lewis Creek during at least one high flow event in 2019. Turbidity was sampled only in the Lewis Creek watershed at the sites selected for the Tyler Bridge bracket monitoring project. Turbidity in the upper portions of this area fell below the standard of 10 NTUs during dry-weather, base-flow conditions but rose above the standard at the Ferrisburgh sites closest to Lake Champlain.

Based on historical monitoring results, turbidity and phosphorus concentrations tend to become elevated during high flows in the mountainous watershed areas of the Lewis Creek, Middlebury River,

and New Haven River. In the valley watershed areas (Little Otter Creek, Lemon Fair, Lewis Creek's Pond Brook and valley area, and Otter Creek), the turbidity and phosphorus concentrations tend to be elevated on a more frequent basis, in a wider range of flow conditions.

In the Lewis Creek and the Lemon Fair River, 2019 was the second year of a two-year focus study, where additional sites were monitored for an expanded list of parameters to better define the spatial extent and magnitude of sediment and nutrient concentrations in these watersheds.

- Lewis Creek watershed: 2019 was the second year of bracket monitoring at six stations established to better define potential or suspected source(s) of pathogens detected in past years at the Tyler Bridge Road crossing of the Lewis Creek (LCR14). Bracket monitoring during both wet- and dry-weather conditions in 2017-2018 identified a segment of the creek upstream of Tyler Bridge with increased *E. coli* and Total Phosphorus. Several potential sources of pathogens and nutrients exist in the drainage area to this segment, including human and wildlife sources, and livestock with direct access to the Creek. These livestock were removed from the Creek in October 2018 as part of a farm transition and property sale. Data from the first two relevant post-treatment sampling events in 2019 are promising, showing substantial drops in both *E. coli* and Total Phosphorus. This bracket monitoring study will continue in 2020 and include targeted wet-weather samples in addition to the 6 regular sampling events.

- Lemon Fair River watershed: Tributary monitoring was carried out in the Lemon Fair River to better define spatial trends in sediment and nutrients between the Shacksboro Road crossing in Shoreham (LFR15.8) and the Lemon Fair Road crossing (LFR4) in Weybridge. New stations were established at the Buttolph Road crossing of the Perry Brook and Bascom Brook in Shoreham, as well as three new stations on the Beaver Branch in Cornwall. Turbidity and Total Phosphorus results for dry-weather, baseflow conditions on summer sampling dates suggest a contributing source(s) of sediment and nutrients between the Shacksboro Road crossing (LFR15.8) and Route 74 (LFR12), from areas largely outside of the contributing Perry Brook, Bascom Brook and Beaver Branch tributaries.

While the scheduled two-year cycle of focused monitoring is now complete in the Lemon Fair River and Lewis Creek, there remain unanswered questions about the geographic distribution of nutrients in the Lemon Fair River. Also, a grant from the LaRosa Volunteer Monitoring Program has generously provided funding for the Lewis Creek bracket monitoring study through 2020. While the ACRWC will move forward with a two-year monitoring focus on the Middlebury River and Otter Creek, the Collaborative will select only a few sites and parameters on these two focus rivers while continuing to build on the information gained regarding sediment and nutrients in the Lemon Fair River and Lewis Creek.

ACRWC relies on partners to identify projects for implementation and ongoing monitoring. Monitoring results have been shared with partners including the Lewis Creek Association (LCA), the VT Agency of Agriculture, UVM Extension, USDA Farm Service Agency, and the Otter Creek Natural Resource Conservation District to support outreach to landowners and farmers in these watersheds and the design of Best Management Practices. The ACRWC and LCA also share data with conservation commissions and planning boards in watershed towns to inform Town and stormwater plans and conservation investments.

Acknowledgements

Sampling in six Addison County rivers was carried out by a network of trained volunteers operating under the Addison County River Watch Collaborative (fiscal agent and partner, Lewis Creek Association). Logistical and technical support were provided by Angie Allen of the VTDEC Watershed Planning Program, Kevin Behm of the Addison County Regional Planning Commission and Kristen Underwood of South Mountain Research & Consulting. Analytical services were provided by the Vermont Agricultural & Environmental Laboratory (previously LaRosa Laboratory) in Randolph, VT, under direction of Rebecca Harvey, through an analytical services partnership grant under the coordination of Jim Kellogg.

Operational support was provided to ACRWC through private and corporate donations and in-kind services. ACRWC also receives annual contributions from 10 Addison County towns, including

- Bristol
- Cornwall
- Ferrisburgh
- Lincoln
- Middlebury
- New Haven
- Ripton
- Salisbury
- Vergennes
- Weybridge

1.0 Introduction

This report summarizes the 2019 sampling results for six rivers monitored by the Addison County River Watch Collaborative (ACRWC).

2.0 Background

The ACRWC has been monitoring water quality (including sediment, phosphorus, nitrogen, and *E. coli*) in six watersheds in Addison County for two and a half decades, beginning in 1992:

- Lemon Fair River (2003 – present)
- Lewis Creek (1992 – present)
- Little Otter Creek (1997 – present)
- Middlebury River (1993 – present)
- New Haven River (1993 – present)
- Otter Creek (1992 – present)

Baseline data now exist for the six ACRWC watersheds, so the sampling schedule was revised, beginning in 2010, to include longer-term temporal trend monitoring at a reduced number of strategic sites in each watershed (sentinel sites) with a reduced number of water quality parameters. These sentinel sites are combined with a focused monitoring effort in two of the six watersheds that rotate for a period of two years "on" and four years "off" (Table 1). The focused evaluation typically involves a greater number of sites and parameters than the sentinel sites, and is conducted to meet watershed-specific data needs.

Table 1. Rotational Schedule for Focused Monitoring

2016 – 2017	2018 - 2019	2020 - 2021
Little Otter Creek	Lewis Creek	Middlebury River
New Haven River	Lemon Fair	Otter Creek

For the 2019 sampling season, the Lewis Creek and the Lemon Fair River were focus watersheds (Figure 1, watersheds in bold outline), for the second year in a row. Rotational sites were selected and sampled in 2018 in addition to the sentinel sites in these two watersheds. The same sites were sampled during the 2019 focus year. Table 2 displays the schedule of sampling sites and parameters for the 2019 season. "R" denotes a rotational site, "S" for a sentinel site, and "O" for other. A different schedule of sampling parameters is indicated for spring versus summer months. For example, *E. coli* was added to the list for summer events. While ACRPC originally scheduled *E. coli*, Turbidity, and Total Suspended Solids analyses for the sites highlighted in Table 2, these were eliminated for the Summer sampling events to comply with a mid-season request from the LaRosa Volunteer Monitoring Program to reduce requested services.

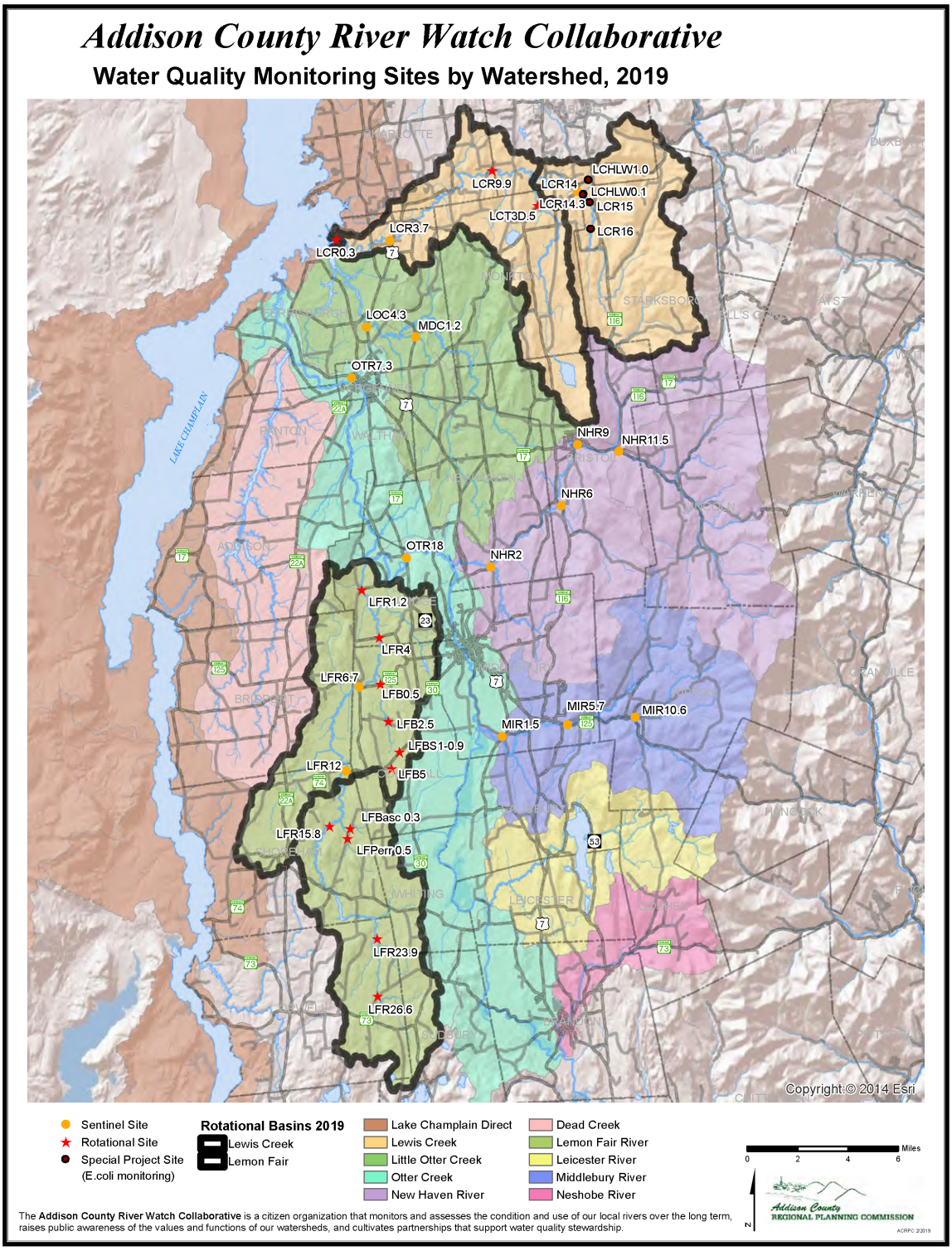


Figure 1. Location of ACRWC monitoring stations for 2018 and 2019.

Table 2. 2019 Schedule of Sites / Parameters – Spring, Summer and Fall

Project Number: **137-01**				Spring Schedule (Apr, May)						Summer Schedule (Jun, Jul, Aug, Sep)						
Sample Year: **2019 - Revised**										PARAMETERS						
Type	**River Name**	**Site ID**	**Site Location**	**TP**	**DP**	**TN**	**NOX**	**Turbidity**	**TSS**	***E.coli***	**TP**	**DP**	**TN**	**NOX**	**Turbidity**	**TSS**
R	Lewis Creek	LCR0.3	Boat Access upstream of Hawkins Bay	X				X			X					
S	Lewis Creek	LCR3.7	Old Route 7 Bridge	X				X			X					
R	Lewis Creek	LCR9.9	Upper Covered Bridge, Roscoe Rd.	X				X			X					
R	Pond Brook	LCT3D.5	Silver Street culvert	X				X			X					
S	Lewis Creek	LCR14	Tyler Bridge	X	X	X		X		X	X	X	X		X	
O	Hollow Bk (Lewis Ck)	LCHLW1.0	Tyler Bridge Rd X'g of Hollow Bk	X	X	X		X		X	X	X	X		X	
O	Hollow Bk (Lewis Ck)	LCHLW0.1	Hollow Brook at Confl w/ Lewis	X	X	X		X		X	X	X	X		X	
O	Lewis Creek	LCR14.3	Just above confluence of Hollow Bk	X	X	X		X		X	X	X	X		X	
O	Lewis Creek	LCR15	Just above Clifford stabilized crossing	X	X	X		X		X	X	X	X		X	
O	Lewis Creek	LCR16	LaRue bridge crossing	X	X	X		X		X	X	X	X		X	
R	Lemon Fair River	LFR1.2	Prunier Road bridge	X	X	X		X	X		X	X	X			
R	Lemon Fair River	LFR4	Lemon Fair Rd bridge	X	X	X		X	X		X	X	X			
S	Lemon Fair River	LFR6.7	Route 125 bridge.	X	X	X		X	X		X	X	X			
S	Lemon Fair River	LFR12	Downstream of Route 74 bridge	X	X	X		X	X		X	X	X			
R	Lemon Fair River	LFR15.8	Shacksboro Road bridge	X	X	X		X	X		X	X	X			
R	Lemon Fair River	LFR23.9	Murray Road Bridge	X	X	X		X	X		X	X	X			
R	Lemon Fair River	LFR26.6	Old Sawmill Rd bridge	X	X	X		X	X		X	X	X			
R	Beaver Branch (LFR)	LFB0.5	Route 125 crossing	X	X	X		X			X	X	X			
R	Beaver Branch (LFR)	LFB2.5	Sperry Road crossing, Beaver Branch	X	X	X		X			X	X	X			
R	Beaver Branch (LFR)	LFB5	Clark Rd bridge	X	X	X		X			X	X	X			
R	Trib to Beaver Br (LFR)	LFBS1-0.9	Route 74 crossing	X	X	X		X			X	X	X			
R	Bascom Brook (LFR)	LFBasc 0.3	Buttolph Rd crossing	X	X	X		X			X	X	X			
R	Perry Brook (LFR)	LFPerr 0.5	Buttolph Rd crossing	X	X	X		X			X	X	X			
S	Little Otter Creek	LOC4.3	Route 7 Bridge	X							X					
S	Mud Creek	MDC1.2	Wing Rd./Middlebrook Rd. (South)	X							X					
S	Middlebury River	MIR1.5	Shard Villa Road Bridge	X						X	X					
S	Middlebury River	MIR5.7	Midd. Gorge @ Rte 125 Bridge	X						X	X					
S	Middlebury River (Midd Br)	MIR10.6	Natural Turnpike Road	X							X					
S	New Haven River	NHR2	Muddy Branch confluence (just below)	X							X					
S	New Haven River	NHR6	Route 116 Bridge, Sycamore Park							X						
S	New Haven River	NHR9	South St. Bridge	X							X					
S	New Haven River	NHR11.5	Bartlett's Falls Pool							X						
S	Otter Creek	OTR7.3	Vergennes Falls / below outfall	X							X					
S	Otter Creek	OTR18	Twin Bridges Picnic Area	X							X					

Types: "R" denotes a rotational site, "S" indicates a sentinel site, and "O" is for other.

**In spring, Total Suspended Solids and Turbidity were sampled in April only. They were removed from the plan before the May sampling, after ACRWC was asked for a second round of plan revisions in April.*

3.0 Methods

Water quality samples were collected by ACRWC volunteers in accordance with quality assurance procedures outlined in the EPA-approved Generic Quality Assurance Project Plan prepared by VTDEC. A Quality Assurance Summary report for the 2019 sampling data is provided as Appendix D. Samples were delivered to the Vermont Agricultural & Environmental Laboratory (VAEL) housed at the Vermont Technical College campus in Randolph, Vermont.

During 2019, ACRWC volunteers collected grab samples in six watersheds at 34 sites during two Spring events (April and May) and four Summer events (June, July, August and September). Sampling dates were pre-determined. Typically, they were scheduled on the first Wednesday of each month, but the April event was delayed a week because of icy conditions, and the July date was delayed to avoid the holiday week. Sampling dates were not designed to capture any specific flow condition.

Scheduled Monthly Sampling – Sentinel, Rotational, and Bracket sites

- April 10
- May 1
- June 5
- July 10
- August 7
- September 4

4.0 Precipitation Data

Precipitation data were compiled from existing weather stations in vicinity of the ACRWC watersheds (Appendix B, Table B-1). Overall, 2019 was slightly above average for precipitation, as recorded at regional weather stations in South Burlington (Airport) and Rutland. Near-normal snowfall was recorded for the Rutland station during the winter of 2018-2019, while higher-than-normal snowfall was recorded at the South Burlington station (Appendix B, Table B-2). While there is no weather station in Addison County, Northeast Regional Climate Center data indicate that Addison County may have received more of precipitation than either of these nearby stations.

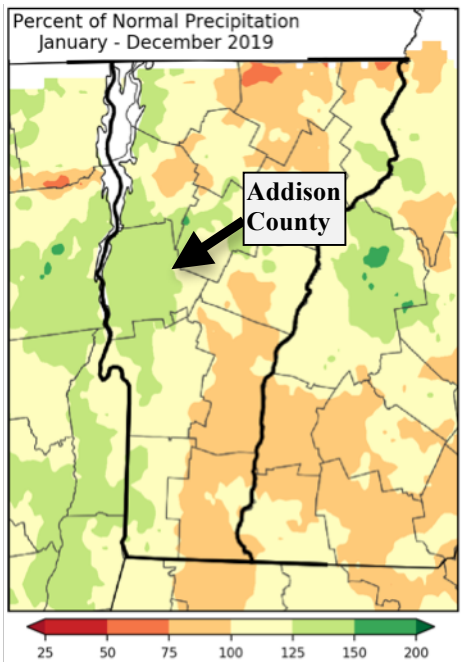


Figure 2. Data from the Northeast Regional Climate Center indicate that Addison County had higher than average precipitation in 2019, with most of the county averaging 125 to 150 percent of normal (http://www.nrcc.cornell.edu/regional/monthly/monthly.html).

5.0 Hydrologic Data

5.1 Seasonal Trends

Appendix B presents graphs of the instantaneous discharge record (provisional data) from 2019 for USGS flow gaging stations on the New Haven River, Lewis Creek, Little Otter Creek, and the Otter Creek at Middlebury stations. Primary ice-out conditions occurred slowly in all four rivers in April, although the New Haven River also experienced a partial thaw in January with conditions approaching 2-year flood recurrence levels. In April, the New Haven and Otter Creek Rivers approached or exceeded 2-year flood recurrence intervals. Lewis Creek did not experience such high water levels until May. The Little Otter Creek rose slowly at this time, but no flooding occurred. Summer storm events also affected the New Haven River in July, when it again reached the 2- year flood recurrence interval. Two-year flood conditions were exceeded in the Lewis Creek and the New Haven River in early November, following an end-of-October storm. (Olson, 2014).

The 2019 sampling season was not one of significant flooding or significant drought, although the New Haven River achieved a 10-year flood level and 50-year flood level during two October storms. Lewis Creek experienced a 10-year flood during the second of these events, dubbed "the Halloween storm." These reported flood recurrence intervals were documented at the downstream gages; flooding was more severe in the un-gaged headwaters, according to local water quality specialist Kristen Underwood. Overall, flows in all watersheds were higher than normal for most of the year. In fact, low flow conditions were not achieved at all in Lewis Creek or the New Haven River until after our sampling season, when September conditions were close to normal in all rivers. Water levels then rose to somewhat higher than normal once again for the rest of the year. While flows throughout the rest of the year in Otter Creek were higher than normal, they receded to slightly below the Low Median Monthly flow value for most of August and September before rising again.

Figure 3. October brought both a 10-year and a 50-year flood to the New Haven River in 2019.

5.2 Flow Conditions During Sampling

During scheduled monthly sampling, volunteers encountered higher-than-normal flows on nearly all sample dates. High-flow conditions in which water was actively rising or falling in response to recent rainfall or snow melt—also called freshet flows—were encountered during spring events in April and May and continued into June (Appendix B, Table B-3). The July event represented moderate-flow, baseflow conditions on all four gaged rivers (Lewis Creek, the New Haven River, Little Otter Creek, and Otter Creek), where river stage was not changing appreciably and groundwater levels were relatively high following spring rains. High flow levels are defined as those flow conditions which are equaled or exceeded only 25% of the time, while moderate flows are equaled or exceeded between 25 and 75% of the time[1]. Low-flow conditions are equaled or exceeded more than 75% of the time, based on a flow duration curve of daily mean flows (Appendix B). Baseflow conditions represent relatively stable flow stage, not significantly rising or falling in response to a rainfall or snowmelt event.[1] The August event coincided with low-flow, base-flow conditions in the Little Otter Creek, but localized thunderstorms the night before the sample date caused the New Haven River and Otter Creek to rise significantly. While the Lewis Creek did not rise post-storm, water levels were not low enough to be considered base flow. In all four gaged rivers, significant rain in the days prior to the September sampling event increased water levels to moderate flows.

Figure 4 presents daily mean flows recorded at the USGS gage in the Little Otter Creek during the 2019 season. Sample dates are superimposed as orange circles for the six scheduled monthly sampling dates. During the dry-weather sampling event in August, Little Otter Creek exhibited low-flow, base-flow conditions, although discharge was still above the Low Median Monthly flow (Appendix B, Table B-3). This was the only sampling date to occur under these conditions, and the Little Otter Creek was the only gaged river where low-flow, base-flow conditions coincided with a sampling date.

[1] VTDEC *Guidance on Streamflow Observations at time of Water Quality Sampling of Rivers and Streams*

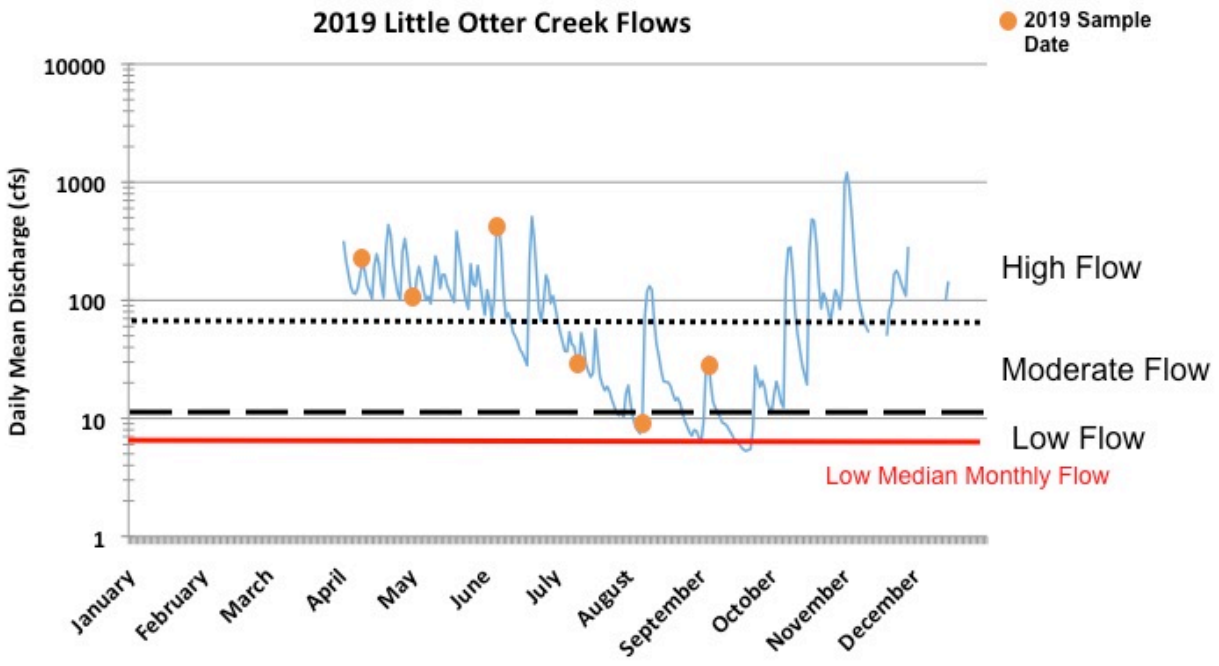


Figure 4. Daily mean flows measured at the USGS streamflow gaging station on Little Otter Creek during the 2019 sampling season.

6.0 Monitoring Results

Appendix C contains quality-assured sample results for the 2019 season for the ACRWC watersheds. Attachments 1-6 summarize these results for each watershed. These attachments are handouts for use in future outreach events to watershed stakeholders and relevant town boards. As discussed in Section 2.0, the Lewis Creek and the Lemon Fair River were chosen as focus watersheds for 2019. Therefore, sample results are presented for sentinel as well as rotational sites in these two watersheds.

In general, water quality results for 2019 were consistent with historic results and trends summarized in the 2009 Draft Water Quality Reports for each watershed (Hoadley, 2009). Expanded information has been gathered for newly-established stations in focus watersheds. The Vermont Agency of Natural Resources (VTANR) updated the Vermont Water Quality Standards, effective January 2017 (VWMD, 2016). Water quality standards relevant to each watershed are detailed in the footnotes in Appendix C.

The ACRWC stations are monitored to: (1) evaluate health and safety at swimming holes and recreation sites; (2) track temporal trends in constituents; (3) investigate spatial trends in constituents; (4) build data sets for assessing the effectiveness of implemented treatments or management practices; and (5) compute coarse estimates of pollutant loads.

6.1 Health and Safety at Swimming Holes and Recreation Sites

The original sampling motivation for many member groups of the Collaborative was to monitor for pathogens at swimming holes and other popular recreation sites on our Addison County rivers. Twenty-seven years later, measuring and publicizing *E. coli* data continues to be a principal goal of the ACRWC. Historic data from ACRWC has informed the *Vermont Statewide TMDL for Bacteria-impaired Waters* (VTDEC, 2011) which addresses impaired segments of the Little Otter Creek, Lewis Creek, Middlebury River, and Otter Creek.

This year, *E. coli* counts exceeded the health-based standard of 235 organisms/ 100 mL at every station during one or more summer sampling dates. This included one site on the Lewis Creek and two locations each on the Middlebury and New Haven Rivers. In contrast with past years, not all rivers or all stations were monitored this year for *E. coli*, due to a request from LaRosa Volunteer Monitoring Program to conserve analytical expenses. As a consequence, no stations on the Otter Creek, Little Otter Creek, or the Lemon Fair River were tested for *E. coli*, and only recreational sites in the New Haven and Middlebury Rivers were tested. In Lewis Creek, *E. coli* was sampled as part of an on-going bracket monitoring study to identify sources of *E. coli*, but samples were limited to the sites identified for this study, which included one recreational site. Generally, elevated *E. coli* levels were associated with developed land uses including nearby agriculture and livestock with direct access to the river. Human sources (e.g., failed septic systems) and wildlife sources of *E. coli* also exist in these rivers, including beaver, deer, and waterfowl. Periodic sewage overflows from wastewater treatment systems and combined stormwater/sewer systems were recorded this past year in the Otter Creek[2], and may have contributed to elevated pathogen levels. However, cutbacks in *E. coli* testing meant that we were unable to monitor for this parameter in the Otter Creek.

During the Summer of 2019, each of the recreation sites sampled had one or more detection of *E. coli* above the health-based standard during the four dates sampled (Table 3). At all sites except Sycamore Park, values were elevated during the June sampling, which occurred at high flows that followed a Spring storm. At Sycamore Park, Bartlett's Falls Pool, and Tyler Bridge, *E. coli* levels were also elevated during the August sampling event. For the New Haven River, this sampling event followed localized thunderstorms that elevated water levels in the watershed. While it does not appear that the Tyler Bridge site experienced these storms, the wet Spring and Summer meant that even base flow conditions were elevated above normal for August, resulting in moderate flow conditions. Historic monitoring of Addison County rivers show that *E. coli* counts can become elevated during high flow conditions following heavy rains or snow melt, and can also be associated with low-flow conditions and very warm Summer-Fall temperatures.

In the past, the ACRWC posted monthly provisional *E. coli* results at popular recreation sites on the New Haven River, Middlebury River, Lewis Creek and Otter Creek. Notices are also posted electronically on *Front Porch Forum* (www.frontporchforum.com). Perhaps because 2019 was the inaugural year of the VAEL lab's new location in Randolph, longer turn around times for *E. coli*

sampling results precluded the ACRWC from posting *E. coli* data in a timely fashion.. Because providing this information is integral to our mission, the ACRWC is actively searching for funding that will allow for in-house analysis or analysis through a private lab that can provide faster results. Look for our signage at your favorite swimming hole, or contact Matt Witten, Managing Director, mwitten@gmavt.net, for *E. coli* posting information.

Table 3. Number of E. coli detections above health-based standards at recreation sites and swimming holes in Summer of 2019. This includes three sample dates: June 5, July 10, and August 7). While samples were also collected on September 4, they were not analyzed due to an error at the VAEL lab.

River Name	Site ID	Site Location	Town	# of Detections
Lewis Creek	LCR3.7	Old Route 7 Bridge	Ferrisburgh	NS
	LCR14	Tyler Bridge	Monkton	**2**
Middlebury River	MIR1.5	Shard Villa Road bridge	Middlebury	**1**
	MIR5.7	Middlebury Gorge @ Rte. 125 bridge	Middlebury	**1**
New Haven River	NHR0.5	Dog Team Tavern (former)	New Haven	NS
	NHR2	Muddy Branch confluence (just below)	New Haven	R
	NHR5	Munger Street Bridge	New Haven	NS
	NHR6	Route 116 bridge (Sycamore Park)	Bristol	**1**
	NHR9	South Street bridge	Bristol	R
	NHR11.5	Bartlett's Falls Pool	Bristol	**2**
	NHR15	South Lincoln bridge (Gap Road)	Lincoln	NS

NS = Not scheduled for sampling in 2019.
R = Removed from sampling plan due to La Rosa request to reduce expenses

6.2 Trend Monitoring - Temporal

Water quality in the ACRWC watersheds varies over time, in response to climate change, seasonal fluctuations in weather and vegetation, and daily to seasonal variations in hydrology. Sentinel stations were established to track interannual variability in water quality resulting from natural and anthropogenic factors such as shifting land use or changes in management practices. Sentinel stations are positioned at locations which offer a finer-scale assessment than the single long-term monitoring stations maintained by VTDEC at the mouth of the Lewis Creek, Little Otter Creek and Otter Creek. In other words, the ACRWC sentinel stations are located further upstream on our six rivers to examine long-term trends at a sub-watershed scale, as a complement to the Lake Champlain Long-term Tributary Monitoring Program[3]. The ACRWC reviews long-term trends at its sentinel stations every six to ten years, depending on the availability of funding.

6.3 Trend Monitoring – Spatial

Water quality in the ACRWC watersheds also varies in space, depending on the geologic setting and soil types present in the catchment areas draining to each station, as well as variation in land use and land cover characteristics (see Appendix A). Focus monitoring was carried out during 2019 in the Lewis Creek and Lemon Fair River watersheds, for the second year in a row, to better define the spatial

extents and magnitudes of pathogen, sediment and nutrient concentrations in these watersheds. Detailed results for these two focus watersheds are provided in Appendix E. The following paragraphs highlight results which help to better define spatial trends in these watersheds.

6.3.1 Lewis Creek

A multi-year bracket monitoring study at the Tyler Bridge Road crossing of the Lewis Creek (LCR14) will allow the ACRWC tobetterunderstandpotential or suspected source(s) of consistently elevated pathogens.Six stations were monitored, including sentinel station LCR14 and five temporary stations upstream of LCR14 (Figures 5, 6). Season 2019 was the third year of bracket monitoring at these sites, following a special project implemented in2017 and reported separately (SMRC, 2018). This study will continue for one more year, in 2020.

E. coli counts exceeded the State's health-based standard of 235 org/100 mL for a majority of the sample dates at bracket stations LCR16 through LCR14 (Attachment 2). The geometric mean of results exceeded the State's geomean standard of 126 organisms/ 100 mL at these same stations during the dry-weather, base-flow conditions in the Summer of 2018 and 2019 (Figure 5).

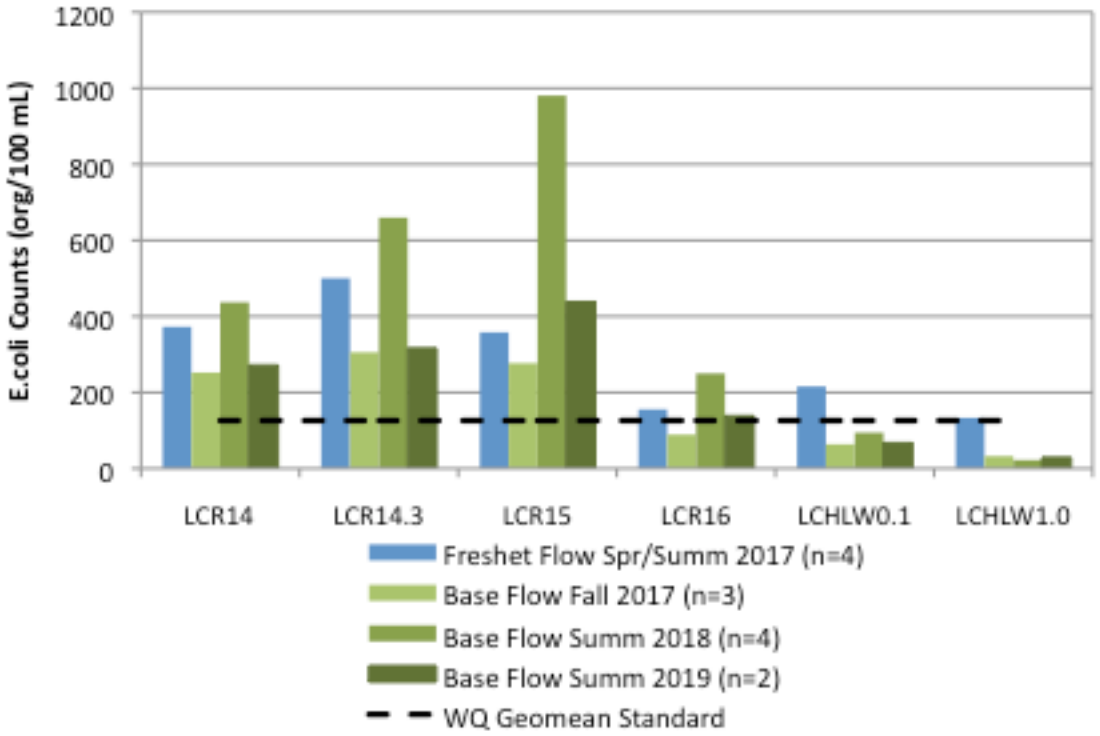


Figure 5. Geometric mean of E. coli monitoring results for Lewis Creek and Hollow Brook bracket monitoring stations during wet-weather, freshet flow events (in blue) versus dry-weather, baseflow events (in green) during 2017, 2018, and 2019.

Downstream along the main stem, an increase in mean *E. coli* counts was apparent in 2018 compared to upstream "control "station LCR16 and station LCR15, followed by a decline in*E. coli*

counts at stations LCR14.3. A similar pattern was observed during both dry- and wet- weather conditions in the previous year (Figure 5), and Total Phosphorus concentrations were also elevated at LCR15 (see Appendix E). These results indicate a contributing source(s) of bacteria and nutrients within the drainage area of LCR15.

Sources of fecal matter in surface waters can be variable, and include humans, ruminants (e.g., deer and cows), wildlife, and waterfowl (USEPA, 2011). The upstream drainage area to Tyler Bridge Road is sparsely populated by residential structures serviced by onsite septic systems (Figure 6). Failing septic systems can be a source of *E. coli* to groundwater and to the Creek, particularly for those structures located within the riparian corridor. Station LCR14 is located one mile downstream of a pasture where for several decades dairy cows have had direct access to the stream along a mile of pasture (small, conventional dairy). Another conventional dairy farm, located 0.3 mile upstream of LCR14, excluded cows along 3,600 feet the Lewis Creek with fencing since 2007, reducing access to a single stabilized crossing. Several management practices have been implemented at this farm in recent years, resulting in expansion of vegetated riparian buffers, increased setbacks of crop fields and pasture areas, and cedar revetments and willow waddle treatments to enhance streambank stability (SMRC, 2010, 2017). In October 2018, livestock were removed from the upper site, as part of a farm transition and sale of the property. Initial 2019 baseflow results suggest that this change in practice could lead to a reduction in *E. coli* and nutrient levels in Lewis Creek. Bracket sampling will continue at these sites in 2020 to continue monitoring for changes in water quality.

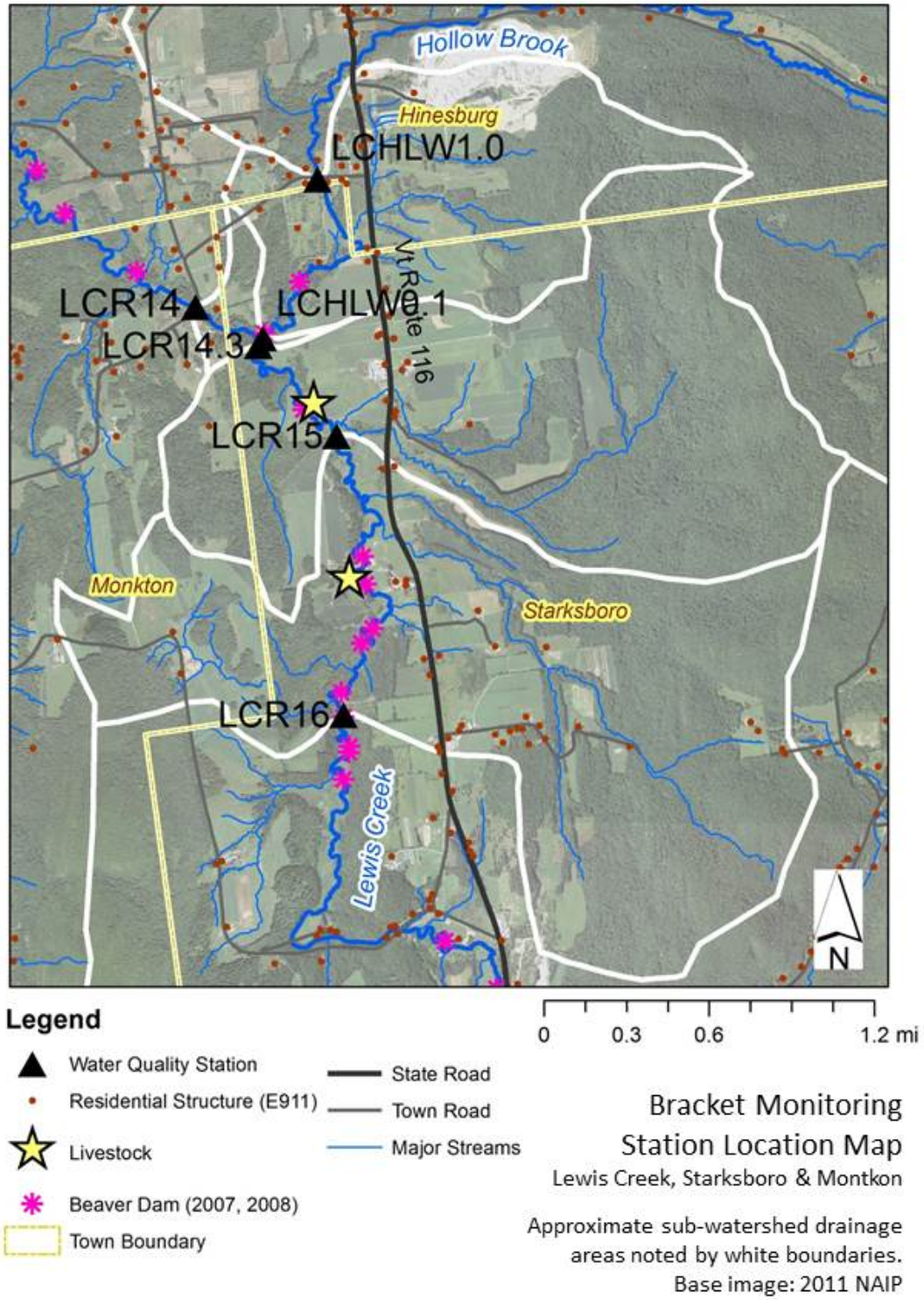


Figure 6. Location of Bracket Monitoring Sites on Lewis Creek

6.3.2 Lemon Fair River

Tributary monitoring in the Lemon Fair River was carried out to better understand spatial patterns in sediment and nutrients between the Shacksboro Road crossing in Shoreham (LFR15.8) and the

Lemon Fair Road crossing (LFR4) in Weybridge. New stations were established in 2018 at the Buttolph Road crossing of the Perry Brook and Bascom Brook in Shoreham, as well as three new stations on the Beaver Branch in Cornwall (Figure 7). These stations were sampled for a second year in 2019. Mean concentrations of Turbidity (Figure 7A) and Total Phosphorus (Figure 7B) detected during dry-weather, baseflow conditions in the Summers of 2018 and 2019 suggest a contributing source(s) of sediment and nutrients between the Shacksboro Road crossing (LFR15.8) and Route 74 (LFR12). The Lemon Fair receives runoff from both the Perry and Bascom Brooks between these two stations. However, Turbidity levels measured in these tributaries on the same sample dates were reasonably low and similar in magnitude to upstream station LFR15.8. Total Phosphorus was elevated in Perry Brook, though not at the magnitude reported at station LFR12 (see Attachment 1). Tributary monitoring has further refined the spatial distribution of sediment and nutrients in the Lemon Fair River.

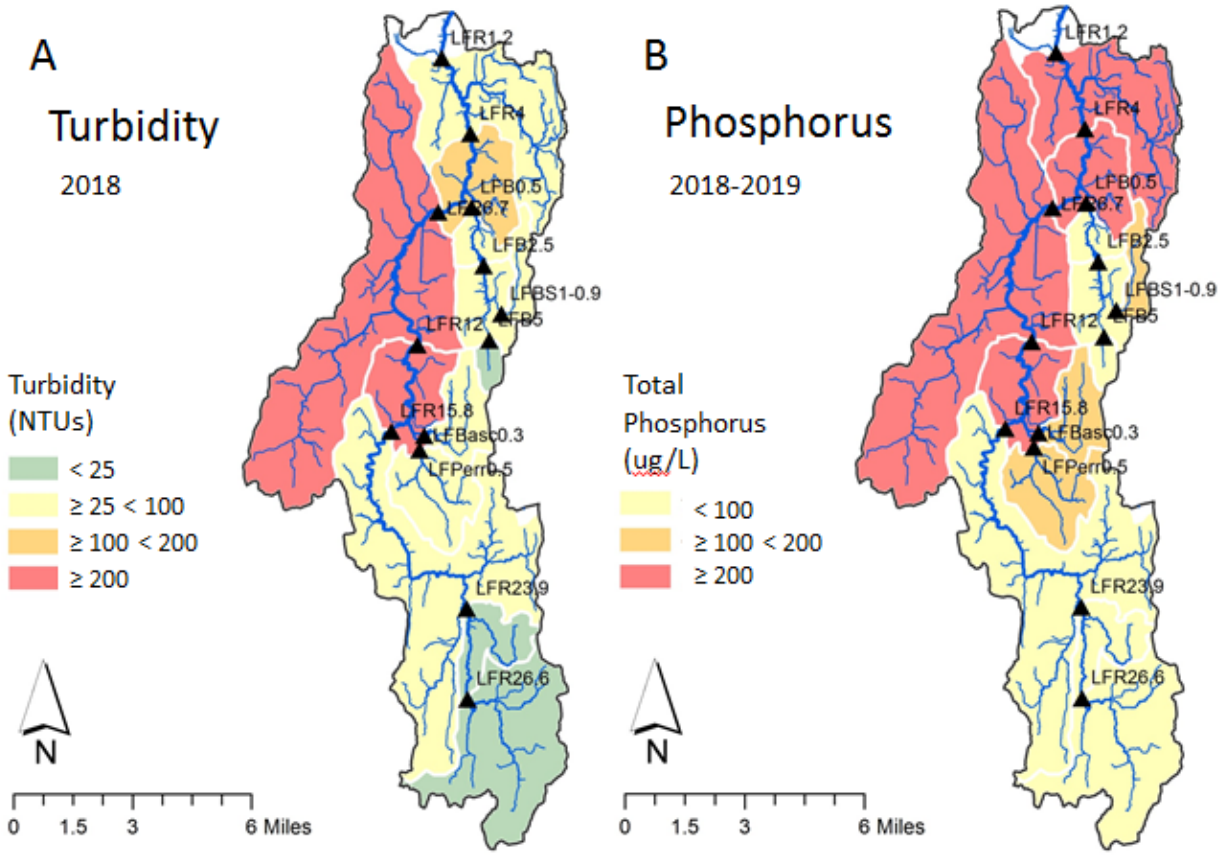


Figure 7. Mean values of (A) Turbidity detected during dry-weather, baseflow events in 2018 (n=4) and (B) Total Phosphorus detected during baseflow conditions at or below the Low-Median-Monthly Flow in the Lemon Fair River watershed in 2018 (n=4) and 2019 (n=1). Due to budgetary constraints, turbidity sampling was suspended by the LaRosa Program in 2019 after the April event.

Regions with high Turbidity and phosphorus concentrations are areas where restoration and mitigation actions should be focused, including nutrient management to reduce phosphorus and nitrogen inputs and best management practices to reduce runoff of manure and other pathogen sources.

6.4 Treatment Effectiveness

The ACRWC has periodically used its results to analyze treatment effectiveness for best management or restoration practices implemented by its partner agencies. One such project is active in 2019: a bracket monitoring of *E. coli*, nutrients, and sediment in the Tyler Bridge region of the Lewis Creek.

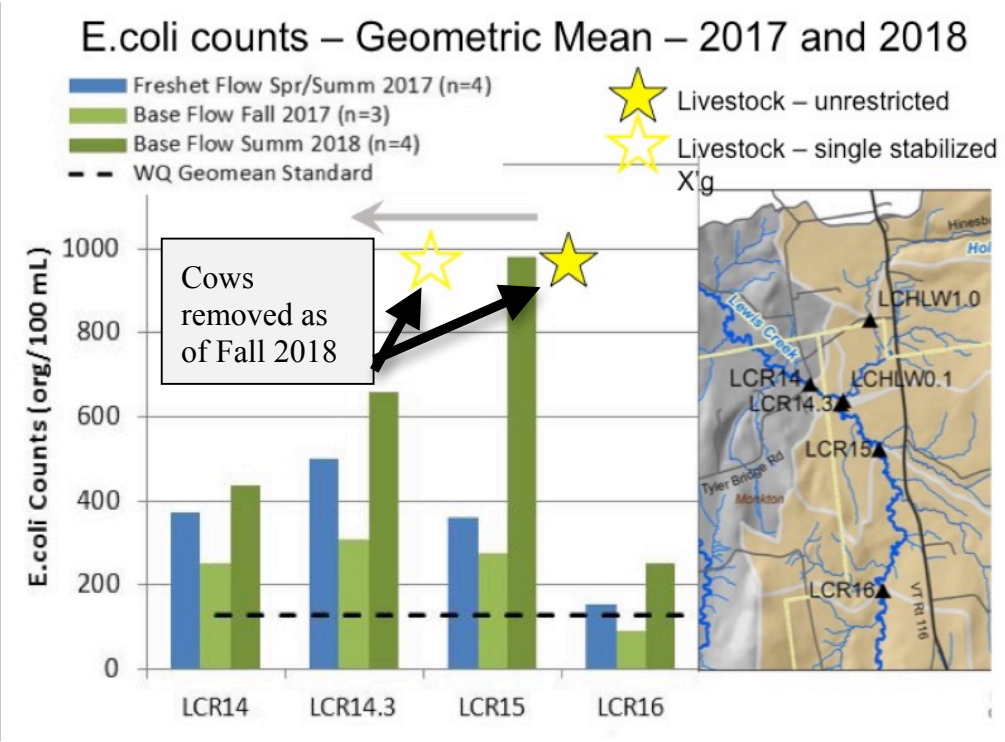


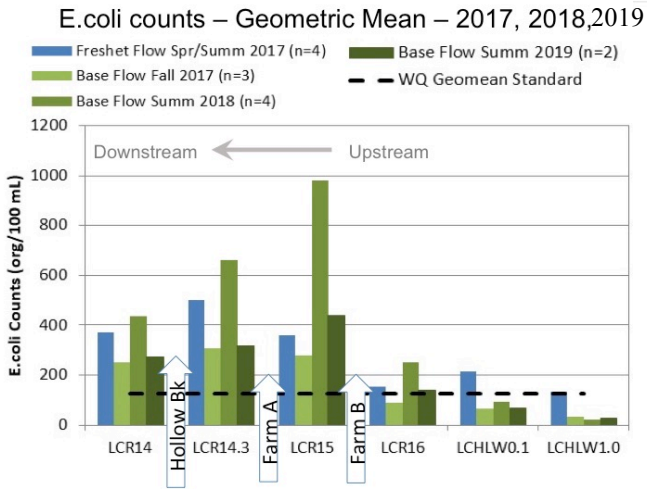
Figure 8. Bordering the LCR15 sampling site are two farms that have historically allowed livestock to access Lewis Creek—one upstream and one downstream. In October of 2018, cows were removed from the upstream site as part of a farm conversion. Within the same timeframe, we learned that the downstream farmer no longer pastured cows.

As of October of 2018, dairy cattle with previously unrestricted access to the Lewis Creek between stations LCR16 and LCR15 were removed from a pasture as part of a farm transition. Future plans for this property include an approved river corridor easement and buffer planting project (estimated 2019). It was anticipated that livestock exclusion will result in a notable decrease in pathogens in the Lewis Creek, similar to the statistically-significant drop in *E. coli* detected for a 1998 livestock exclusion project on an upstream reach of the river in Starksboro (SMRC, 2017). Moreover, a gradual reduction in

turbidity and nutrients is anticipated as the riparian buffer along these 1.5 river miles begins to establish itself and the channel returns to a more stable condition.

In 2019, the first year of post-treatment sampling during two base-flow events showed a reduction in *E. coli* counts and total phosphorus. In 2020, bracket monitoring of *E. coli*, phosphorus, and turbidity in the vicinity of Tyler Bridge Road will continue at the same sites. Previous monitoring will serve as a baseline for future monitoring to quantify effectiveness of this completed livestock exclusion.

A.



B.

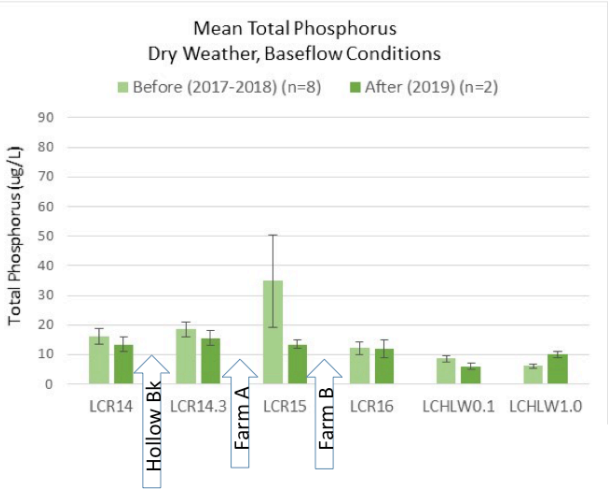


Figure 9. After the removal of cows from Farms A and B in Fall of 2018, we now have a first year of post-treatment data. The two relevant sampling events from 2019 are promising, showing a reduction in baseflow counts of E. coli (A) and total Phosphorus (B) at station LCR15 located downstream of Farm B. However, further sampling is required.

In the Lewis Creek in 2019, a gully stabilization project along the Pond Brook tributary to Lewis Creek was another opportunity to understand treatment effectiveness. In 2012, a stream geomorphic assessment suggested that erosion along a series of six gullies on this tributary likely contributed substantial quantities of sediment and nutrients to Lewis Creek. In 2014-2015, the gullies were stabilized through an NRCS EQUIP grant and a VT ANR grant award managed by Lewis Creek Association. The treatment practices included using a combination of stone-lined waterway practices and a bioengineering practice using log check dams, stones, and log stacks.

Initial post-treatment results from 2018 and 2019 show a significant decrease in both phosphorus and turbidity at the downstream sampling site during wet-weather conditions. We will continue collecting data at this site in 2020.

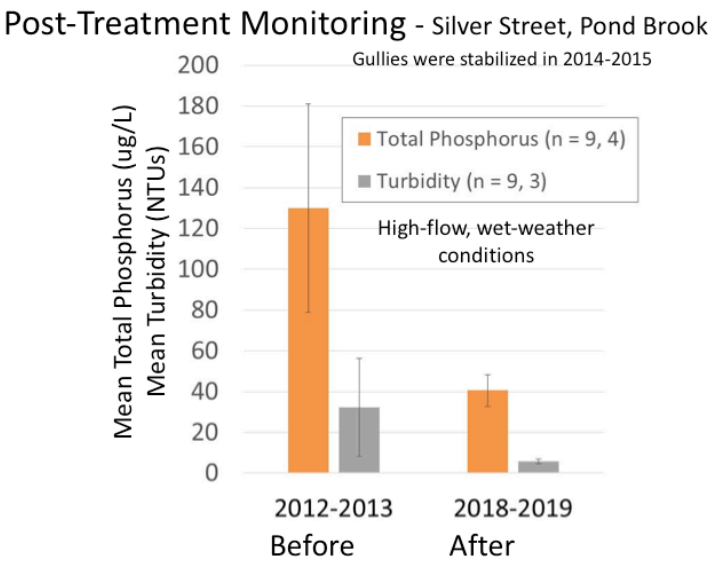


Figure 10. After a 2014-2015 gulley stabilization project along the Pond Brook tributary to Lewis Creek, preliminary post-treatment data from 2018 and 2019 indicate a significant decrease in total phosphorus and turbidity.

6.5 Loading Estimates

Another reason to monitor for sediment and nutrients at the sub-watershed level in Addison County watersheds is to evaluate relative contributions of sediment and nutrients to Lake Champlain in the context of the Lake Champlain Total Maximum Daily Load (TMDL) for phosphorus. Each of the watersheds monitored by ACRWC contributes significant phosphorus to the Lake, either directly (Lewis Creek, Little Otter Creek) or via Otter Creek (Middlebury River, New Haven River, Lemon Fair). The most substantial loading occurs during high flow events – typically in the Spring or Fall. The Vermont Department of Environmental Conservation monitors loading of constituents at the mouths of the Lewis Creek, Little Otter Creek and Otter Creek. The ACRWC has conducted special projects in the past to quantify loading in sub-watersheds of the Pond Brook (Lewis Creek) and Little Otter Creek (reported separately). Going forward, concentration data collected during high flowss at our Sentinel and Rotational sites will serve as a proxy for constituent loading, and will help to prioritize watershed locations for restoration and conservation projects and practices.

7.0 Project Implementation

The ACRWC relies on partner agencies and Lewis Creek Association to identify projects for implementation and ongoing monitoring. Monitoring results have been shared with partner agencies including the VT Agency of Agriculture, UVM Extension, USDA Farm Service Agency, and the Otter Creek NRCD to support outreach to landowners and farmers in these watersheds and the design of Best Management Practices. Water quality monitoring data are used to inform and develop priority implementation projects in watersheds monitored by the ACRWC. Sediment and

nutrient data (and coarse estimates of phosphorus yields, where available)are to communicate land use impacts on water quality and encourage landowner and municipal participation in watershed restoration. In cooperation with local, state and federal partners, projects are prioritized within the context of River Corridor Plans and the Otter Creek Tactical Basin Plan. Some have been implemented over the years, and with landowner willingness, others will be developed to achieve reductions in nutrient and sediment loading from these catchments. Projects have included wetland restoration, conservation agreements, livestock exclusion, riparian buffer plantings, alternate tillage and crop rotation practices, gully stabilization, improved forest management techniques, and improved road maintenance practices. Water quality data are also being shared with VTDEC biomonitoring teams and used to inform municipal-level discussions regarding water quality management classification in ongoing basin planning efforts.

8.0 References

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Appendix A

Physical Features of Watersheds Monitored by Addison County River Watch Collaborative

Table A-1 summarizes the physical characteristics of the ACRWC watersheds and nearby LaPlatte River. A majority of the drainage area for the New Haven River and Middlebury River is positioned in the mountainous terrain of the Northern Green Mountain physiographic province. Lewis Creek also has a significant percentage of its drainage area in this province. LaPlatte River, Little Otter Creek and Lemon Fair River are located further to the west in the broad, low-relief, Champlain Valley physiographic province. Thus, topographic relief and overall gradients of the New Haven River, Middlebury River and Lewis Creek are substantially higher than that of the Champlain Valley watersheds.

The Green Mountain watersheds (New Haven River, Middlebury River, and Lewis Creek; shaded yellow in Table A-1) tend to exhibit flashier flows, than the Champlain Valley watersheds due, in part, to the steeper overall gradients. The lower-gradient watersheds of the Champlain Valley (shaded blue in Table A-1) tend to be characterized by higher percentages of hydric soils derived from lacustrine and marine lake sediments, and have higher percentages of wetlands. These conditions offer temporary surface water storage and lagged flows, resulting in broader, lower-magnitude storm peaks, longer times to peak, and gradual hydrograph recessions.

In general, the Green Mountain watersheds tend to have higher percentages of forest cover, while the Champlain Valley watersheds have higher percentages of agricultural land use.

The geophysical setting of these watersheds influences water quality. For example, in the mountainous watersheds of Lewis Creek, Middlebury River, and New Haven River, turbidity and sediment-bound phosphorus concentrations tend to become elevated and exceed the water quality standard during high flows. In the valley watersheds (Little Otter Creek and Lemon Fair), the turbidity and phosphorus standards tend to be exceeded on a more frequent basis, in a wider range of flow conditions. As noted in Table A-1 the valley watersheds have a much higher percentage of fine-grained silt and clay soils derived from glacial lake sediments. A separate study recently completed by ACRWC found a strong, and statistically-significant, positive correlation between mean water quality concentrations (for Total Phosphorus, *E. coli* and Turbidity) and both the percentage of these fine-grained glacial lake soils and the percentage of agricultural land use in the catchments draining to water quality stations in these two watersheds (ACRWC & SMRC, 2016).

Table A-1. Physical Features of Watersheds.

Watershed	Physical Characteristics										
	Geologic Province (1)		Soils (2) (% Lake Sediments)	% Hydric Soils	% Wetlands (VSWI)	Topography		Major Land Cover/ Land Use			Stream Classification (Class B) (3)
	NGM	CV				Relief (ft)	Gradient (ft / mile)	Forest	Agric	Urban	
Middlebury River 63 sq mi	71%	29%	10%	15.2%	3.2%	1,758	111	81%	11%	3%	Cold Water Fish
New Haven River 116 sq mi	63%	37%	14%	9.8%	2.5%	2,720	106	76%	15%	4%	Cold Water Fish
Lewis Creek 81 sq mi	31%	69%	24%	18.6%	6.5%	1,676	52	60%	26%	5%	Cold Water Fish
LaPlatte River 53 sq mi	5%	95%	45%	25.3%	6.1%	960	49	38%	39%	16%	Warm Water Fish
Little Otter Creek 73 sq mi	--	100%	62%	30.3%	9.7%	416	18	35%	45%	4%	Cold Water Fish
Lemon Fair River 91 sq mi	--	91%	63%	19.3%	7.3%	256	8	25%	63%	6%	Warm Water Fish
Lower Otter Creek 498 sq mi (of 944 sq mi basin)	29%	69%	38%	20.8%	8.9%	NM	NM	67%	21%	6%	Warm Water Fish

(1) NGM = Northern Green Mountains; CV = Champlain Valley; geologic province after Stewart & MacClintock (1969) or biophysical province after the VT Biodiversity Project.

(2) Soils of glaciolacustrine parent material, Natural Resource Conservation Service County Soil Survey Data.

(3) As per VT Water Quality Standards, effective Jan 1, 2008.

Appendix B

Precipitation and Flow Data

Table B-1. Monthly / Annual Precipitation at climate stations located in vicinity of Addison County.

	Data Source	Time Period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Burlington, VT (Airpor	*1*	1971-2000	2.22	1.67	2.32	2.88	3.32	3.43	3.97	4.01	3.83	3.12	3.06	2.22	36.05
	2	1981-2010	2.05	1.76	2.21	2.82	3.45	3.69	4.15	3.91	3.64	3.60	3.12	2.37	36.77
330 ft amsl	*2*	2011	1.44	3.02	3.39	7.88	8.67	3.52	3.68	6.11	6.06	3.49	1.43	2.23	50.92
	2	2012	1.96	0.89	0.98	2.84	4.41	3.22	3.78	2.92	5.36	5.04	1.24	3.30	35.94
330 ft amsl	*2*	2013	1.11	1.32	2.05	2.05	8.74	9.86	4.49	3.07	4.74	2.59	2.43	2.54	44.99
20 miles N	*2*	2014	2.45	1.83	1.88	3.66	3.94	4.35	5.54	2.05	1.63	4.17	1.98	2.85	36.33
	2	2015	1.29	1.09	0.90	2.64	2.92	8.67	4.67	1.98	4.86	3.17	1.21	4.44	37.84
	2	2016	1.19	3.14	2.26	1.80	2.46	3.05	3.05	2.25	1.39	2.66	2.13	2.35	27.73
	2	2017	2.00	2.67	3.27	3.83	4.91	7.17	3.45	2.40	2.79	3.55	1.68	2.18	39.90
	2	2018	2.54	1.40	2.63	4.84	1.97	4.10	2.52	2.54	4.20	4.22	5.48	2.83	39.27
	2	2019	3.29	2.34	2.31	3.53	5.15	4.99	1.91	2.77	3.71	8.50	3.38	1.59	43.47
Rutland, VT	*1*	1971-2000	2.70	1.97	2.59	2.80	3.52	3.85	4.58	4.18	3.91	3.21	3.08	2.73	39.12
	2	1981-2010	2.44	2.15	2.77	2.88	3.71	4.00	4.77	4.10	3.78	3.83	3.25	2.96	40.64
620 ft amsl	*2*	2011	2.93	3.76	3.61	5.69	4.40	4.38	4.88	11.24	4.88	3.48	1.29	2.80	53.34
40 miles SSE	*2*	2012	1.69	0.69	1.12	3.32	5.26	3.66	3.62	3.42	4.58	4.57	0.71	4.08	36.72
	2	2013	1.85	0.78	1.51	2.58	5.60	5.93	5.59	3.30	3.25	1.36	2.58	2.55	36.88
	2	2014	3.61	3.42	2.56	2.05	4.14	4.44	5.19	2.69	1.54	4.30	2.12	3.77	39.83
	2	2015	2.50	1.66	0.84	2.26	2.94	7.13	3.11	1.69	3.72	3.34	1.22	3.91	34.32
	2	2016	1.06	4.25	2.88	1.97	2.85	3.67	2.44	3.62	2.48	3.87	2.62	3.00	34.71
	2	2017	1.69	2.26	2.91	2.87	5.79	4.17	3.37	2.45	2.35	4.10	1.21	3.06	36.23
	2	2018	2.42	2.50	3.26	3.76	1.28	3.77	4.36	5.15	2.96	3.61	4.10	2.96	40.13
	2	2019	5.89	2.05	1.41	5.83	4.58	4.24	2.38	2.71	3.19	5.66	3.90	3.96	45.80

Total precipitation in inches, including liquid equivalent of snow, sleet. M = Missing

Values for 1971-2000 and 1981-2010 periods reflect averages for the time period. Values for individual years are totals.

Data Sources: [1] National Climatic Data Center, 2002, Climatography of the United States No. 81 - 43 (Vermont), Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days: 1971-2000

[2] NOAA Online Weather Data, https://w2.weather.gov/climate/xmacis.php?wfo=btv

Table B-2. Monthly / Seasonal Snowfall Totals at climate stations located in vicinity of Addison County.

	Time Period	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Season
So. Burlington, VT (Airport)	1971-2000	0.0	0.0	0.0	0.3	7.2	17.1	20.9	15.3	15.4	5.8	0.0	0.0	81.9
	1981-2011	0.0	0.0	0.0	0.3	5.1	19.1	21.9	16.9	15.6	4.6	0.0	0.0	83.6
	2011-2012	0.0	0.0	0.0	0.1	5.0	6.9	13.4	6.4	5.9	0.0	0.0	0.0	37.7
	2012-2013	0.0	0.0	0.0	0.0	3.8	30.7	14.6	16.6	16.2	1.0	0.0	0.0	82.9
	2013-2014	0.0	0.0	0.0	Tr	6.4	15.3	12.5	24.1	25.4	2.8	0.0	0.0	86.5
	2014-2015	0.0	0.0	0.0	0.0	10.6	21.9	20.7	22.7	4.4	3.1	0.0	0.0	83.4
	2015-2016	0.0	0.0	0.0	Tr	0.2	7.1	13.1	8.6	1.8	3.5	Tr	0.0	34.3
	2016-2017	0.0	0.0	0.0	Tr	4.3	16.7	7.6	30.6	36.8	4.4	0.0	0.0	100.4
	2017-2018	0.0	0.0	0.0	0.0	3.0	23.5	15.2	12.7	30.1	4.2	0.0	0.0	88.7
	2018-2019	0.0	0.0	0.0	Tr	19.5	8.6	41.8	17.3	15.2	1.2	0.0	0.0	103.6
Rutland, VT	1971-2000	0.0	0.0	0.0	0.3	5.6	13.5	16.7	13.9	12.4	3.6	0.0	0.0	66.0
	1981-2011	0.0	0.0	0.0	0.5	4.4	16.7	17.3	14.7	12.6	3.3	0.0	0.0	69.3
	2011-2012	0.0	0.0	0.0	6.5	2.9	5.0	8.9	2.7	4.2	0.0	0.0	0.0	30.2
	2012-2013	0.0	0.0	0.0	0.0	0.4	23.9	8.1	8.5	10.9	0.2	0.0	0.0	52.0
	2013-2014	0.0	0.0	0.0	0.3	4.5	18.9	14.5	30.4	20.5	1.7	0.0	0.0	90.8
	2014-2015	0.0	0.0	0.0	0.0	10.3	14.7	19.8	31.6	4.1	3.1	0.0	0.0	83.6
	2015-2016	0.0	0.0	0.0	Tr	0.0	4.1	9.6	5.8	0.4	2.8	0.0	0.0	22.7
	2016-2017	0.0	0.0	0.0	Tr	3.4	19.4	9.3	19.2	17.3	6.2	Tr	0.0	74.8
	2017-2018	0.0	0.0	0.0	0.0	Tr	25.6	12.0	31.0	35.2	M	0.0	0.0	103.8
	2018-2019	0.0	0.0	0.0	Tr	12.1	5.0	34.7	10.5	12.5	Tr	0.0	0.0	74.8

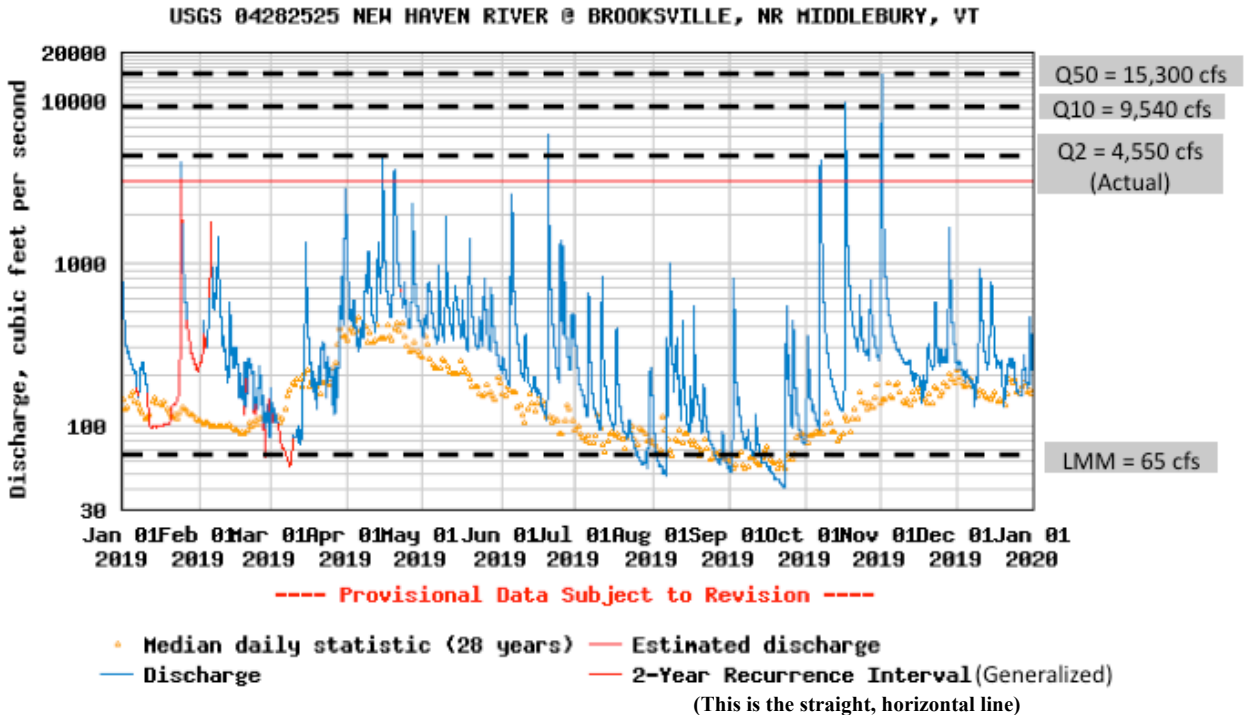
Total snowfall in inches. Values for 1971-2000 and 1981-2011 periods reflect averages for the time period. Values for seasons are totals.
Source: https://w2.weather.gov/climate/xmacis.php?wfo=btv data available as of 1/6/2020
Tr = Trace; M - Missing data

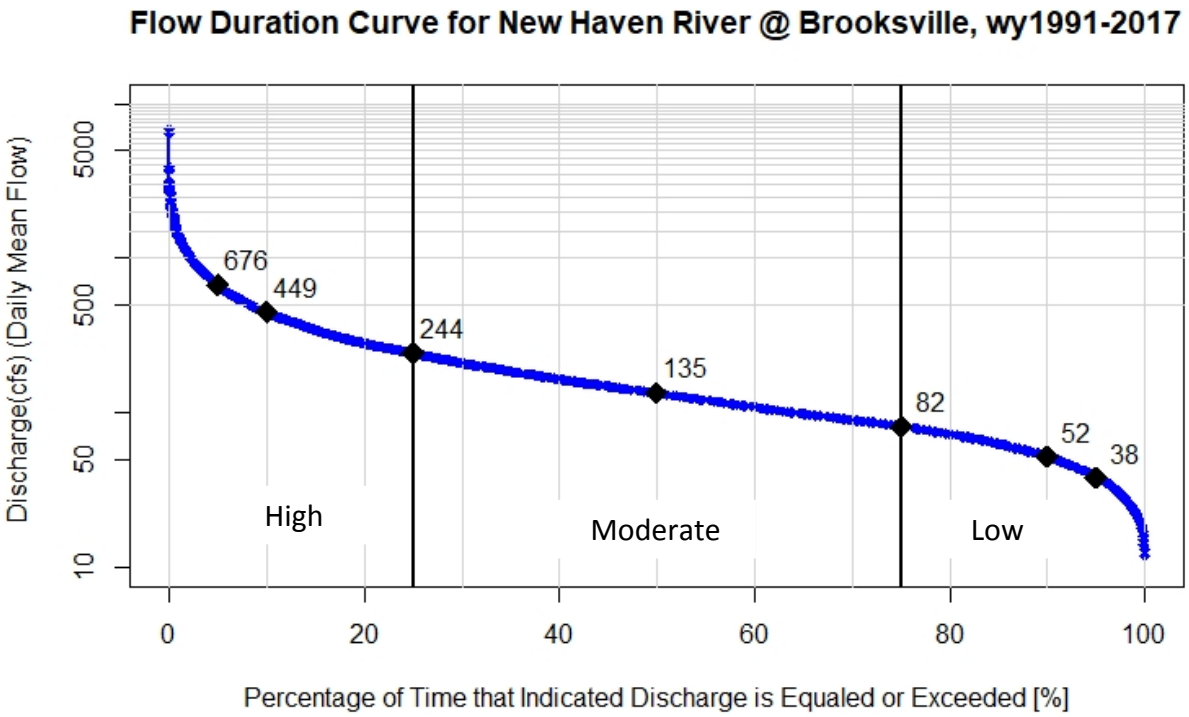
Table B-3. 2019 Daily Mean Flows recorded in Addison County gaged rivers on sample dates, with reference to estimated peak flows and low median monthly flows.

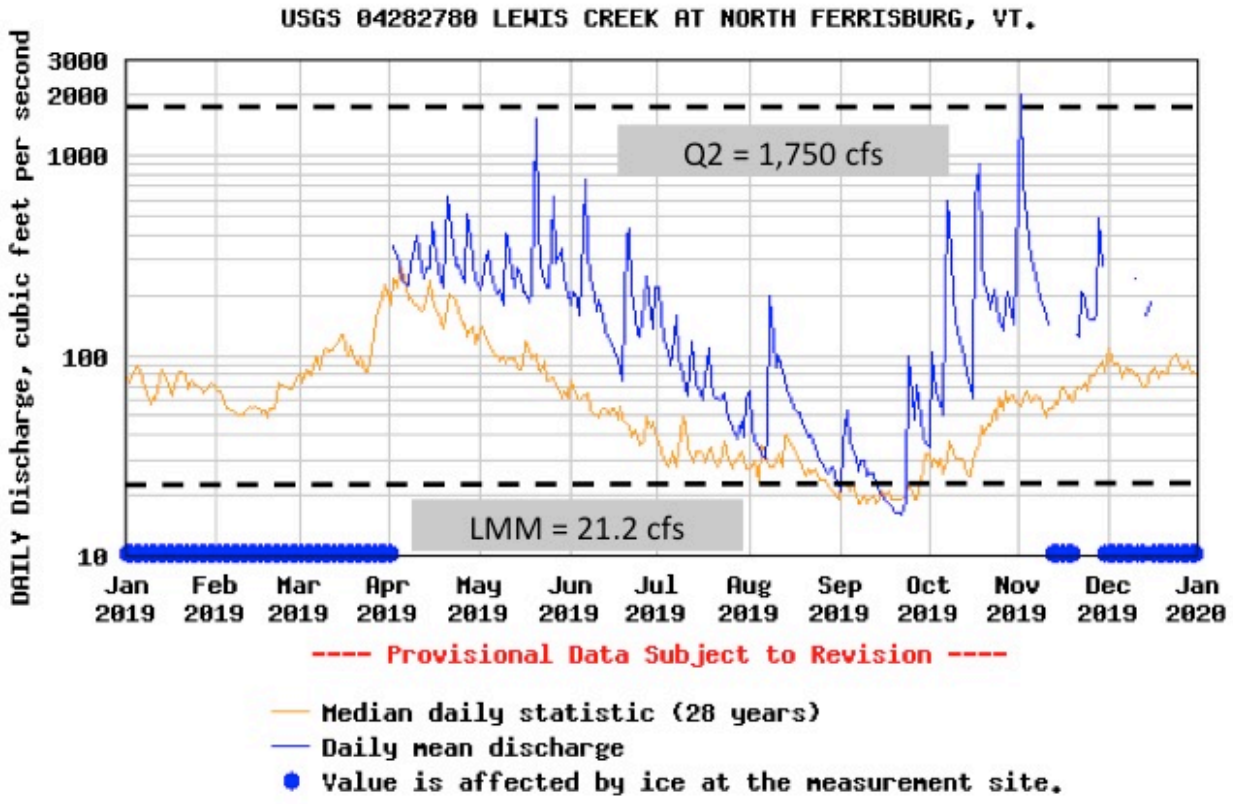
River		Little Otter Ck			Lewis Creek			New Haven River			Otter Ck MB		
USGS Gage #		#04282650			#04282780			#04282525			#04282500		
Drainage Area (sq mi)		57.1			77.4			115			630		
Sample Dates	4/10/19	215	H	FF	397	H	FF	814	H	FF	2,560	H	BF
(Daily Mean Flows)	5/1/19	104	H	FF	215	H	FF	357	H	FF	3,520	H	FF
(cfs)	6/5/19	103.0	H	FF	242.0	H	FF	540.0	H	FF	2,010	H	BF
* incidates	7/10/19	31.3	M	BF	68.6	M	BF	106.0	M	BF	552	M	BF
flow < LMM	8/7/19	9.8	L	BF	39.7	M	BF	186.0	M	FF	217	L	FF
	9/4/19	34.4	M	FF	36.5	M	FF	142.0	M	FF	548	M	FF
Peak Flows	Q2	890			1,750			4,550			4,310		
(Olson, 2014; App 3)	Q5	1,370			2,910			7,330			5,880		
(Weighted)	Q10	1,740			3,820			9,540			7,030		
	Q25	2,270			5,110			12,700			8,660		
	Q50	2,720			6,160			15,300			10,000		
	Q100	3,200			7,270			18,200			11,500		
	Q500	4,520			10,400			26,400			15,400		
Low Median Monthly Flow		6.6 (Sept)			21.2 (Sept)			65.0 (Sept)			325 (Aug)		
7Q10 Flow		1.4			5.8			19.4			148		

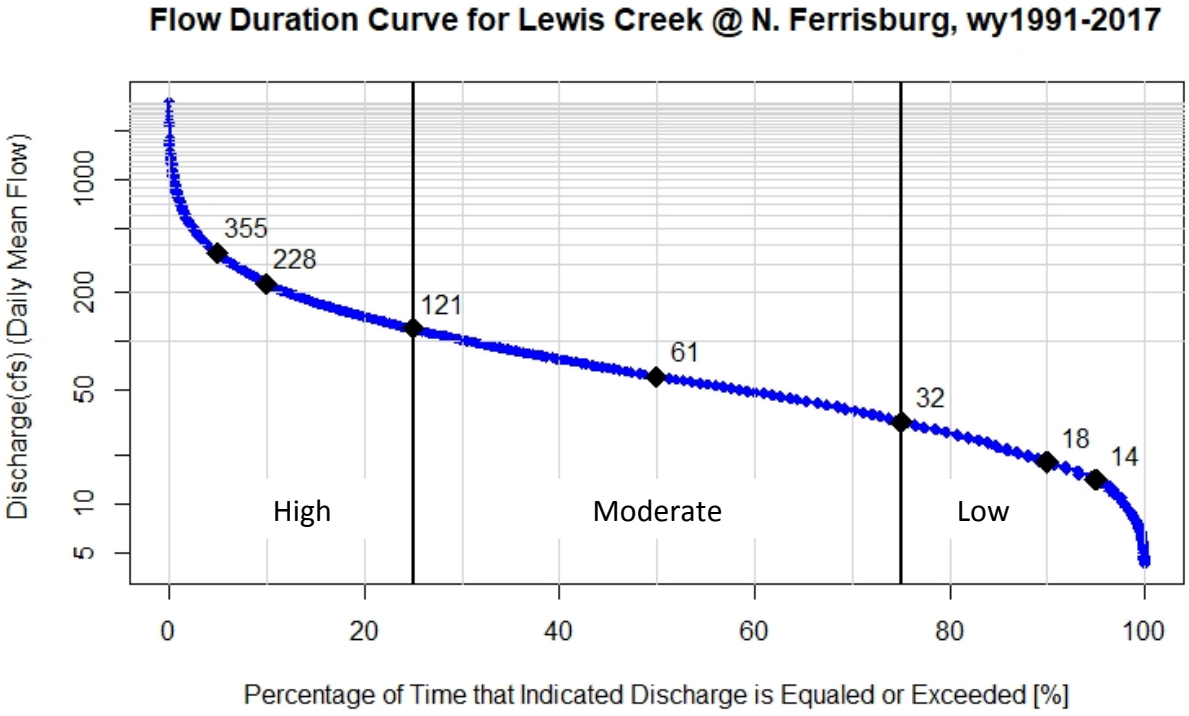
(Blaine Hastings, VWMD, Jan 2014; based on gaging records of variable lengths through water year 2012)

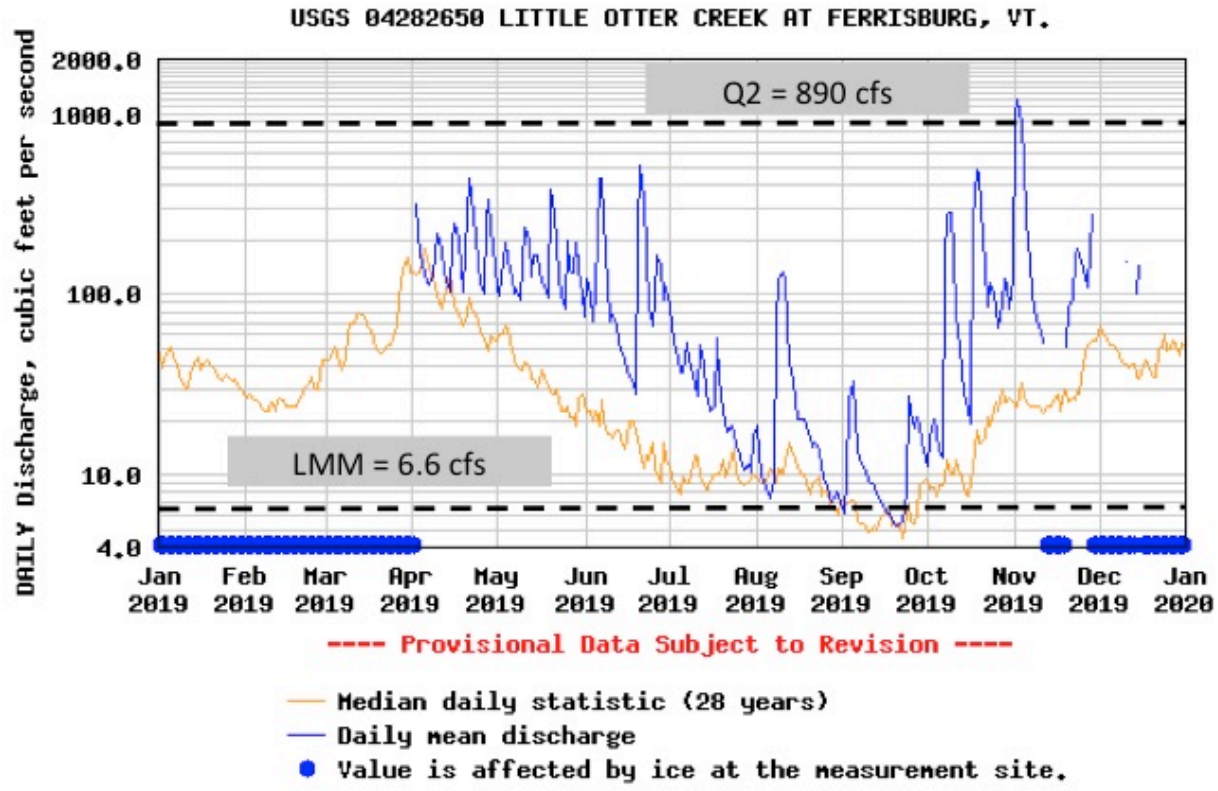
Source: USGS National Water Information System, https://waterdata.usgs.gov/vt/nwis, downloaded 1/6/2020
Abbreviations: Flow condition follows VTDEC Guidance:
Flow Level: Fd - Flood (>bankfull flow), H - High (>p.75), M - Moderate (>p.25 ≤p.75), L - Low (≤ p.25), where p = percentile
Flow Category: BF - Base Flow, FF - Freshet Flow, HF - Hydro Flow

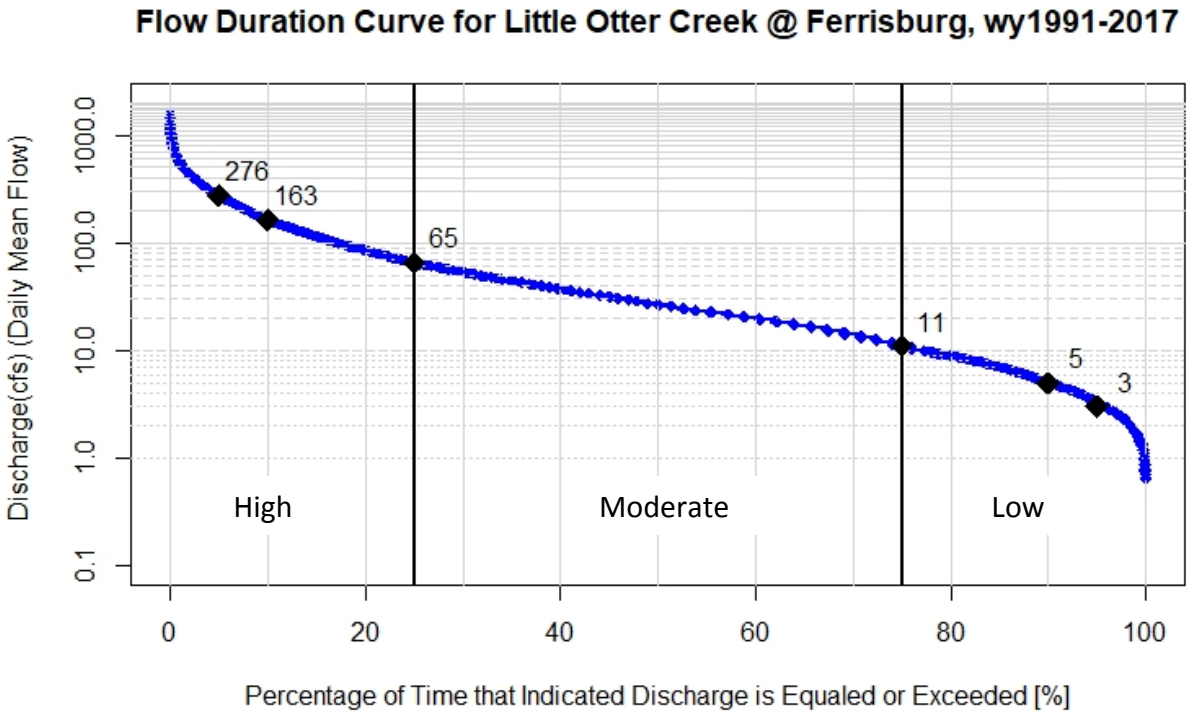

USGS 04282525 NEW HAVEN RIVER @ BROOKSVILLE, NR MIDDLEBURY, VT
Discharge, cubic feet per second
20000
10000
1000
100
30
Q50 = 15,300 cfs
Q10 = 9,540 cfs
Q2 = 4,550 cfs (Actual)
LMM = 65 cfs
Jan 01 2019
Feb 01 2019
Mar 01 2019
Apr 01 2019
May 01 2019
Jun 01 2019
Jul 01 2019
Aug 01 2019
Sep 01 2019
Oct 01 2019
Nov 01 2019
Dec 01 2019
Jan 01 2020
---- Provisional Data Subject to Revision ----
Median daily statistic (28 years)
Estimated discharge
Discharge
2-Year Recurrence Interval (Generalized)
(This is the straight, horizontal line)

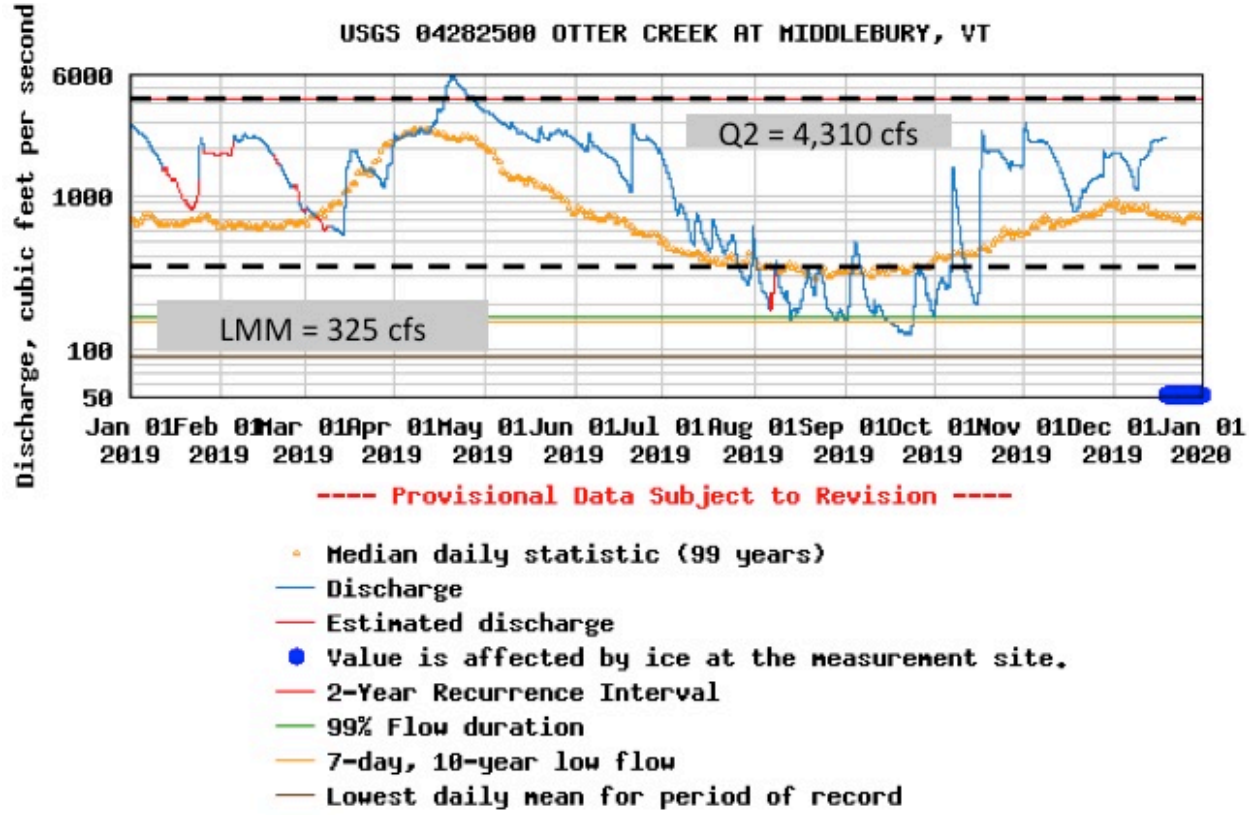

Flow Duration Curve for New Haven River @ Brooksville, wy1991-2017
Discharge(cfs) (Daily Mean Flow)
5000
500
50
10
676
449
244
135
82
52
38
High
Moderate
Low
0
20
40
60
80
100
Percentage of Time that Indicated Discharge is Equaled or Exceeded [%]

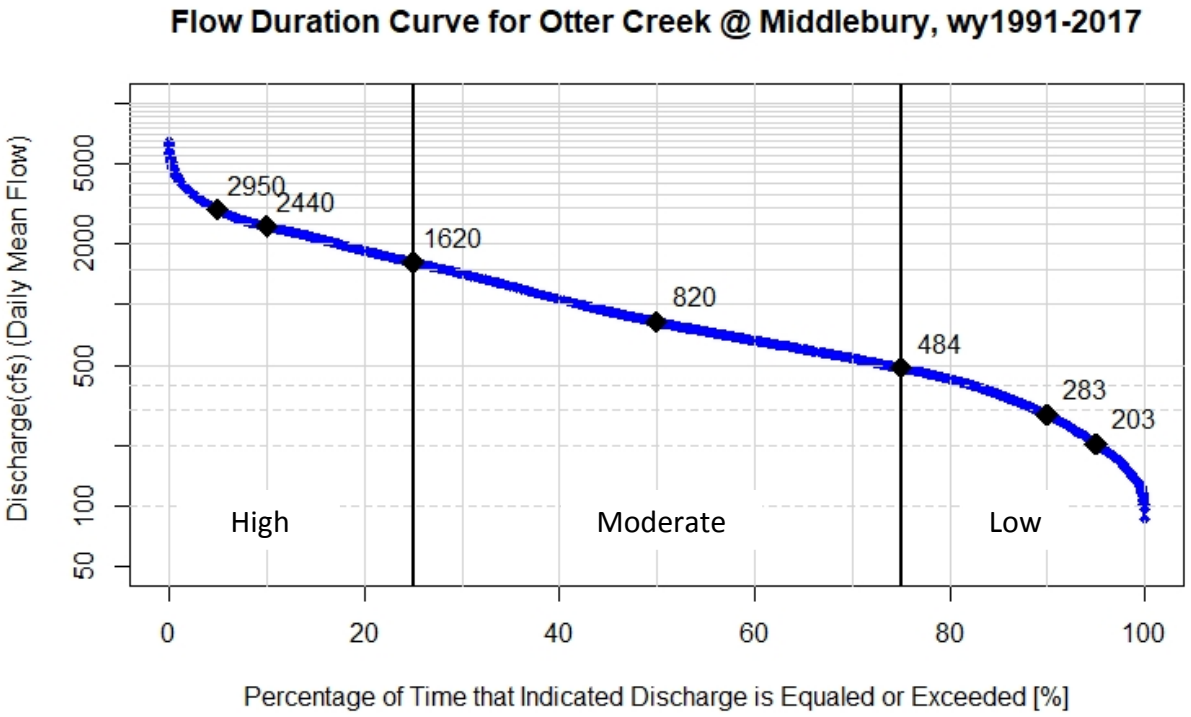

USGS 04282780 LEWIS CREEK AT NORTH FERRISBURG, VT.
DAILY Discharge, cubic feet per second
3000
2000
1000
100
10
Q2 = 1,750 cfs
LMM = 21.2 cfs
Jan 2019
Feb 2019
Mar 2019
Apr 2019
May 2019
Jun 2019
Jul 2019
Aug 2019
Sep 2019
Oct 2019
Nov 2019
Dec 2019
Jan 2020
---- Provisional Data Subject to Revision ----
Median daily statistic (28 years)
Daily mean discharge
Value is affected by ice at the measurement site.


Flow Duration Curve for Lewis Creek @ N. Ferrisburg, wy1991-2017
Discharge(cfs) (Daily Mean Flow)
1000
200
50
10
5
355
228
121
61
32
18
14
High
Moderate
Low
0
20
40
60
80
100
Percentage of Time that Indicated Discharge is Equaled or Exceeded [%]


USGS 04282650 LITTLE OTTER CREEK AT FERRISBURG, VT.
DAILY Discharge, cubic feet per second
2000.0
1000.0
100.0
10.0
4.0
Q2 = 890 cfs
LMM = 6.6 cfs
Jan 2019
Feb 2019
Mar 2019
Apr 2019
May 2019
Jun 2019
Jul 2019
Aug 2019
Sep 2019
Oct 2019
Nov 2019
Dec 2019
Jan 2020
---- Provisional Data Subject to Revision ----
Median daily statistic (28 years)
Daily mean discharge
Value is affected by ice at the measurement site.


Flow Duration Curve for Little Otter Creek @ Ferrisburg, wy1991-2017
Discharge(cfs) (Daily Mean Flow)
1000.0
100.0
10.0
1.0
0.1
276
163
65
11
5
3
High
Moderate
Low
0
20
40
60
80
100
Percentage of Time that Indicated Discharge is Equaled or Exceeded [%]


USGS 04282500 OTTER CREEK AT MIDDLEBURY, VT
Discharge, cubic feet per second
6000
1000
100
50
Q2 = 4,310 cfs
LMM = 325 cfs
Jan 01 2019
Feb 01 2019
Mar 01 2019
Apr 01 2019
May 01 2019
Jun 01 2019
Jul 01 2019
Aug 01 2019
Sep 01 2019
Oct 01 2019
Nov 01 2019
Dec 01 2019
Jan 01 2020
---- Provisional Data Subject to Revision ----
Median daily statistic (99 years)
Discharge
Estimated discharge
Value is affected by ice at the measurement site.
2-Year Recurrence Interval
99% Flow duration
7-day, 10-year low flow
Lowest daily mean for period of record


Flow Duration Curve for Otter Creek @ Middlebury, wy1991-2017
Discharge(cfs) (Daily Mean Flow)
5000
2000
500
100
50
2950
2440
1620
820
484
283
203
High
Moderate
Low
0
20
40
60
80
100
Percentage of Time that Indicated Discharge is Equaled or Exceeded [%]

Appendix C

Water Quality Data Tables by Watershed

Abbreviations:

TN = Total Nitrogen
NO2-NO3-Nitrogen = nitrite and nitrate forms of nitrogen (also abbreviated, NOX)
TP = Total Phosphorus
DP = Dissolved Phosphorus
TSS = Total Suspended Sediments

MPN/100 mL = organisms per 100 milliliters
mg/L = milligrams per liter
ug/ L = micrograms per liter
NTU = Nephelometric Turbidity Units

-- = No Data
NS = Not Sampled
NA = Not Analyzed (e.g., insufficient sample volume; vial broken in transit)
NM = Not Measured

JB = estimated value; constituent was present at more than 5x the detection limit in an associated field blank

JD = estimated value; Relative Percent Difference (RPD) of primary and field duplicate sample values exceeded the QAPP RPD goal for that constituent

Note: QA/QC issues further detailed in separate QA Summary Report

Lemon Fair River

Location	Date	QA	E. Coli. (mpn/100ml)	Total Nitrogen (mg/L)	Totoal Phosphorus (ug/L)	Dissolved Phosphorus (ug/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
LFR1.2	4/10/19	A		0.69	63.00	37	6	21.70
LFR1.2	5/1/19	A		0.73	100.00	75		
LFR1.2	6/5/19	A		0.86	151.00	54		
LFR1.2	7/10/19	A		0.92	168.00	66		
LFR1.2	8/7/19	A		1.89	292.00	155		
LFR1.2	9/4/19	A		0.79	129.00	48		
LFR4	4/10/19	A		0.83	88	41	25.33	49
LFR4	5/1/19	A		0.73	94	57		
LFR4	6/5/19	A		0.77	138	51		
LFR4	7/10/19	A		0.8	181	62		
LFR4	8/7/19	A		2.54	252	119		
LFR4	9/4/19	A		0.8	129	42		
LFR6.7	4/10/19	A		0.94	120	42	38	83.9
LFR6.7	5/1/19	A		0.75	89	58		
LFR6.7	6/5/19	A		0.7	127	46		
LFR6.7	7/10/19	A		0.85	222	58		
LFR6.7	8/7/19	A		1.67	266	84		
LFR6.7	9/4/19	A		0.73	112	43		
LFR12	4/10/19	A		0.91	95	43	35.33	50.1
LFR12	5/1/19	A		0.69	100	52		
LFR12	6/5/19	A		0.65	122	53		
LFR12	7/10/19	A		0.66	174	72		
LFR12	8/7/19	A		0.85	144	51		
LFR12	9/4/19	A		0.62	133	35		
LFR15.8	4/10/19	A		0.66	72	34	22.8	31.8
LFR15.8	5/1/19	A		0.76	106	57		
LFR15.8	6/5/19	A		0.59	130	65		
LFR15.8	7/10/19	A		0.75	127	82		
LFR15.8	8/7/19	A		0.66	71	47		
LFR15.8	9/4/19	A		0.59	52	27		
LFR23.9	4/10/19	A		1.09	80	36	22.8	59
LFR23.9	5/1/19	A		0.29	23	14		
LFR23.9	6/5/19	A		0.33	37	19		
LFR23.9	7/10/19	A		0.66	78	32		
LFR23.9	8/7/19	A		0.68	68	20		
LFR23.9	9/4/19	A		0.85	76	22		

Lemon Fair River (continued)

Location	Date	QA	E. Coli. (mpn/100ml)	Total Nitrogen (mg/L)	Totoal Phosphorus (ug/L)	Dissolved Phosphorus (ug/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
LFR26.6	4/10/19	A		0.88	49	29	4	24.5
LFR26.6	5/1/19	A		0.25	16	12		
LFR26.6	6/5/19	A		0.28	27	19		
LFR26.6	7/10/19	A		0.51	56	39		
LFR26.6	8/7/19	A		0.65	54	27		
LFR26.6	9/4/19	A		0.74	50	21		
LFB0.5	4/10/19	A		0.86	74	31		40.2
LFB0.5	5/1/19	A		0.31	25	14		
LFB0.5	6/5/19	A		0.38	44	18		
LFB0.5	7/10/19	A		0.41	62	25		
LFB0.5	8/7/19	A		0.41	65	27		
LFB0.5	9/4/19	A		0.64	83	33		
LFB2.5	4/10/19	A		0.78	54	32		19.8
LFB2.5	5/1/19	A		0.36	27	15		
LFB2.5	6/5/19	A		0.34	35	27		
LFB2.5	8/7/19	A		0.51	91	23		
LFB2.5	9/4/19	A		0.72	90	40		
LFB5	4/10/19	A		0.87	34	16		7.42
LFB5	5/1/19	A		0.57	23	15		
LFB5	6/5/19	A		0.51	37	20		
LFB5	8/7/19	A		0.97	104	26		
LFB5	9/4/19	A		0.85	69	25		
LFBS1-0.9	4/10/19	A		0.54	29	20		8.82
LFBS1-0.9	5/1/19	A		0.28	16	14		
LFBS1-0.9	6/5/19	A		0.32	40	18		
LFBS1-0.9	7/10/19	A		0.55	62	43		
LFBS1-0.9	8/7/19	A		0.62	100	47		
LFBS1-0.9	9/4/19	A		0.59	63	45		

Lemon Fair River (continued)

Location	Date	QA	E. Coli. (mpn/100ml)	Total Nitrogen (mg/L)	Totoal Phosphorus (ug/L)	Dissolved Phosphorus (ug/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
LFBasc 0.3	4/10/19	A		0.94	87	40		41.2
LFBasc 0.3	5/1/19	A		0.41	49	40		
LFBasc 0.3	6/5/19	A		0.57	54	42		
LFBasc 0.3	7/10/19	A		0.55	67	28		
LFBasc 0.3	8/7/19	A		0.68	60	21		
LFBasc 0.3	9/4/19	A		0.48	53	24		
LFPerr 0.5	4/10/19	A		1.73	109	71		36.1
LFPerr 0.5	5/1/19	A		0.31	39	26		
LFPerr 0.5	6/5/19	A		0.38	63	37		
LFPerr 0.5	7/10/19	A		0.58	126	40		
LFPerr 0.5	8/7/19	A		0.56	113	42		
LFPerr 0.5	9/4/19	A		0.65	120	30		

VT Water Quality Standards (effective January 2017):

- **Turbidity** (warm water Class B) = **25 NTUs** as an annual average under dry weather base-flow conditions.
- ***E. coli*** (Class B): Not to exceed a geometric mean of 126 organisms /100ml obtained over a representative period of 60 days, and no more than 10% of samples above **235 organisms/100 ml**. In waters receiving combined sewer overflows, the representative period shall be 30 days.
- **Phosphorus** (Class B, Warm-water Medium Gradient): Not to exceed **27 ug/L** at low median monthly flow during June through October in a section of the stream representative of well-mixed flow.

Lewis Creek

Location	Date	QA	E. Coli. (mpn/100ml)	Total Nitrogen (mg/L)	Totoal Phosphorus (ug/L)	Dissolved Phosphorus (ug/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
LCR0.3	4/10/19	A			114			55
LCR0.3	5/1/19	A			35			
LCR0.3	6/5/19	A			32			
LCR0.3	7/10/19	A			88			
LCR0.3	8/7/19	A			33			
LCR0.3	9/4/19	A			33			
LCR3.7	4/10/19	A			123			41.2
LCR3.7	5/1/19	A			29			
LCR3.7	6/5/19	A			30			
LCR3.7	7/10/19	A			48			
LCR3.7	8/7/19	A			19			
LCR3.7	9/4/19	A			21			
LCR9.9	4/10/19	A			137			38.6
LCR9.9	5/1/19	A			31			
LCR9.9	6/5/19	A			48			
LCR9.9	7/10/19	A			50			
LCR9.9	8/7/19	A			29			
LCR9.9	9/4/19	A			27			
LCR14	4/10/19	A		0.5	69	10		11.2
LCR14	5/1/19	A		0.53	16	9		
LCR14	6/5/19	A	365.40	0.6	36	14		7.02
LCR14	7/10/19	A	101.44	0.68	11	7		0.9
LCR14	8/7/19	A	726.99	0.8	16	7		1.21
LCR14	9/4/19	A		0.69	13	8		2.32
LCR14.3	4/10/19	A		0.49	72	11		20.8
LCR14.3	5/1/19	A		0.58	19	10		
LCR14.3	6/5/19	A	517.21	0.7	49	18		11.7
LCR14.3	7/10/19	A	101.93	0.76	13	8		1.25
LCR14.3	8/7/19	A	980.39	0.89	18	8		1.31
LCR14.3	9/4/19	A		0.73	16	8		3
LCR15	4/10/19	A		0.49	76	9		21.4
LCR15	5/1/19	A		0.53	16	7		
LCR15	6/5/19	A	193.49	0.6	36	10		3.69
LCR15	7/10/19	A	123.56	0.8	12	7		0.83
LCR15	8/7/19	A	1553.12	0.91	15	7		0.97
LCR15	9/4/19	A		0.74	13	7		1.99

Lewis Creek (continued)

Location	Date	QA	E. Coli. (mpn/100ml)	Total Nitrogen (mg/L)	Totoal Phosphorus (ug/L)	Dissolved Phosphorus (ug/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
LCR16	4/10/19	A		0.43	40	8		4.22
LCR16	5/1/19	A		0.52	14	7		
LCR16	6/5/19	A	104.97	0.53	20	9		1.51
LCR16	7/10/19	A	41.35	0.75	9	7		0.43
LCR16	8/7/19	A	461.11	0.98	15	8		0.58
LCR16	9/4/19	A		0.7	12	7		1.33
LCHLW0.1	4/10/19	A		0.47	14	7		2.66
LCHLW0.1	5/1/19	A		0.61	8	6		
LCHLW0.1	6/5/19	A	218.72	0.35	26	9		2.72
LCHLW0.1	7/10/19	A	40.44	0.48	5	5		0.34
LCHLW0.1	8/7/19	A	111.23	0.49	7	5		0.26
LCHLW0.1	9/4/19	A		0.5	7	6		0.35
LCHLW1.0	4/10/19	A		0.42	10	7		1.73
LCHLW1.0	5/1/19	A		0.38	6	6		
LCHLW1.0	6/5/19	A	191.79	0.31	17	8		1.94
LCHLW1.0	7/10/19	A	37.86	0.62	11	5		<0.20
LCHLW1.0	8/7/19	A	21.82	0.56	9	5		0.35
LCHLW1.0	9/4/19	A		0.58	6	6		0.22
LCT3D.5	4/10/19	A			27			2.47
LCT3D.5	6/5/19	A			62			
LCT3D.5	7/10/19	A			176			
LCT3D.5	8/7/19	A			64			
LCT3D.5	9/4/19	A			52			

VT Water Quality Standards (effective January 2017):

- **Turbidity** (cold water Class B) = **10 NTUs** as an annual average under dry weather base-flow conditions.
- **E. coli** (Class B): Not to exceed a geometric mean of 126 organisms /100ml obtained over a representative period of 60 days, and no more than 10% of samples above **235 organisms/100 ml**. In waters receiving combined sewer overflows, the representative period shall be 30 days.
- **Phosphorus** (Class B, Warm-water Medium Gradient): Not to exceed **27 ug/L** at low median monthly flow during June through October in a section of the stream representative of well-mixed flow.
- **Nitrogen** as nitrate (NO3) is not to exceed 5.0 mg/L at flows exceeding the low median monthly discharge. Total nitrogen includes organic and inorganic forms of nitrogen. A test of NO3-NO2 inorganic forms of nitrogen is required to evaluate water quality relative to the VWQS.

Little Otter Creek

Location	Date	QA	E. Coli. (mpn/100ml)	Total Nitrogen (mg/L)	Totoal Phosphorus (ug/L)	Dissolved Phosphorus (ug/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
LOC4.3	4/10/19	A			98			
LOC4.3	5/1/19	A			45			
LOC4.3	6/5/19	A			85			
LOC4.3	7/10/19	A			422			
LOC4.3	8/7/19	A			126			
LOC4.3	9/4/19	A			190			
MDC1.2	4/10/19	A			62			
MDC1.2	5/1/19	A			47			
MDC1.2	6/5/19	A			98			
MDC1.2	7/10/19	A			625			
MDC1.2	8/7/19	A			214			
MDC1.2	9/4/19	A			158			

VT Water Quality Standards (effective January 2017):

- **Turbidity** (cold water Class B) = **10 NTUs** as an annual average under dry weather base-flow conditions.
- **E. coli** (Class B): Not to exceed a geometric mean of 126 organisms /100ml obtained over a representative period of 60 days, and no more than 10% of samples above **235 organisms/100 ml**. In waters receiving combined sewer overflows, the representative period shall be 30 days.
- **Phosphorus** (Class B, Warm-water Medium Gradient): Not to exceed **27 ug/L** at low median monthly flow during June through October in a section of the stream representative of well-mixed flow.
- **Nitrogen** as nitrate (NO3) is not to exceed 5.0 mg/L at flows exceeding the low median monthly discharge. Total nitrogen includes organic and inorganic forms of nitrogen. A test of NO3-NO2 inorganic forms of nitrogen is required to evaluate water quality relative to the VWQS.

Middlebury River

Location	Date	QA	E. Coli. (mpn/100ml)	Total Nitrogen (mg/L)	Totoal Phosphorus (ug/L)	Dissolved Phosphorus (ug/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
MIR1.5	4/10/19	A			42			
MIR1.5	5/1/19	A			15			
MIR1.5	6/5/19	A	261.25		31			
MIR1.5	7/10/19	A	63.14		24			
MIR1.5	8/7/19	A	146.72		19			
MIR1.5	9/4/19	A			24			
MIR5.7	4/10/19	A			14			
MIR5.7	5/1/19	A			6			
MIR5.7	6/5/19	A	307.59		47			
MIR5.7	7/10/19	A	24.05		6			
MIR5.7	8/7/19	A	21.09		8			
MIR5.7	9/4/19	A			8			
MIR10.6	4/10/19	A			12			
MIR10.6	5/1/19	A			8			
MIR10.6	6/5/19	A			41			
MIR10.6	7/10/19	A			9			
MIR10.6	8/7/19	A			11			
MIR10.6	9/4/19	A			11			

VT Water Quality Standards (effective January 2017):

- **Turbidity** (cold water Class B) = **10 NTUs** as an annual average under dry weather base-flow conditions.
- **E. coli** (Class B): Not to exceed a geometric mean of 126 organisms /100ml obtained over a representative period of 60 days, and no more than 10% of samples above **235 organisms/100 ml**. In waters receiving combined sewer overflows, the representative period shall be 30 days.
- **Phosphorus** (Class B, Warm-water Medium Gradient): Not to exceed **27 ug/L** at low median monthly flow during June through October in a section of the stream representative of well-mixed flow.

New Haven River

Location	Date	QA	E. Coli. (mpn/100ml)	Total Nitrogen (mg/L)	Totoal Phosphorus (ug/L)	Dissolved Phosphorus (ug/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
NHR2	4/10/19	A			54			
NHR2	5/1/19	A			10			
NHR2	6/5/19	A			17			
NHR2	7/10/19	A			17			
NHR2	8/7/19	A			48			
NHR2	9/4/19	A			40			
NHR6	6/5/19	A	166.4					
NHR6	7/10/19	A	71.16					
NHR6	8/7/19	A	866.44					
NHR9	4/10/19	A			13			
NHR9	5/1/19	A			7			
NHR9	6/5/19	A			33			
NHR9	7/10/19	A			<5			
NHR9	8/7/19	A			19			
NHR9	9/4/19	A			6			
NHR11.5	6/5/19	A	461.11					
NHR11.5	7/10/19	A	17.12					
NHR11.5	8/7/19	A	726.99					

VT Water Quality Standards (effective January 2017):

- **Turbidity** (cold water Class B) = **10 NTUs** as an annual average under dry weather base-flow conditions.
- **E. coli** (Class B): Not to exceed a geometric mean of 126 organisms /100ml obtained over a representative period of 60 days, and no more than 10% of samples above **235 organisms/100 ml**. In waters receiving combined sewer overflows, the representative period shall be 30 days.
- **Phosphorus** (Class B, Warm-water Medium Gradient): Not to exceed **27 ug/L** at low median monthly flow during June through October in a section of the stream representative of well-mixed flow.

Otter Creek (Lower)

Location	Date	QA	E. Coli. (mpn/100ml)	Total Nitrogen (mg/L)	Totoal Phosphorus (ug/L)	Dissolved Phosphorus (ug/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
OTR7.3	4/10/19	A			35			
OTR7.3	5/1/19	A			31			
OTR7.3	6/5/19	A			40			
OTR7.3	7/10/19	A			46			
OTR7.3	8/7/19	A			36	13		
OTR7.3	9/4/19	A			41			
OTR18	4/10/19	A			48			
OTR18	5/1/19	A			24			
OTR18	6/5/19	A			35			
OTR18	7/10/19	A			34			
OTR18	8/7/19	A			44			
OTR18	9/4/19	A			27			

VT Water Quality Standards (effective January 2017):

- **Turbidity** (warm water Class B) = **25 NTUs** as an annual average under dry weather base-flow conditions.
- **E. coli** (Class B): Not to exceed a geometric mean of 126 organisms /100ml obtained over a representative period of 60 days, and no more than 10% of samples above **235 organisms/100 ml**. In waters receiving combined sewer overflows, the representative period shall be 30 days.
- **Phosphorus** (Class B, Warm-water Medium Gradient): Not to exceed **27 ug/L** at low median monthly flow during June through October in a section of the stream representative of well-mixed flow.

Appendix D
Addison County River Watch Collaborative
Summary Report: 2019 Sampling Results

Quality Assurance / Quality Control Summary Report

TABLE OF CONTENTS

I. Introduction

This appendix provides a summary of the Quality Assurance review of sampling results for the 2019 season in six watersheds monitored by the Addison County River Watch Collaborative:

- Lemon Fair River
- Lewis Creek
- Little Otter Creek (including Mud Creek)
- Middlebury River
- New Haven River
- Otter Creek

The Addison County River Watch Collaborative sampled 34 sites in these six watersheds during two Spring events (April and May) four Summer events (June, July, August and September) in 2019.

Table 1. Sampling Dates in 2019

Stations	Sampling Dates	
34 sentinel and rotational stations	April 10 May 1 June 5	July 10 Aug 7 Sept 4

Sampling sites and parameters monitored during Spring and Summer months are presented in Table 2. Parameters included Total Phosphorus (TP), Dissolved Phosphorus (DP), Total Nitrogen (TN), Total Suspended Sediments (TSS), Turbidity, and *E. coli*. Originally-scheduled *E. coli* and Turbidity analyses for highlighted (yellow) sites in Table 2 were eliminated for the Summer sampling events to comply with a mid-season request from the LaRosa Volunteer Monitoring Program to reduce requested services.

II. Data Validation

The following sections discuss data quality objectives and 2019 season results with respect to completeness, accuracy (Field Blank results) and precision (Field Duplicate results). Recommended corrective actions for identified issues are addressed in Section IV.

II.A Completeness

Overall completeness **(96.1%)** exceeded the goal outlined in the ACRWC Quality Assurance Project Plan (80%) as detailed in Table 3. Due to differences in scheduled parameters, completeness has been calculated separately for the Spring versus Summer events.

Table 2. 2019 Schedule of Sites / Parameters – Spring, Summer *Site Types: R = Rotational; S = Sentinel; O = Other (special project).*

Project Number: **137-01**				Spring Schedule (Apr, May)						Summer Schedule (Jun, Jul, Aug, Sep)						
Sample Year: **2019 - Revised**										PARAMETERS						
Type	**River Name**	**Site ID**	**Site Location**	**TP**	**DP**	**TN**	**NOX**	**Turbidity**	**TSS**	***E.coli***	**TP**	**DP**	**TN**	**NOX**	**Turbidity**	**TSS**
R	Lewis Creek	LCR0.3	Boat Access upstream of Hawkins Bay	X				X			X					
S	Lewis Creek	LCR3.7	Old Route 7 Bridge	X				X			X					
R	Lewis Creek	LCR9.9	Upper Covered Bridge, Roscoe Rd.	X				X			X					
R	Pond Brook	LCT3D.5	Silver Street culvert	X				X			X					
S	Lewis Creek	LCR14	Tyler Bridge	X	X	X		X		X	X	X	X		X	
O	Hollow Bk (Lewis Ck)	LCHLW1.0	Tyler Bridge Rd X'g of Hollow Bk	X	X	X		X		X	X	X	X		X	
O	Hollow Bk (Lewis Ck)	LCHLW0.1	Hollow Brook at Confl w/ Lewis	X	X	X		X		X	X	X	X		X	
O	Lewis Creek	LCR14.3	Just above confluence of Hollow Bk	X	X	X		X		X	X	X	X		X	
O	Lewis Creek	LCR15	Just above Clifford stabilized crossing	X	X	X		X		X	X	X	X		X	
O	Lewis Creek	LCR16	LaRue bridge crossing	X	X	X		X		X	X	X	X		X	
R	Lemon Fair River	LFR1.2	Prunier Road bridge	X	X	X		X	X		X	X	X			
R	Lemon Fair River	LFR4	Lemon Fair Rd bridge	X	X	X		X	X		X	X	X			
S	Lemon Fair River	LFR6.7	Route 125 bridge.	X	X	X		X	X		X	X	X			
S	Lemon Fair River	LFR12	Downstream of Route 74 bridge	X	X	X		X	X		X	X	X			
R	Lemon Fair River	LFR15.8	Shacksboro Road bridge	X	X	X		X	X		X	X	X			
R	Lemon Fair River	LFR23.9	Murray Road Bridge	X	X	X		X	X		X	X	X			
R	Lemon Fair River	LFR26.6	Old Sawmill Rd bridge	X	X	X		X	X		X	X	X			
R	Beaver Branch (LFR)	LFB0.5	Route 125 crossing	X	X	X		X			X	X	X			
R	Beaver Branch (LFR)	LFB2.5	Sperry Road crossing, Beaver Branch	X	X	X		X			X	X	X			
R	Beaver Branch (LFR)	LFB5	Clark Rd bridge	X	X	X		X			X	X	X			
R	Trib to Beaver Br (LFR)	LFBS1-0.9	Route 74 crossing	X	X	X		X			X	X	X			
R	Bascom Brook (LFR)	LFBasc 0.3	Buttolph Rd crossing	X	X	X		X			X	X	X			
R	Perry Brook (LFR)	LFPerr 0.5	Buttolph Rd crossing	X	X	X		X			X	X	X			
S	Little Otter Creek	LOC4.3	Route 7 Bridge	X							X					
S	Mud Creek	MDC1.2	Wing Rd./Middlebrook Rd. (South)	X							X					
S	Middlebury River	MIR1.5	Shard Villa Road Bridge	X						X	X					
S	Middlebury River	MIR5.7	Midd. Gorge @ Rte 125 Bridge	X						X	X					
S	Middlebury River (Midd Br)	MIR10.6	Natural Turnpike Road	X							X					
S	New Haven River	NHR2	Muddy Branch confluence (just below)	X							X					
S	New Haven River	NHR6	Route 116 Bridge, Sycamore Park							X						
S	New Haven River	NHR9	South St. Bridge	X							X					
S	New Haven River	NHR11.5	Bartlett's Falls Pool							X						
S	Otter Creek	OTR7.3	Vergennes Falls / below outfall	X							X					
S	Otter Creek	OTR18	Twin Bridges Picnic Area	X							X					

Table 3. Project Completeness

Table 7c - Project Completeness

* Anticipated totals were revised after the April 2019 event to comply with LaRosa Program request to reduce analytical expenses. Therefore these anticipated totals do not match those in the approved QAPP for the 2019 season.

Parameter			Number of Samples Anticipated Primary	QC	Total	Number of Valid Samples Collected & Analyzed Primary	QC	Total	Percent Complete
Chlorophyll-*a*			-	-	-				
Phosphorus	Total	*Spring*	64	16	80	63	20	83	100.0
		Summer	128	32	160	126	32	158	98.8
	Dissolved	*Spring*	38	8	46	38	12	50	100.0
		Summer	76	16	92	74	24	98	100.0
E. coli		*Summer*	40	8	48	30	4	34	70.8
Total Suspended Solids		*Spring*	7	2	9	7	2	9	100.0
		Summer	0	0	0	0	0	0	
Transparency					-				
Alkalinity		*Summer*	-	-	-				
pH					-				
Turbidity		*Spring*	23	6	29	23	6	29	100.0
		Summer	24	8	32	24	4	28	87.5
Total Nitrogen		*Spring*	38	8	46	38	12	50	100.0
		Summer	76	16	92	74	19	93	100.0
Total Nox		*Spring*							
		Summer							
Si, dissolved			-	-	-				
Dissolved Oxygen			-	-	-				
Conductivitiy			-	-	-				
Temperature		*Spring/Summer*	160		160	160		160	100.0

Completeness - Primary Samples

Select constituent analyses for several primary samples were missed during the 2019 season:

- On **May 1**, a mix-up of collection materials resulted in a missing sample from the Lewis Creek station LCT3D.5. This accounts for one sample of total phosphorus.
- For the **July 10** event, an abundance of poison parsnip at Lemon Fair River sites LFB0.5 and LFB2.5 prevented volunteers from approaching the river at these locations. Samples were not taken. This included total nitrogen, total phosphorus, and dissolved phosphorus samples for each of the two sites.
- For the **August 7** event, an unanticipated sample of dissolved phosphorus was collected at Otter Creek site OTR7.3. This was due to a mix-up during the bottle ordering process. This can be attributed to two factors: the state was transitioning into a new ordering system that everyone was still learning, and ACRWC was transitioning to a new person completing the ordering process.
- For the **September 4** event, VAEL reported a lab error that prevented all *E. coli* samples from being analyzed after they were delivered to the lab. This included 10 primary and 2 QC samples.

Completeness - Field QC Samples

The ACRWC QAPP specifies collection of Field Blanks and Field Duplicates at a frequency of 1 per 10 primary samples for each scheduled analyte, per event. Field blank and duplicate samples were collected and processed at a frequency of 10% or greater during each of the spring and summer sampling events, except in these instances:

- At the **August 7** sampling event at the Lewis Creek LCR14 site, four anticipated QC samples were not taken. This included a field blank and duplicate for *E. coli* and a field blank and duplicate for turbidity. ACRWC believes this was due to the transition to the new ordering system in the state. This transition caused some confusion, and the proper bottles were not ordered.
- During the **September 4** sampling event, two QC turbidity samples went missing from the Lewis Creek LCR16 site. Volunteer samplers wrote on the data form that they collected the samples, but they were not checked in and sent to the lab. It is unclear exactly how this occurred.
- Also for the **September 4** sampling event, VAEL reported a lab error that prevented all *E. coli* samples from being analyzed after they were delivered to the lab. This included 10 primary and 2 QC samples.

II.B Field Blank results

Field Blank results are summarized in Table 4. Field Blanks collected for each constituent in the Spring and Summer events were within field accuracy goals (no constituents detected above the respective method detection limits in the blanks) – except for the following cases.

- In some Field Blank results for various events and various constituents, a value of the indicated constituent was detected slightly above the respective method detection limit (see light orange-shaded values in Table 4). It is unknown whether contamination of the Field Blank occurred in the field or in the lab. ACRWC utilized deionized water that had been provided by the VAEL. Since the reported value was only slightly above the detection limit, and It is not uncommon for Turbidity and TP to be detected in Field Blanks at very low levels, but somewhat above the method detection limit (Jim Kellogg, email communication with Kristen Underwood, 1/15/2018), none of the corresponding results for these stations have been rejected or flagged as estimated values on account of these Field Blank results.

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Sample Number	Location	Date	Final E. Coli. (mpn/100ml)	Turdidity (NTU)	TN (mg-N/L)	TP (ug P/L)	DP (ug P/L)	TSS
1900141-035	LCHLW1.0 BLK	4/10/19		<0.2	<0.1	<5	<5	
1900141-039	LFB5 BLK	4/10/19		<0.2	<0.1	6.00	7.00	
1900141-037	LFR15.8 BLK	4/10/19		<0.2	<0.1	<5	<5	<2.0
1900338-033	LCHLW1.0 BLK	5/1/19			<0.1	<5	<5	
1900338-037	LFB5 BLK	5/1/19			<0.1	<5	<5	
1900338-035	LFR15.8 BLK	5/1/19			0.10	<5	<5	
1900338-040	MIR1.5 BLK	5/1/19				6.00		
1900338-041	OTR7.3 BLK	5/1/19				6.00		
1900363-035	LCR15 BLK	6/5/19		<0.2	<0.1	<5	<5	
1900363-035	LCR15 BLK	6/5/19	<1.00					
1900363-039	LFBasc 0.3 BLK	6/5/19			<0.1	<5	<5	
1900363-037	LFR6.7 BLK	6/5/19			<0.1	<5	<5	
1900363-041	NHR2 BLK	6/5/19				<5		
1900569-035	LCR14 BLK	7/10/19		<0.2	<0.1	<5	<5	
1900569-035	LCR14 BLK	7/10/19	<1.00					
1900569-039	LFPerr 0.5 BLK	7/10/19			<0.1	<5	<5	
1900569-037	LFR12 BLK	7/10/19			<0.1	<5	<5	
1900569-041	OTR7.3 BLK	7/10/19				<5		
1900812-035	LCR14 BLK	8/7/19			<0.1	<5	<5	
1900812-039	LFPerr 0.5 BLK	8/7/19			<0.1	<5	<5	
1900812-037	LFR12 BLK	8/7/19			<0.1	<5	<5	
1900812-041	OTR7.3 BLK	8/7/19				<5	<5	
1900981-035	LCR16 BLK	9/4/19			<0.1	<5	<5	
1900981-039	LFB0.5 BLK	9/4/19			<0.1	<5	<5	
1900981-037	LFR15.8 BLK	9/4/19			<0.1	<5	<5	
1900981-041	LOC4.3 BLK	9/4/19				<5		

Shaded cells indicate values detected at or above the method detection limit.

Table 4. Field Blank Results

II.C Field Duplicate results

Field Duplicate results are summarized in Table 5, which presents the Relative Percent Difference (RPD) values for each analyte for each Field Duplicate pair. As per the QAPP, Mean Relative Percent Difference was calculated as follows:

$$RPD_{\text{field duplicate pair 1}} = \frac{\text{absolute value } (sample_1 - sample_2)}{\text{average } (sample_1 \text{ and } sample_2)}$$

and, mean RPD for "n" duplicate pairs = average $(RPD_{pair\ 1} + RPD_{pair\ 2} + ... + RPD_{pair\ n})$

Mean RPD values for the season were within the precision goals specified for the project for all analytes.

While the mean values met precision goals, RPD values in one instance exceeded this goal (shaded in orange in Table 5). This was the dissolved phosphorus sample and duplicate pair from the Lewis Creek site LCR16 on September 4. It is unclear what caused this elevated RPD value, but various aspects of sampling and analysis procedures, as well as natural variability, may have contributed. The detected concentration in the duplicate pair was quite low – a condition which can contribute to elevated RPD. Since the overall mean RPD for the 2019 sample year met the precision goal, none of the results were rejected or flagged as estimated values on account of RPD results for Field Duplicate pairs.

Table 5. Field Duplicate Results *(presented values are Relative Percent Difference of Field Duplicate pairs)*

Location	Date	E. Coli. (mpn/100ml)	Total Nitrogen (mg/L)	Totoal Phosphorus (ug/L)	Dissolved Phosphorus (ug/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
LCHLW1.0	4/10/19		2.35	9.52	0.00		0.58
LFB5	4/10/19		1.16	9.23	11.76		1.07
LFR15.8	4/10/19		1.50	1.40	12.50	0.88	0.31
MIR1.5	4/10/19			2.41			
OTR7.3	4/10/19			13.33			
LCHLW1.0	5/1/19		5.41	15.38	0.00		
LFB5	5/1/19		1.74	0.00	12.50		
LFR15.8	5/1/19		1.31	2.79	3.57		
MIR1.5	5/1/19			6.90			
OTR7.3	5/1/19			3.28			
LCR15	6/5/19	3.31	3.39	25.00	9.52		0.27
LFBasc 0.3	6/5/19		1.77	1.83	0.00		
LFR6.7	6/5/19		10.53	3.10	4.26		
NHR2	6/5/19			16.22			
LCR14	7/10/19	5.88	1.48	9.52	0.00		10.53
LFPerr 0.5	7/10/19		14.81	1.60	0.00		
LFR12	7/10/19		5.88	3.51	1.38		
OTR7.3	7/10/19			0.00			
LCR14	8/7/19			0.00	25.00		
LFPerr 0.5	8/7/19			0.88	2.35		
LFR12	8/7/19			2.06	0.00		
OTR7.3	8/7/19			2.74			
OTR7.4	8/7/19			0.00			
LCR16	9/4/19		7.41	18.18	131.71		
LFB0.5	9/4/19			1.20			
LFR15.8	9/4/19		3.33	1.94	3.64		
LOC4.3	9/4/19			3.11			
Number of Duplicate Pairs		**2**	**14**	**27**	**17**	**1**	**5**
Average RPD for Sample Year		**4.59**	**4.43**	**5.75**	**12.83**	**0.88**	**2.55**
QAPP Acceptable RPD		**≤50% (>25mpn) ≤125% (<25mpn)**	**≤20%**	**≤30%**	**≤30%**	**≤15%**	**≤15%**

KEY	
	Missing a Duplicate Sample
	Samples have been flagged due to unusual values

III. Other QA/QC Issues

1. Results for one sample was reported by the lab with an incorrect sample ID:

Lab_ID	Order	Site	DateTime
1900141-018		LFB0.5	4/10/2019 7:05
1900338-018		LFB0.5	5/1/2019 8:15
1900363-018		LFB0.5	6/5/2019 8:25
1900569-018		LFB0.5	7/10/2019 8:05
1900812-018		LFB0.5	8/7/2019 8:03
1900981-018		LFBR0.5	9/4/2019 8:00

2. In one Lewis Creek duplicate sample (LCR16), collected during the June 5 event, subtraction of the reported DP concentration from the TP concentration resulted in a negative value. ACRWC is not certain what happened. As a duplicate sample, however, it is notable that the value of DP is very similar to the sample value for TP, and vice versa. It is probable that TP and DP vials were reversed in the field.

IV. Corrective Actions

The following corrective actions are recommended to address issues encountered in 2019.

A. ACRWC will continue with the annual refresher training that is mandatory for all volunteer samplers. A new sampling instruction video was prepared by ACRWC in 2017 that will be used at training, and available to samplers throughout the season, to emphasize proper sampling techniques. http://acrpc.org/programs-services/natural-resources/acrwc/whatsnew/.

B. Spring training has been emphasizing field collection methods for duplicate and field blank samples, as this is an area of recurring sampling errors. Sampling coordinators have been making concerted efforts to ensure that field blank vials are filled with DI water prior to sampling so that there is no opportunity to fill a blank vial (erroneously) with river water.

C. The ACRWC Coordinator will continue to generate a Lab Runner Log. This form was used to document any QA issues relevant to sample transport and delivery and record them as they happened, which proved useful to the generation of this QA/QC summary report.

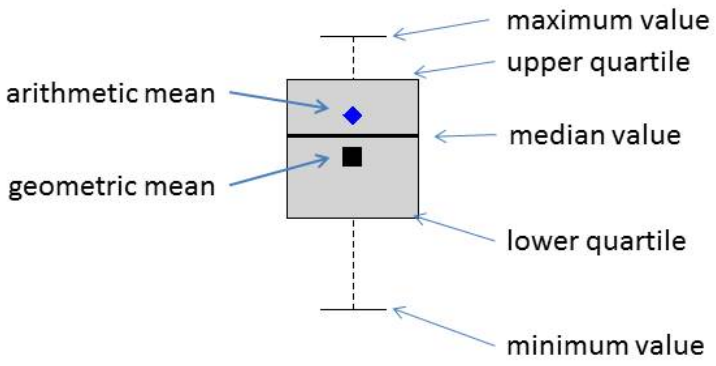
D. ACRWC was able to avoid many QC issues this year, as a result of a series of checks and data reviews throughout the sampling season (detailed in the 2010 season QA Summary Report). Far fewer omissions and incidents have occurred in recent years as a result of instituting these checks and balances. ACRWC will continue with these procedures in future years.

E. ACRWC staff and volunteers will continue the learning process of the new VAEL ordering system. With time and experience, ACRWC believes that there will be fewer errors with the bottle ordering and labeling process, resulting in an even better completeness score.

F. ACRWC is undergoing a transition from one QC Coordinator to another. ACRWC will make every effort to make this transition smooth by writing down methods, maintaining open communication between both individuals, and providing appropriate training.

Appendix E: 2019 Individual Watershed Summaries

1 Lemon Fair River – 2019 Water Quality Summary
2 Lewis Creek – 2019 Water Quality Summary
3 Little Otter Creek – 2019 Water Quality Summary
4 Middlebury River – 2019 Water Quality Summary
5 New Haven River – 2019 Water Quality Summary
6 Otter Creek (Lower) – 2019 Water Quality Summary



Focus watershed:
2018 and 2019

Lemon Fair River – 2018-2019 Water Quality Summary

Addison County River Watch Collaborative
Prepared in conjunction with South Mountain Research and Consulting

Type	Strean	Site	Location	Town
R	Lemon Fair	LFR1.2	Prunier Road bridge	Weybridge
R	Lemon Fair	LFR4	Lemon Fair Rd bridge	Weybridge
S	Lemon Fair	LFR6.7	Route 125 bridge.	Cornwall
S	Lemon Fair	LFR12	Downstream of Route 74 bridge	Shoreham
R	Lemon Fair	LFR15.8	Shacksboro Road bridge	Shoreham
R	Lemon Fair	LFR23.9	Murray Road bridge	Orwell
R	Lemon Fair	LFR26.6	Old Sawmill Rd bridge	Orwell
R	Beaver Br (Lemon Fair)	LFB0.5	Route 125 crossing, Beaver Br.	Cornwall
R	Beaver Br (Lemon Fair)	LFB2.5	Sperry Road crossing, Beaver Br.	Cornwall
R	Beaver Br (Lemon Fair)	LFB5	Clark Rd crossing, Beaver Br.	Cornwall
R	Trib to Beaver Br	LFBS1-0.9	Route 74 crossing, trib to Beaver Br.	Cornwall
R	Bascom Br (Lemon Fair)	LFBasc0.3	Buttolph Rd crossing, Bascom Br.	Shoreham
R	Perry Brook (Lemon Fair)	LFPerr0.5	Buttolph Rd crossing, Perry Br.	Shoreham

The Addison County River Watch Collaborative has been monitoring water quality in the Lemon Fair River since 2003. In 2018-2019, the Collaborative undertook a two-year, more intensive monitoring focus in the Lemon Fair where rotational sites as well as long-term sentinel stations were monitored, and additional parameters were tested to better define spatial variability in pathogen, sediment and nutrient concentrations. In particular, new monitoring stations were established on Bascom Brook, Perry Brook and Beaver Branch, tributaries which join the main stem between the Shacksboro Road crossing and the Lemon Fair Road crossing.

The two years brought quite different precipitation conditions. In each year, sampling occurred on two spring dates (April 4 and May 2 in 2018 and April 10 and May 1 in 2019) and four summer dates (June 6, July 11, August 1, and September 5 in 2018 and June 5, July 10, August 7, and September 4 in 2019). While 2018 was characterized by near-normal precipitation, 2019 brought above-normal conditions. In both years, April and May sampling events took place during high flow conditions resulting from snowmelt and spring rains, based on the streamflow records for the nearby USGS gaging station on Otter Creek at Middlebury. In 2019, these conditions continued into June. June 2018 and July 2019 events occurred during moderate-flow, baseflow conditions where river stage was not changing appreciably, and groundwater levels were relatively high following spring rains. Low-flow, baseflow conditions, at or below the Low Median Monthly (LMM) flow were likely met in July, August, and September of 2018, and in August 2019. However, there is no gage on the Lemon Fair river. In the nearby Otter and Little Otter Creeks, the August 2019 flows were not below the Low Median Monthly (LMM) flow condition, so this seems likely to also be true in the Lemon Fair. September 2019 samples were once again at moderate flow conditions that followed a storm event.

Samples from the Lemon Fair watershed were tested in 2018 and 2019 for phosphorus (total and dissolved), total nitrogen, and turbidity. Due to a request from the La Rosa Volunteer Monitoring program to reduce expenses, turbidity was not sampled in 2019.

Due to budgetary constraints, ***E.coli*** was not able to be sampled in Lemon Fair in 2019. In 2018, *E.coli* counts at the Lemon Fair sites ranged from 10 to 1,011 organisms/100 mL. Vermont Water Quality Criteria (VWMD, 2016) state that *E.coli* is not to exceed a geometric mean of 126 organisms /100mL obtained over a representative period of 60 days, and no more than 10% of samples should be above 235 organisms/100 mL. *E.coli* counts exceeded the state's health-based standard of 235 organisms/ 100 mL at on one or more dates at each of the sampled stations except for LFR12. The geometric mean of summer sampling results exceeded the state's geomean standard of 126 organisms/ 100 mL at main stem station, LFR 15.8, and at tributary stations, LFB5 and LFBS1.0.9 in the Beaver Branch watershed, LFPerr0.5 on Perry Brook, and LFBasc0.3 on Bascom Brook (Figure 1).

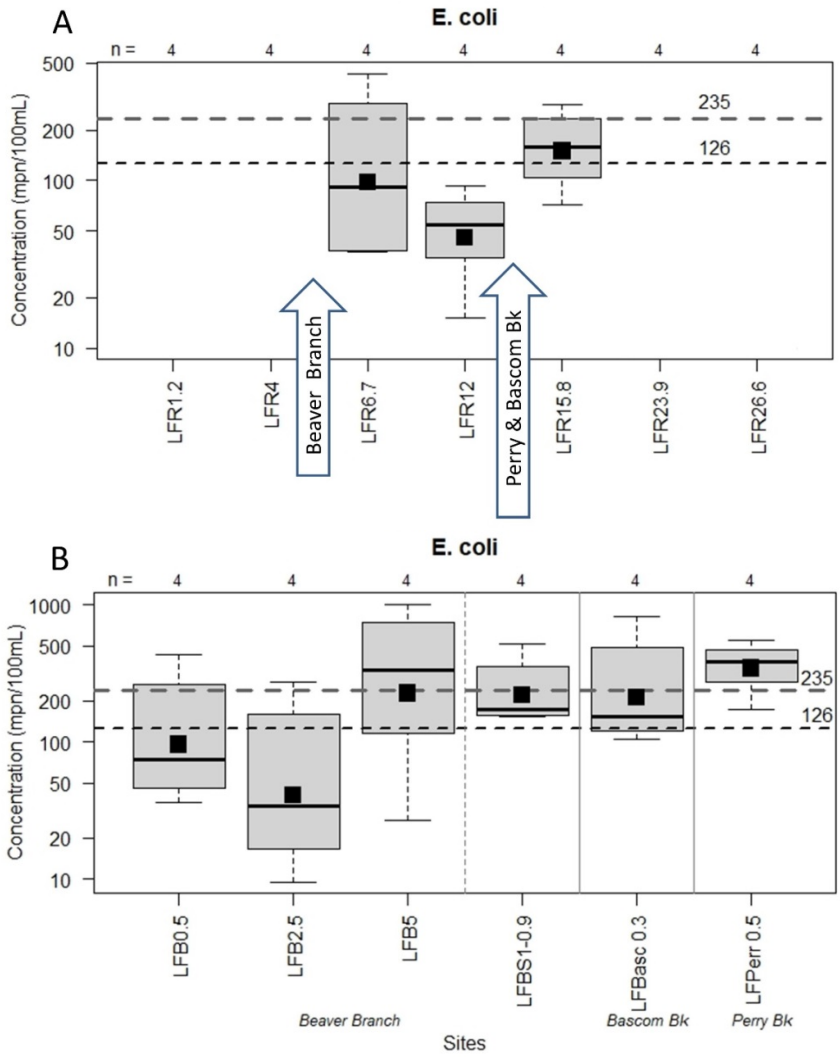


Figure 1. E.coli measured at sites on the Lemon Fair main stem (A) and tributaries (B) on four dry-weather, base-flow events between June and September in 2018. Due to budgetary constraints, E.coli was not able to be sampled in Lemon Fair in 2019. The whiskers extend to the maximum and minimum values, while the gray-shaded box represents the middle 50% of values. The median value is marked by the dark horizontal line. The geometric mean of all available samples for each station is displayed as the black square symbol. The horizontal, gray dashed lines represent the health-based (235) and geomean (126) standards for E.coli.

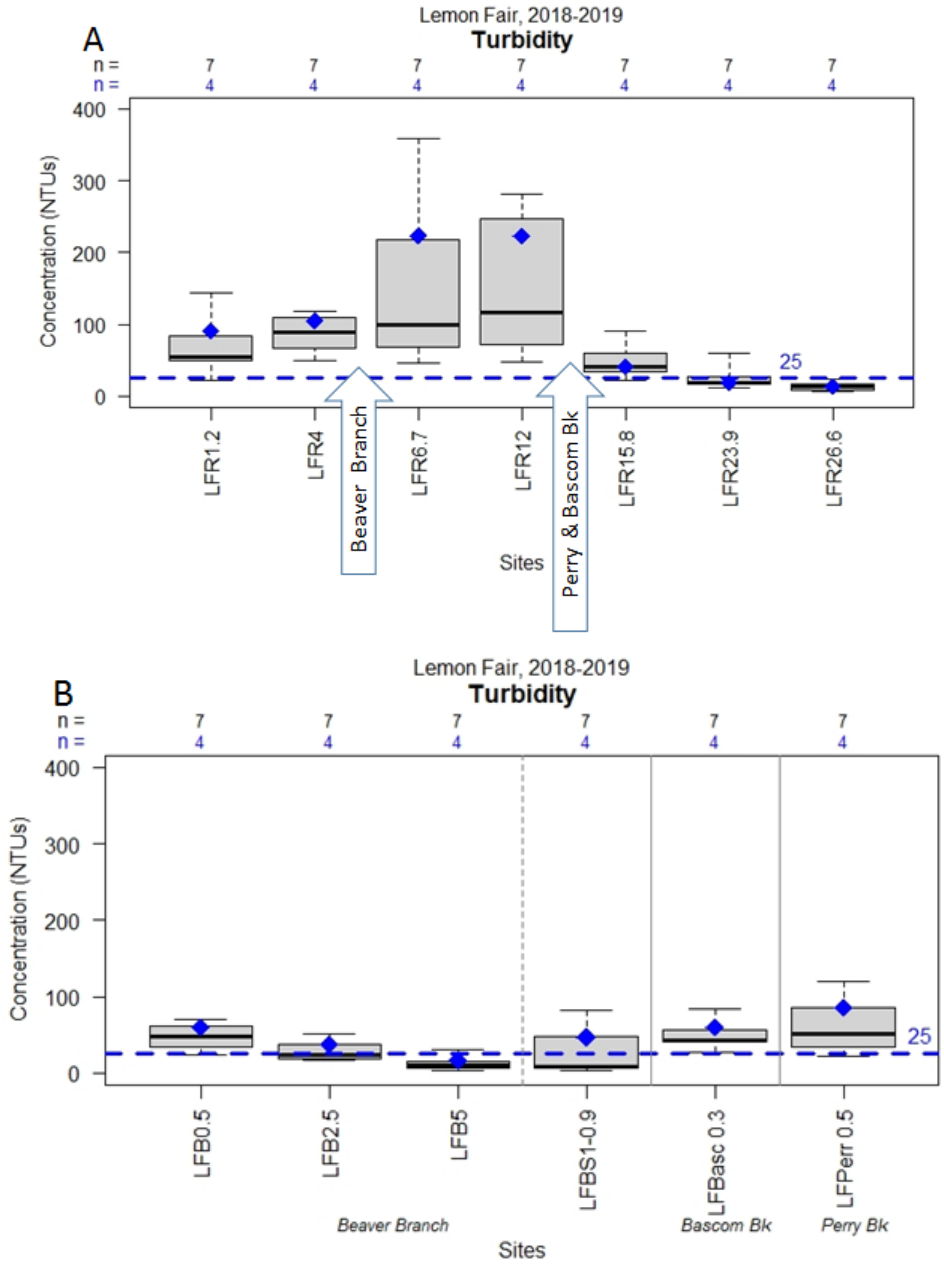


Figure 2. Summary of Turbidity measured at sites on the Lemon Fair main stem (A) and tributaries (B) in 2018 (n=6) and 2019 (n=1). Due to budgetary constraints, Turbidity sampling was suspended by the LaRosa Program in 2019 after the April event. The blue diamond marks the mean of that subset of samples collected during dry-weather, base-flow conditions, with the corresponding number of samples (n=4; 2018) indicated in blue along the top of the chart.

Due to budgetary constraints, **turbidity** was not able to be sampled in Lemon Fair in 2019. In 2018, turbidity levels at the Lemon Fair stations ranged from 3.3 to 358 NTUs. The Vermont state standard of 25 NTUs (for warm-water fisheries) is applicable during dry-weather, baseflow conditions which were relevant to each of the July, August and September events. Mean turbidity concentrations for these three dates were above the standard at main stem stations including and downstream from LFR15.8 (Shacksboro Road Bridge) (Figure 2A). Turbidity increased markedly between LFR15.8 and LFR12, and stayed high at the next downstream station, LFR6.7, before declining again (Figure 2A). These results

suggest a contributing source of Turbidity between the Shacksboro Road crossing and Route 74. The Lemon Fair receives runoff from both the Perry and Bascom Brooks between these two stations. However, Turbidity levels measured in these tributaries on the same sample dates were reasonably low and similar in magnitude to upstream station LFR15.8 (Figure 2B). These results suggest an alternate source(s) of Turbidity draining to the Lemon Fair between LFR15.8 and LFR12 (Figure 3A).

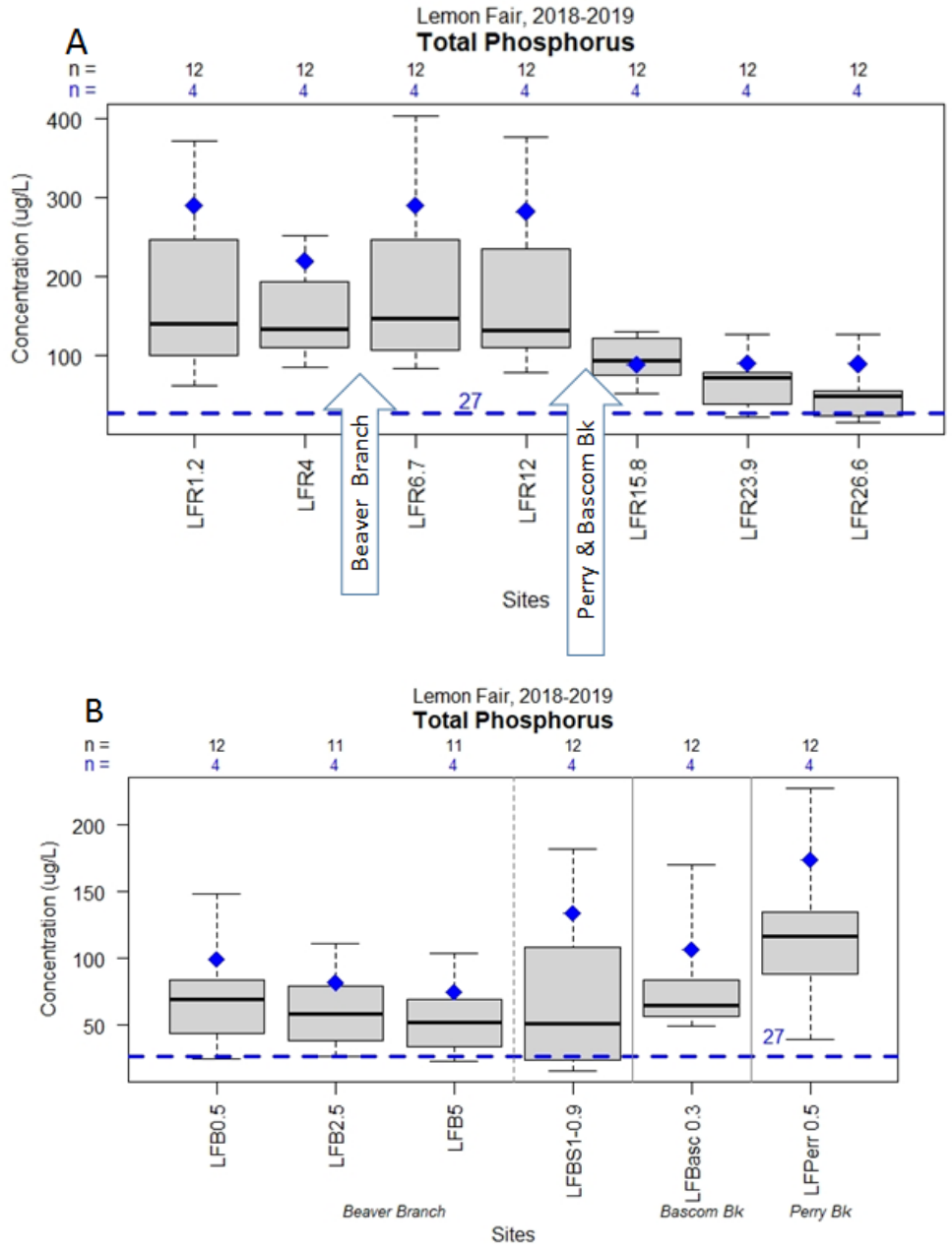


Figure 4. Summary of Total Phosphorus measured at sites on the Lemon Fair main stem (A) and tributaries (B) in 2018 (n=6) and 2019 (n=6). (Except LFB2.5 and LFB5 which are missing TP values for the July 10, 2019 sampling event). The blue diamond marks the mean of that subset of samples collected during base-flow conditions at or below the Low Median Monthly Flow (2018: n=3; 2019: n=1).

Phosphorus was detected at moderate to high levels during the twelve spring and summer sampling dates of 2018-2019, with concentrations ranging from 16 to 404 µg/L. The instream phosphorus

criterion of 27 µg/L for warm-water medium gradient (WWMG) wadeable stream ecotypes in Class B waters is applicable at low median monthly flow during June through October. Based on gaging records for nearby rivers of similar character (Little Otter Creek and Otter Creek), flows in Lemon Fair were likely near the low median monthly flow during the July, August and September dates in 2018, and during the August date in 2019. Mean Total Phosphorus (TP) concentrations for these dates exceeded the instream phosphorus criterion at every main stem and tributary site. It is possible that the Lemon Fair River would instead be classified as a Slow-Winder stream ecotype (not yet determined for the reaches sampled); there is no instream phosphorus criterion yet established for the Slow-Winder ecotype. Dissolved phosphorus (DP) was also tested at each site; as a percentage of TP, DP ranged from 15 to 88% during the twelve sample dates. As with Turbidity, TP increased notably between LFR15.8 and LFR12, suggesting a contributing source(s) of phosphorus between the Shacksboro Road crossing and Route 74. TP was somewhat elevated in Perry Brook, though not at the magnitude reported at station LFR12 (Figure 3B, Figure 4B).

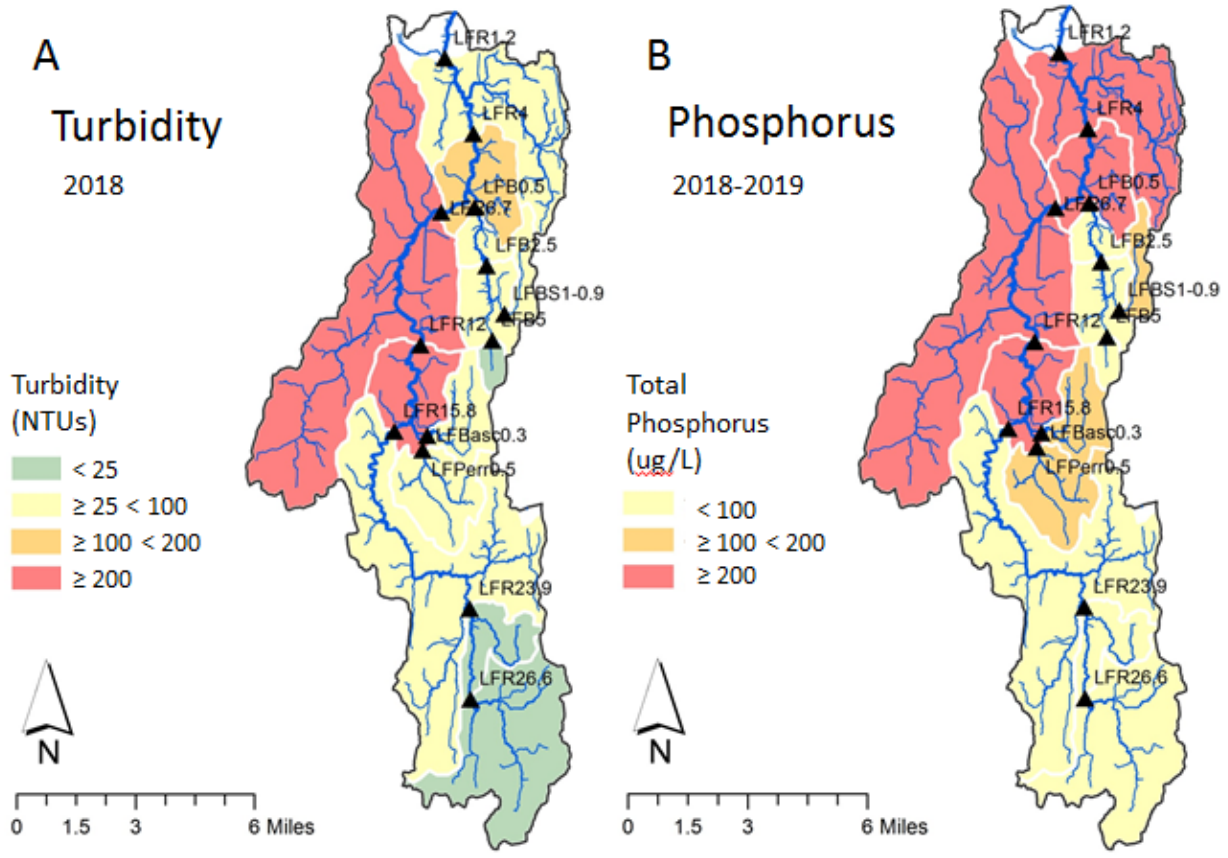


Figure 3. Mean values of (A) Turbidity detected during dry-weather, baseflow events (2018: n=4) and (B) Total Phosphorus detected during baseflow conditions at or below the Low-Median-Monthly Flow (2018: n=3; 2019: n=1) in the Lemon Fair River watershed.

Nitrogen levels were detected at low to high concentrations at most stations during the 2018-2019 spring and summer sampling dates, ranging from 0.25 to 2.54 mg/L. Highest nitrogen concentrations were detected during baseflow conditions at or below the Low Median Monthly flow, although April 2019 samples from two sites (Perry Brook and LFR 23.9) also exceeded 1.0 mg/L during high spring flows. According to Vermont Water Quality Standards, nitrogen as nitrate (NO3) is not to exceed 5.0

mg/L at flows exceeding the low median monthly discharge. In 2020, stations exceeding 1.0mg/L in 2018-2019 will be sampled for nitrates and nitrites.

2020: While the two-year focus on the Lemon Fair River has ended, questions remain about which reaches and tributaries are contributing high concentrations of phosphorus to the Lemon Fair River. The Collaborative plans to move primary focus areas to other watersheds, but we will also select several new sites along previously un-sampled tributaries to further our understanding of phosphorus contributions to this river. Monitoring at sentinel sites will also continue.

For more information, contact the Lemon Fair sampling coordinator:
Heidi Willis, 352-4327, redsprings@myfairpoint.net
Addison County River Watch Collaborative managing director:
Matt Witten, 434-3236, mwitten@gmavt.net
or visit our web page at: www.acrpc.org/acrwc

Focus watershed:
2018 and 2019

Lewis Creek – 2018-2019 Water Quality Summary

Addison County River Watch Collaborative (ACRWC), Lewis Creek Association (LCA)
Prepared in conjunction with South Mountain Research and Consulting

Type	Stream	Site	Location	Town
R	Lewis Creek	LCR0.3	Boat Access upstream of Hawkins Bay	Ferrisburgh
S	Lewis Creek	LCR3.7	Old Route 7 Bridge	Ferrisburgh
R	Lewis Creek	LCR9.9	Upper Covered Bridge, Roscoe Rd.	Charlotte
R	Pond Brook	LCT3D.5	Silver Street culvert	Monkton
S	Lewis Creek	LCR14	Tyler Bridge	Monkton
O	Hollow Bk (Lewis Ck)	LCHLW1.0	Tyler Bridge Rd X'g of Hollow Bk	Hinesburg
O	Hollow Bk (Lewis Ck)	LCHLW0.1	Hollow Brook at Confl w/ Lewis	Monkton
O	Lewis Creek	LCR14.3	Just above confluence of Hollow Bk	Starksboro
O	Lewis Creek	LCR15	Just above Clifford stabilized crossing	Starksboro
O	Lewis Creek	LCR16	LaRue bridge crossing	Starksboro

The ACRWC and member LCA have been monitoring water quality in the Lewis Creek since 1992. In 2018-2019, Lewis Creek was the subject of a two-year, intensive monitoring focus, where rotational (R) sites as well as long-term, sentinel stations (S) were monitored, and additional parameters were tested to better define spatial variability in pathogen, sediment and nutrient concentrations. Additionally, monitoring in vicinity of the Tyler Bridge Road crossing was continued from the previous two years as part of a special project (O = Other) to bracket known or suspected source regions of bacterial contamination, in support of a Total Maximum Daily Load for Bacteria-impaired waters.[2]

The two years brought quite different patterns of precipitation. In each year, sampling occurred on two spring dates (April 4 and May 2 in 2018 and April 10 and May 1 in 2019) and four summer dates (June 6, July 11, August 1, and September 5 in 2018 and June 5, July 10, August 7, and September 4 in 2019). While 2018 was characterized by near-normal precipitation, 2019 brought above-normal conditions. In both years, April and May sampling events took place during high flow conditions resulting from snowmelt and spring rains, based on records from the USGS streamflow gaging station near VT Route 7. In 2019, these conditions continued into June. June 2018 and July 2019 events occurred during moderate-flow, baseflow conditions where river stage was not changing appreciably, and groundwater levels were relatively high following spring rains. In 2019 these conditions, too, continued into August, and then a rainfall event coincided with the September 2019 sampling. Low-flow, baseflow conditions, at or below the Low Median Monthly (LMM) flow were met in July, August, and September of 2018. These conditions were never met during 2019 sampling events in Lewis Creek, and in fact the river only dipped below the LMM at all in 2019 for a few days in mid-September. Flooding occurred later in the fall, with the most severe conditions occurring in the headwaters, following a late October storm.

Samples from the Lewis Creek watershed were tested for *E.coli*, phosphorus (total and dissolved), total nitrogen, and turbidity; *E.coli* was tested only on the summer dates at recreational sites. Turbidity was originally scheduled for all sites on all twelve sampling dates, but due to a mid-season 2019 request by the LaRosa Volunteer Monitoring program to reduce expenditure, May 2019 samples were suspended at all sites, and only sites in the bracket monitoring study were sampled for turbidity that summer.

[2] http://dec.vermont.gov/sites/dec/files/wsm/mapp/docs/mp_bacteriatmdl.pdf

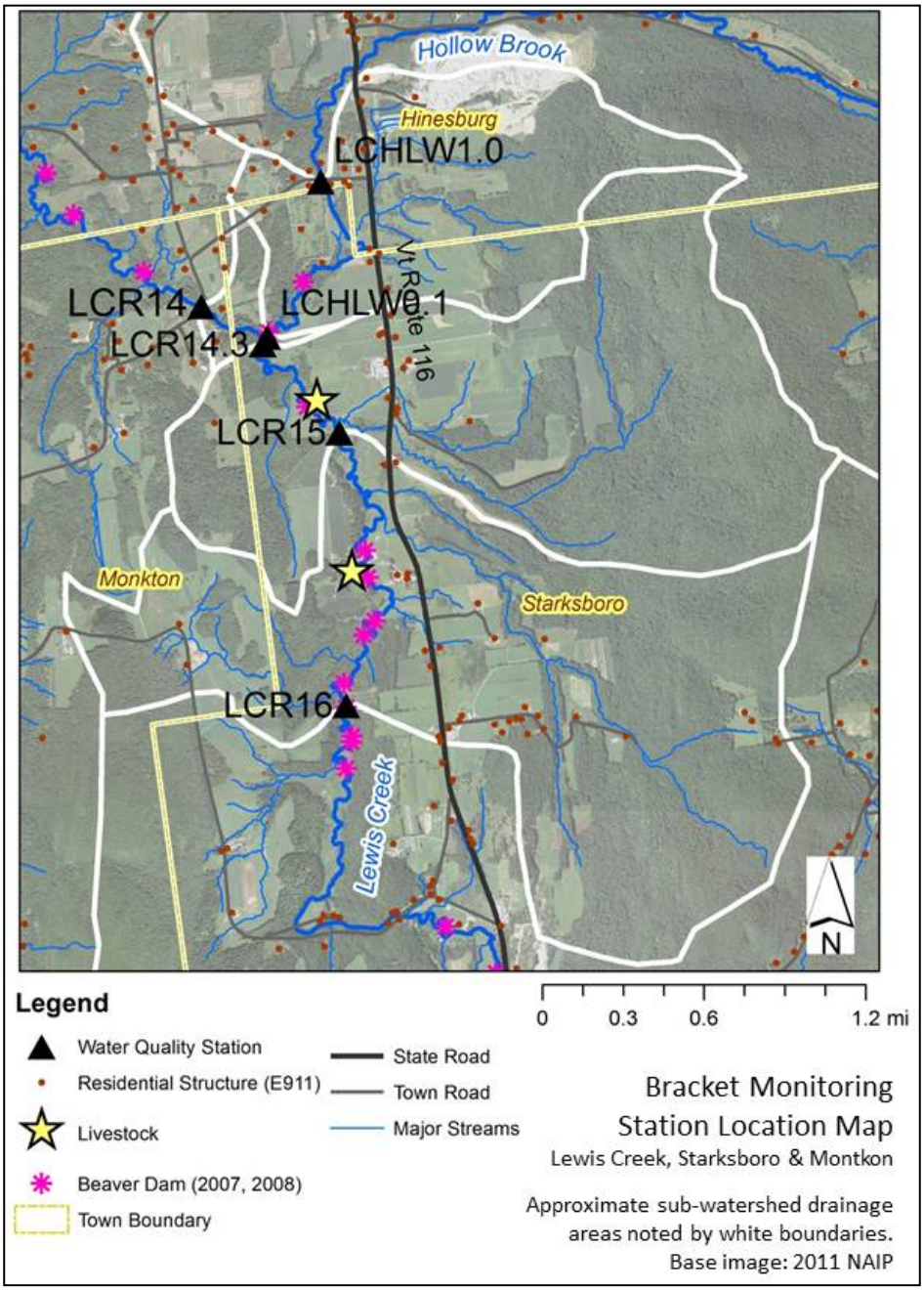


Figure 1. Location of E. coli Bracket Monitoring Sites

E.coli counts at the bracket stations (Figure 1) ranged from 18 to >2420 organisms/100 mL for the seven summer sampling dates in 2018-2019. While samples were additionally taken in September of 2019, they were not analyzed due to an error at the VAEL lab. Vermont Water Quality Standards (VWMD, 2016) state that *E.coli* is not to exceed a geometric mean of 126 org/100mL obtained over a representative period of 60 days, and no more than 10% of samples should be above 235 org/100 mL. *E.coli* counts exceeded the state's health-based standard of 235 org/100 mL for a majority of the sample dates at bracket stations LCR16 through LCR14 (Figure 2). The geometric mean of results exceeded the state's geomean standard of 126 organisms/ 100 mL at these same stations during the dry-weather, base-flow conditions encountered in the summers of 2018-2019 (Figure 3).

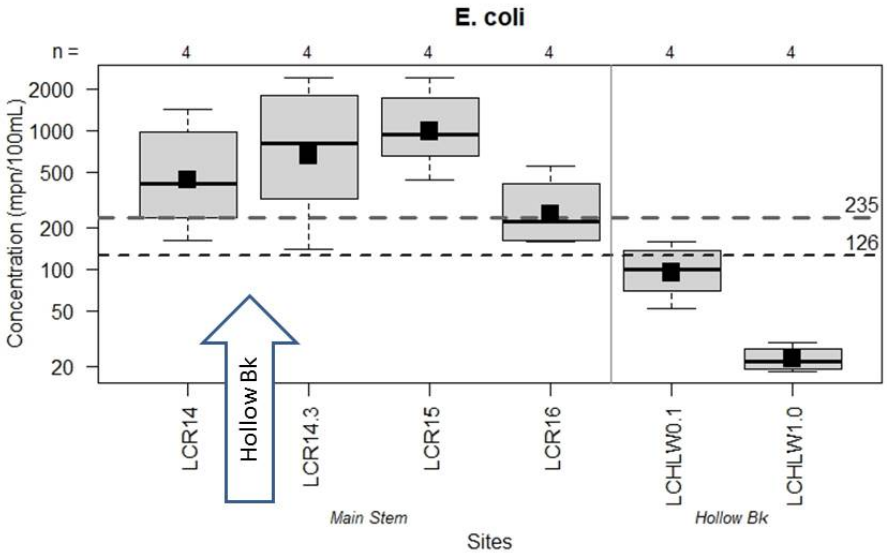


Figure 2. E.coli measured at Lewis Creek and Hollow Brook bracket monitoring stations on four dry-weather, base-flow events between June and September in 2018. The whiskers extend to the maximum and minimum values, while the gray-shaded box represents the middle 50% of values. The median value is marked by the dark horizontal line. The geometric mean of all available samples for each station is displayed as the black square symbol. The horizontal, gray dashed lines represent the health-based (235) and geomean (126) standards for E.coli.

In 2017 and 2018, a marked increase in mean *E.coli* counts was apparent between upstream "control "station LCR16 and station LCR15, followed by a decline in *E.coli* counts at stations LCR14.3, under both dry-weather and wet-weather conditions (Figure 3). These results indicate a contributing source(s) of bacteria within the incremental drainage area for LCR15. Continuing downstream, mean *E.coli* counts decline at station LCR14, likely due in large part to dilutionary effects of inputs from the Hollow Brook. The geometric mean at each of these two Hollow Brook stations was below the mean recorded for each of the main stem stations.

Sources of fecal matter in surface waters can be variable, and include humans, ruminants (e.g., deer and cows), wildlife, and waterfowl (USEPA, 2011). The upstream drainage area to Tyler Bridge Road is sparsely populated by residential structures serviced by onsite septic systems (Figure 1). Failing septic systems can be a source of *E.coli* to groundwater and to the Creek, particularly for those structures located within the riparian corridor. Station LCR14 is located one mile downstream of a pasture (Farm B) where for several decades dairy cows have had direct access to the stream along a mile of pasture (small, conventional dairy). A second conventional dairy farm (Farm A), located 0.3 mile upstream of LCR14, has excluded cows along 3,600 feet the Lewis Creek with fencing since 2007, and has reduced access to a single stabilized crossing. Several management practices have also been implemented at this farm in recent years, resulting in expansion of vegetated riparian buffers, increased setbacks of crop fields and pasture areas, and cedar revetments and willow waddle treatments to enhance streambank stability (SMRC, 2010, 2017). In October 2018, livestock were removed from the upper site (Farm B), as part of a farm transition and sale of the property. We also learned that the lower site (Farm A) is no longer planning to pasture cows, also beginning in the fall of 2018.

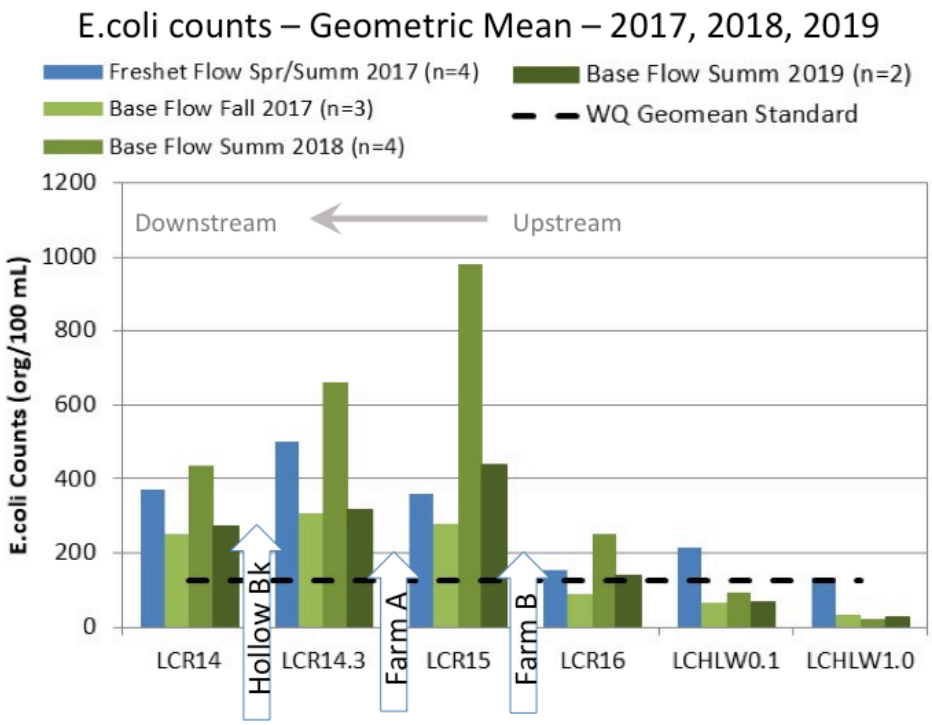


Figure 3. Geometric mean of E.coli monitoring results for Lewis Creek and Hollow Brook bracket monitoring stations during wet-weather, freshet flow events (in blue) versus dry-weather, baseflow events (in green) during 2017 - 2019.

Results of only two post-treatment sampling events in 2019 are promising, showing a reduction in baseflow counts of E.coli at station LCR15 located downstream of Farm B. Additional post-treatment sampling will be conducted in 2020 to target a full range of dry-weather and wet-weather conditions during 6 scheduled monthly events, as well as up to 4 additional events to target storms.

Turbidity levels at the Lewis Creek stations ranged from <0.2 to 55 NTUs for the eleven 2018-2019 sample dates. The Vermont state standard of 10 NTUs (for cold-water fisheries) is applicable during dry-weather, baseflow conditions, which were relevant to the four summer events of 2018 and the July and August 2019 events. The mean concentrations were below the standard at all sites between LCR9.9 and LCT3D.5 (Figure 4), then rose to above standard levels in the lowest portion of the watershed. Similar to past years, there is a generally increasing trend in turbidity with distance downstream along the main stem. A marked increase in Turbidity is evident between stations LCR16 and LCR15, during both dry-weather and wet-weather conditions. This is consistent with the pattern demonstrated with total phosphorus. Given the late 2018 removal of cows from the pasture in the incremental watershed between these two stations, and as the streambank and riparian soils begin to revegetate, we anticipate that Turbidity levels will decrease at stations LCR15. Also, elevated levels of Turbidity in Pond Brook contribute to a notable increase in turbidity between LCR14 (Tyler Bridge Rd) and LCR9.9 (Roscoe Rd – Upper covered bridge). The watershed soils transition toward more clay and silt-rich sediments of glaciolacustrine origin in this lower part of the watershed. During dry-weather, baseflow conditions (low to moderate flow levels), the mean turbidity level is below the VWQS of 10 NTUs for this cold-water river – at least in the middle and upper watershed.

2018 - 2019

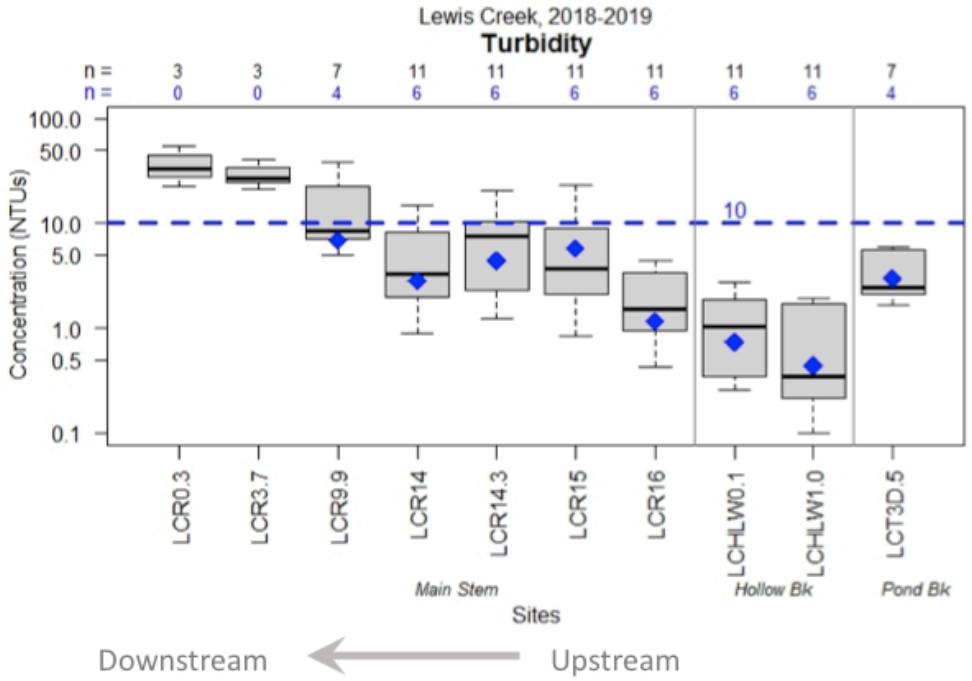


Figure 4. Summary of Turbidity results for Lewis Creek, 2018-2019. The whiskers extend to the maximum and minimum values detected over twelve sampling events, while the gray-shaded box represents the middle 50% of values. The median value is marked by the dark horizontal line. The blue diamond marks the mean of that subset of samples collected during base-flow conditions, with the corresponding number of samples (n) indicated in blue along the top of the chart.

Phosphorus was detected at low to high concentrations during the 12 Spring and Summer sampling dates, ranging from <5 to 176 µg/L. The instream phosphorus criterion of 27 µg/L for warm-water medium gradient (WWMG) wadeable stream ecotypes in Class B waters is applicable at low median monthly flow, a condition which was captured during the 2018 July, August, and September sample dates but not at all in 2019. Detected concentrations of phosphorus on these 2018 dates exceeded the instream nutrient standard of 27 µg/L at main stem stations, LCR15 and LCR0.3, as well as Pond Brook station LCT3D.5 (Figure 5). These results are relatively consistent with historic results, which have shown an increasing trend in phosphorus concentration with distance downstream, as well as a tendency for elevated phosphorus concentrations during high flows. Notably, there was a marked increase in TP concentration at base flow between stations LCR16 and LCR15. The incremental drainage area between these two stations includes now fallow pasture where until October of 2018, cows had unrestrained access to the Lewis Creek. We anticipate a decrease in nutrient and sediment concentrations due to the removal of cows from the brook; unfortunately, we were not able to measure that impact at low-flow baseflow conditions in 2019.

2018 - 2019

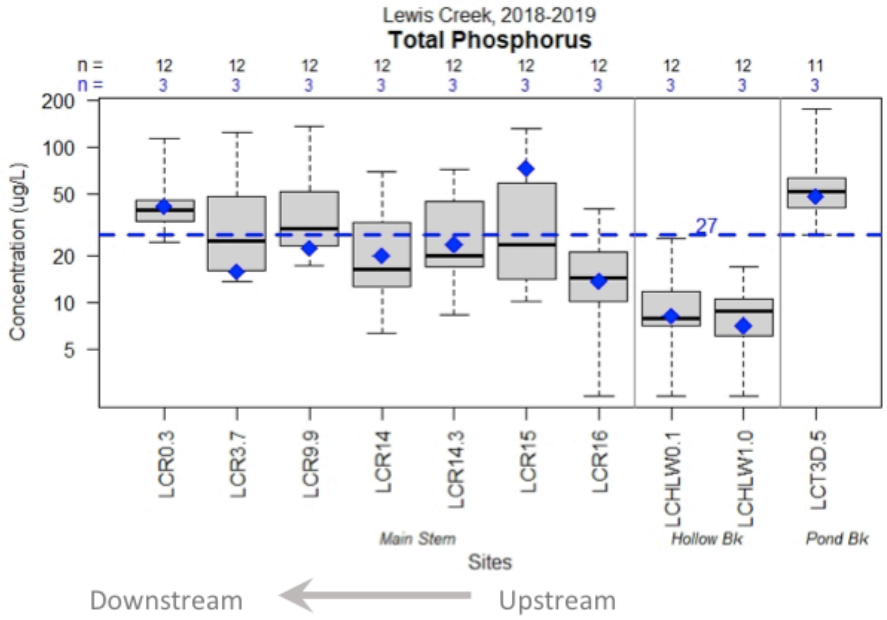


Figure 5. Summary of Total Phosphorus results for Lewis Creek, 2018-2019. 2019 was a wet year, and we were not able to capture a Low-Flow Baseflow event during our 6 scheduled sample dates. Thus, the mean of the TP detected during low-flow, baseflow conditions (shown by the blue diamond symbols) was calculated from the three events in the previous year (2018) that did happen to capture these conditions. The whiskers extend to the maximum and minimum values detected, while the gray-shaded box represents the middle 50% of values. The median value is marked by the dark horizontal line. The blue diamond marks the mean of that subset of samples (n=3) collected during base-flow conditions at or below the Low Median Monthly Flow.

2020: While Lewis Creek will no longer be a focus watershed for Addison County Riverwatch in 2020, the Collaborative will continue with bracket monitoring at stations in the vicinity of the Tyler Bridge Road crossing with funding from a LaRosa Organizational Support grant. In addition to the six regularly-scheduled monthly events, this will include the sampling of targeted storm events to gain a better understanding of water quality patterns following livestock removal from Lewis Creek as part of a farm transition that occurred in October 2018. Monitoring of total phosphorus at the two Lewis Creek Sentinel stations (LCR3.7 and LCR14) will also continue.

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Lewis Creek Association: Kate Kelly, lewiscreekorg@gmail.com
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Or, go to LewisCreek.org

Little Otter Creek – 2019 Water Quality Summary
Addison County River Watch Collaborative

Site	Location	Town
LOC4.3	Route 7 Bridge	Ferrisburgh
MDC1.2	Wing Rd./Middlebrook Rd. (South)	Ferrisburgh

The Addison County River Watch Collaborative has been monitoring water quality in the Little Otter Creek since 1997. For years 2018 through 2021, the number of sampling locations in this watershed has been reduced to two sentinel stations monitored for long-term trends: LOC4.3 and MDC1.2. During 2019, sampling occurred on two spring dates (April 10 and May 1) and four summer dates (June 5, July 10, August 7, and September 4). The year was characterized by above-normal precipitation, overall. April, May, and June sampling events took place during high flow conditions resulting from snowmelt and spring rains, based on records from the USGS streamflow gaging station near VT Route 7. The July event occurred during moderate-flow, baseflow conditions where river stage was not changing appreciably, and groundwater levels were relatively high following spring rains. The August event coincided with low-flow, baseflow conditions, though even then the water was above the Low Median Monthly (LMM) flow, while the September event occurred during a wet-weather event with rising water levels.

Samples were originally scheduled for testing of *E.coli*, total phosphorus and turbidity, with *E.coli* to be tested only in the summer months. Due to a request from the LaRosa Volunteer Monitoring program to reduce analytical costs, only total phosphorus was tested in 2019.

Phosphorus was detected at moderate to high concentrations on the Little Otter Creek during the spring and summer sampling dates in 2019. Concentrations ranged from 45 to 625 µg/L. The instream phosphorus criterion of 27 µg/L for warm-water medium gradient wadeable stream ecotypes in Class B waters is applicable at LMM flow during the months of June through October. Only our August event took place during low-flow conditions, and flows remained above the LMM. The phosphorus concentrations for the August event were 126 µg/L and 214 µg/L (at LOC4.3 and MDC1.2, respectively), which exceed the instream nutrient standard of 27 µg/L at both sentinel stations.

2020: The Addison County River Watch Collaborative will continue to monitor for total phosphorus at these two sentinel sites on the Little Otter Creek in 2019. An increased number of parameters and additional monitoring sites will likely be evaluated when a more intensive monitoring focus rotates back to the watershed for a two-year period beginning in 2022.

For more information, contact the Little Otter Creek sampling coordinator:
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Addison County River Watch Collaborative managing director:
Matt Witten, 434-3236, mwitten@gmavt.net
or visit our web page at: www.acrpc.org/acrwc

Middlebury River – 2019 Water Quality Summary
Addison County River Watch Collaborative

Site	Location	Town
MIR1.5	Shard Villa Rd. Bridge	Middlebury
MIR5.7	Midd. Gorge @ Rte 125 Bridge	Middlebury
MIR10.6	Natural Turnpike Road	Ripton

The Addison County River Watch Collaborative has been monitoring water quality in the Middlebury River since 1993. For years 2016 through 2019, the number of sampling locations in this watershed has been reduced to three sentinel stations monitored for long-term trends: MIR1.5, MIR5.7, and MIR10.6.

During 2019, sampling occurred on two spring dates (April 10 and May 1) and four summer dates (June 5, July 10, August 7, and September 4). The year was characterized by above-normal precipitation, overall. Based on streamflow gaging records from the nearby USGS streamflow gage on the New Haven River, April, May, and June sampling events took place during high flow conditions resulting from snowmelt and spring rains. The July and August events likely occurred during moderate-flow, baseflow conditions where river stage was not changing appreciably, and groundwater levels were relatively high following spring and summer rains, although the August event may have been subject to the same scattered thunderstorms that further elevated flow levels in the New Haven River. The September event coincided with a storm event that elevated water levels. In 2019, no sampling dates occurred during low-flow, baseflow conditions, and while there is no gage on this river, it is likely that water levels never fell below the Low Median Monthly (LMM) flow.

Samples were tested for *E.coli* and total phosphorus. While initial plans included turbidity testing, this was suspended due to a request from the LaRosa Volunteer Monitoring program to reduce analytical costs. *E.coli* was tested only on the summer dates at recreational sites, Shard Villa Road bridge and the Middlebury Gorge.

E.coli counts at Middlebury River sites ranged from 21 to 308 organisms/ 100 mL (*Figure 1)*. Vermont Water Quality Criteria (October 2016) state that *E.coli* is not to exceed a geometric mean of 126 organisms /100mL obtained over a representative period of 60 days, and no more than 10% of samples should be above 235 organisms/100 mL. Samples obtained from both sites contained *E. coli* in excess of the 235 org/100 mL health-based standard during the June event. The geometric mean of only Shard Villa Road Bridge (MIR1.5) exceeded the geometric mean standard of 126 org/100 mL, with 134 org/100 mL.

Based on previous years' monitoring results that include additional sites, *E.coli* counts typically show an increasing trend with distance downstream from the Middlebury Gorge. Developed and agricultural land uses dominate the river corridor in this lower end of the Middlebury River. This year, June *E. coil* counts were actually higher at the Middlebury Gorge. *E.coli* counts can become elevated during high flow conditions following heavy rains or snow melt in most river systems. Water levels remained high in the Middlebury River on this June sampling day following a wet spring and heavy rains that preceded the sampling event.

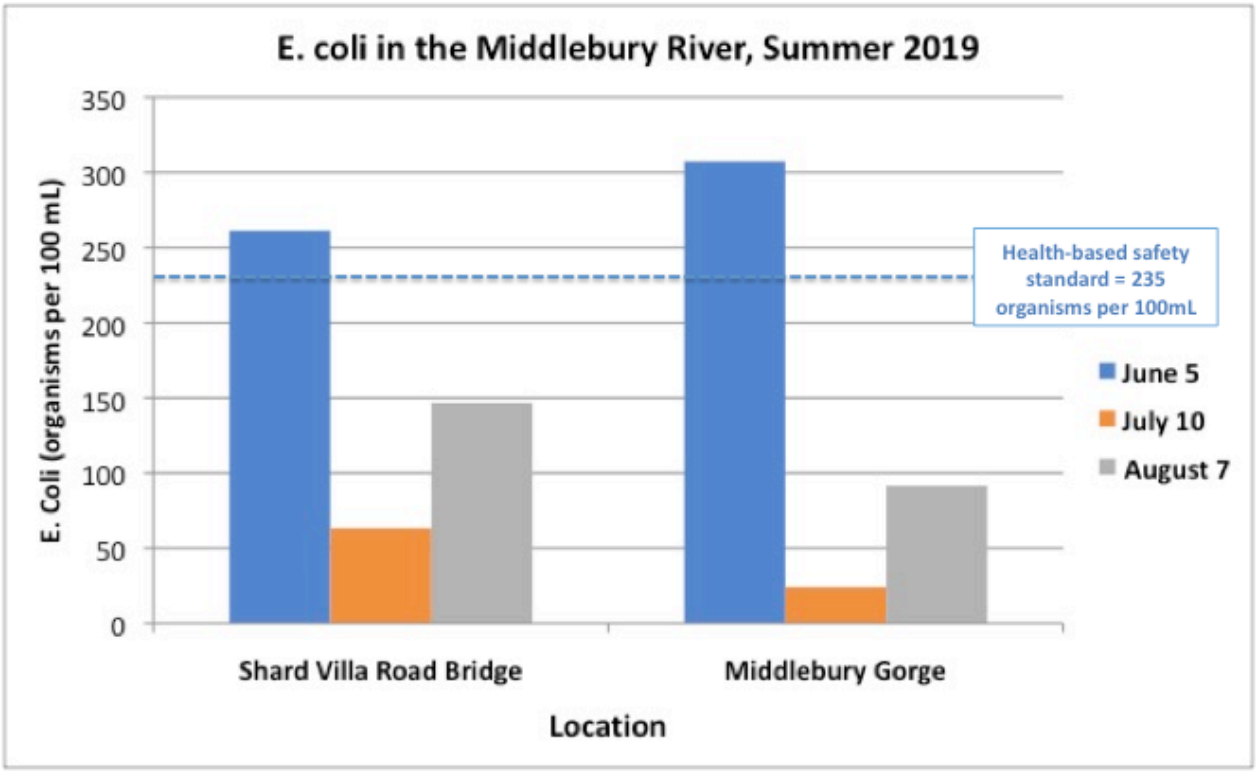

Figure 1. E.coli measured at recreation sites along the Middlebury River on four summer dates in 2019. While September samples were collected, they were not analyzed due to an error at the VAEL lab.

Phosphorus was detected at varying levels during the six spring and summer sampling dates of 2019. Concentrations ranged from 6 to 47 µg/L, with the highest concentrations occurring in June. The instream phosphorus criterion of 27 µg/L for warm-water medium gradient (WWMG) wadeable stream ecotypes in Class B waters is applicable at low median monthly flow, a condition not encountered in 2019. Historic sampling results, which have included additional sites, show a gradually increasing trend in phosphorus concentrations with distance downstream from the Middlebury Gorge.

2020: The Addison County River Watch Collaborative will continue to monitor for *E.coli* and total phosphorus at these three sentinel sites on the Middlebury River in 2020. Additionally, the Middlebury River will be rotated in as a focus watershed in 2020-2021, with a slightly increased number of parameters and additional monitoring sites. Look for regular postings of *E.coli* results at signposts installed at the Middlebury Gorge and at the parking area off Three Mile Bridge Road.

For more information, contact the Middlebury River sampling coordinator:
Heidi Willis, 352-4327, redsprings@myfairpoint.net
Addison County River Watch Collaborative managing director:
Matt Witten, 434-3236, mwitten@gmavt.net
or visit our web page at: www.acrpc.org/acrwc

New Haven River – 2019 Water Quality Summary

Addison County River Watch Collaborative

Site	Location	Town
NHR2	Muddy Branch confluence	New Haven
NHR6	Sycamore Park	Bristol
NHR9	South St. Bridge	Bristol
NHR11.5	Bartlett's Falls Pool	Bristol

The Addison County River Watch Collaborative has been monitoring water quality in the New Haven River since 1993. For years 2018 through 2021, the number of sampling locations in this watershed has been reduced to two sentinel stations monitored for long-term trends (NHR2 and NHR9) and two popular recreational sites monitored only for *E.coli* and only in the summer months (NHR6 and NHR11.5).

During 2018, sampling occurred on two spring dates (April 10 and May 1) and four summer dates (June 5, July 10, August 7, and September 4). The year was characterized by above-normal precipitation, and the New Haven River experienced significant fall flooding. April, May, and June sampling events took place during high flow conditions resulting from snowmelt and spring rains, based on records from the USGS streamflow gaging station near Brooksville. The July event occurred during moderate-flow, baseflow conditions where the river stage was not changing appreciably, and groundwater levels were relatively high following spring rains. August and September events coincided with summer storms that maintained moderate flow conditions. None of our sampling dates coincided with flow levels at or below the Low Median Monthly (LMM) flow, and in fact the river only sank to these levels for a few days during 2019. While sampling dates did not correspond with floods, the river reached 2-year flood conditions following a mid-June storm. In mid-October, rains caused the river to swell to 10-year flood levels, and a Halloween storm caused water levels to rise yet higher on November 1st, this time achieving 50-year flood conditions.

Samples were tested for *E.coli* and total phosphorus. While turbidity testing in the original sampling plan, it was suspended due to a request from the LaRosa Volunteer Monitoring program to reduce analytical costs. *E.coli* was tested only on the summer dates and was the only tested parameter at recreational sites Sycamore Park and Bartlett's Falls.

E.coli counts at the recreational sites ranged from 17 to 866 organisms/ 100 mL. Vermont Department of Health guidance identifies a health-based standard for *E.coli* of 235 organisms/100 mL. *E. coli* counts at these sites were well above this health-based standard on August 7 at Sycamore Park and on both June 5 and August 7 at Bartlett's Falls Pool (Figure 1). Vermont Water Quality Criteria (October 2016) state that *E.coli* is not to exceed a geometric mean of 126 organisms /100mL obtained over a representative period of 60 days, and no more than 10% of samples should be above 235 organisms/100 mL. The geometric mean of values from each site was above this geometric mean standard of 126 org/100 mL (217 organisms/100 mL at Sycamore Park and 179 organisms/100 mL at Bartlett's Falls Pool), although we have just three samples captured. Based on historic monitoring of this river, *E.coli* counts can become elevated during high flow conditions following heavy rains or snow melt, and they can also be associated with low-flow conditions and very warm temperatures often encountered in September. This year, the April 23rd collapse of a beaver dam may also have contributed to elevated *E. coli* concentrations. This occurred in a tributary to the New Haven River that meets the main stem just upstream of Bartlett's Falls Pool. While the event itself occurred well in advance of our sampling events, debris from the collapse could have been caught and

then remobilized throughout the spring high-water season and again in storm events like the one to occur just prior to our August sampling date.

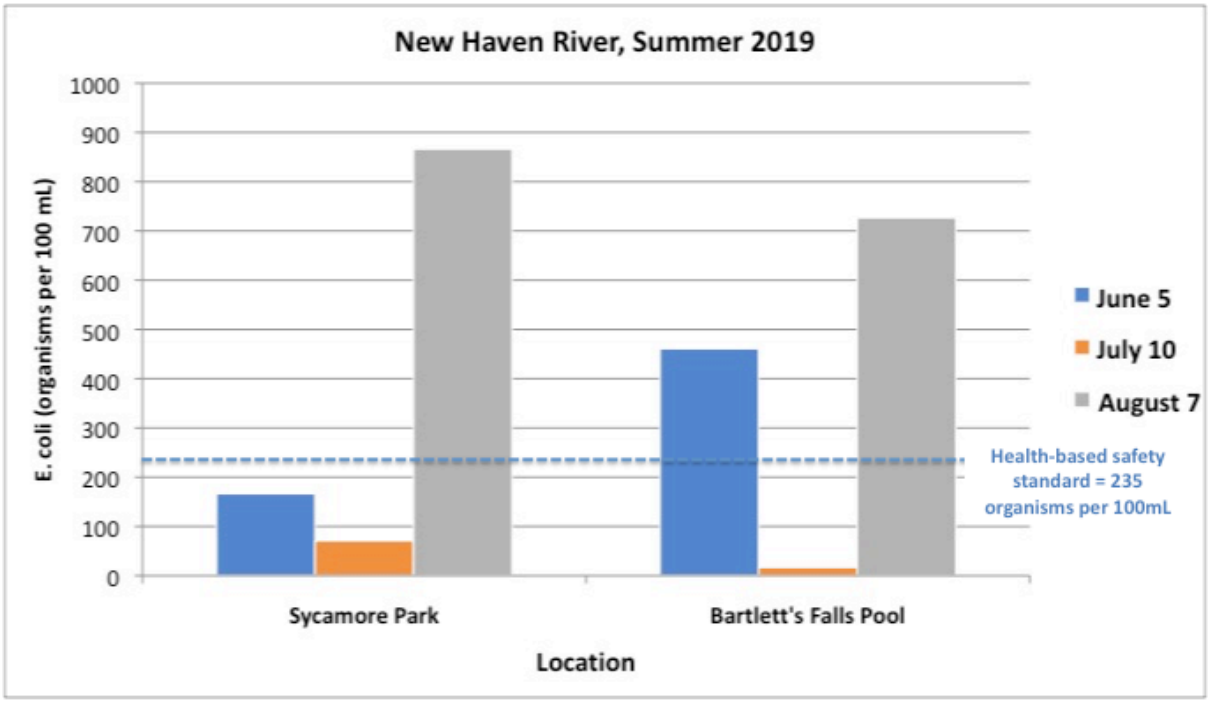

Figure 1. E.coli measured at recreation sites along the New Haven River main stem on four summer dates in 2019. While September samples were collected, they were not analyzed due to an error at the VAEL lab.

Phosphorus levels at New Haven River sentinel stations ranged from 6 to 54 µg/L. The instream phosphorus criterion of 27 µg/L for warm-water medium gradient wadeable stream ecotypes in Class B waters is applicable at LMM flow during the months of June through October. None of our sampling events took place when flows in the river were below the LMM, which disables comparison to this standard.

2020: The Addison County River Watch Collaborative will continue to monitor for total phosphorus at two sentinel stations, NHR2 and NHR9, and for *E.coli* at the two recreational sites, NHR11.5 and NHR6, on the New Haven River in 2020. Look for regular postings of *E.coli* results at kiosks located at Sycamore Park and Eagle Park, and on *Front Porch Forum*.

For more information, contact the New Haven River sampling coordinator:
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Otter Creek – 2019 Water Quality Summary
Addison County River Watch Collaborative

Site	Location	Town
OTR7.3	Vergennes Falls/below outfall	Vergennes
OTR18	Twin Bridges Picnic Area	Weybridge

The Addison County River Watch Collaborative has been monitoring water quality in the lower Otter Creek since 1992. For years 2016 through 2019, the number of sampling locations in this watershed has been reduced to two sentinel stations monitored for long-term trends: OTR18 and OTR7.3. During 2019, sampling occurred on two spring dates (April 10 and May 1) and four summer dates (June 5, July 10, August 7, and September 4). The year was characterized by slightly above-normal precipitation, overall. Flows in the Otter Creek were above normal for much of the year, but trended below normal for the months of September and October, with discharge at or below the Low Median Monthly (LMM) flow. October rains then brought flow above normal for the remainder of the year. The river reached 2-year flood levels in April following ice-out but did not experience the October flood levels seen in some of its tributaries. April, May, and June sampling events took place during high flow conditions resulting from snowmelt and spring rains. The July event occurred during moderate-flow, baseflow conditions where river stage was not changing appreciably, and groundwater levels were relatively high following spring rains. The August event was the only one this year to coincide with low-flow in this river, but sampling followed scattered thunderstorms high in the watershed that caused water levels to rise during sampling. Enough additional rain fell just before the September event to bring water levels temporarily back up to moderate flow conditions. None of our sampling events coincided with low-flow, baseflow conditions on Otter Creek this year.

Samples were originally scheduled for testing of *E.coli*, total phosphorus and turbidity, with *E.coli* to be tested only in the summer months. Due to a request from the LaRosa Volunteer Monitoring program to reduce analytical costs, *E. coli* and turbidity testing were suspended for 2019. One additional sample of dissolved phosphorus was taken during the August 7 sampling event, at the Vergennes Falls sampling site (OTR 7.3).

Phosphorus levels at Otter Creek stations ranged from 24 to 48 µg/L. The instream phosphorus criterion of 27 µg/L for warm-water medium gradient wadeable stream ecotypes in Class B waters is applicable at LMM flow during the months of June through October. Our August event was the only one to take place in 2019 when flows in the river were below the LMM. Phosphorus concentrations for this sampling date exceeded the instream nutrient standard of 27 µg/L at both sentinel stations (36 µg/L OTR7.3 and 44 µg/L OTR18). At the Vergennes Falls station, 36% of this phosphorus was dissolved.

2020: The Addison County River Watch Collaborative will continue to monitor for *E.coli*, total phosphorus and turbidity at these two sentinel sites on the Otter Creek in 2020. In addition, we will increase the number of parameters and add additional monitoring sites, since this river is due for a more intensive monitoring focus in the 2020-2021 cycle. Because Addison County is low in the watershed of this large river, new monitoring sites will be primarily located on tributaries to better understand how our local sub-watersheds contribute to the overall water quality of Otter Creek.

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