Summary Report: 2018 Sampling Results
Addison County River Watch Collaborative

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Prepared by:
Kristen L. Underwood, PG
South Mountain Research & Consulting and
Addison County River Watch Collaborative

Prepared for:
Jim Kellogg
VTDEC Water Quality Division

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Executive Summary

This report provides a summary of the 2018 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 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 near-normal precipitation. Although hot and dry conditions in July and August contributed to moderate drought conditions recorded by summer's end in northern Addison County, fall rains brought relief and rebounding river levels.

E.coli counts in four of the six rivers exceeded the health-based standard of 235 organisms/ 100mL at one or more stations (14 out of 21 stations monitored) during one or more summer sampling dates in 2018. In contrast with past years, not all stations were monitored this year for *E.coli*, due to a request from the LaRosa Volunteer Monitoring Program to conserve analytical expenses. As a consequence, no stations in Otter Creek or Little Otter Creek were tested for *E.coli*, and only the two recreational sites in New Haven River were tested. Generally, elevated *E.coli* detections 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. At the most frequented swimming holes (Bartlett's Falls and Sycamore Park on the New Haven River and the Middlebury River Gorge), *E.coli* values were below the health-based standard on all sample dates.

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). The geometric mean of summer *E.coli* counts exceeded the Vermont water-quality standard of 126 org/100mL at one or both sentinel stations in the Lewis Creek and Middlebury River. Due to budgetary cutbacks, *E.coli* was not able to be monitored this year at sentinel stations in the New Haven River, Little Otter Creek or Otter Creek. During low-flow, baseflow events encountered during scheduled sample dates in 2018, Total Phosphorus concentrations exceeded the respective Vermont water quality standards at sentinel stations in the Lemon Fair, Little Otter Creek and Otter Creek. Based on historical monitoring results, turbidity and sediment-bound phosphorus concentrations tend to become elevated during high flows in the mountainous watersheds of Lewis Creek, Middlebury River, and New Haven River. In the valley watersheds (Little Otter Creek, Lemon Fair and Otter Creek), the turbidity and phosphorus concentrations tend to be elevated on a more frequent basis, in a wider range of flow conditions. The most substantial loading occurs during high flow events – typically occurring in the spring or fall months.

In the Lewis Creek and Lemon Fair River, 2018 marked the first year of a two-year focus study, where additional sites were monitored for an expanded list of parameters, in order to better define the spatial extent and magnitude of sediment and nutrient concentrations in these watersheds. Focus monitoring efforts have expanded the spatial resolution of water quality data in these catchments.

- Lewis Creek watershed: Season 2018 was the second year of bracket monitoring at six stations established in 2017 as part of a special project to better define potential or suspected source(s) of pathogens that have been detected consistently at high levels over several years at the Tyler Bridge Road crossing of Lewis Creek (LCR14). Bracket monitoring during dry-weather conditions in the summer of 2018 identified a segment of the main stem upstream of Tyler Bridge with a marked increase in mean *E.coli* counts and Total Phosphorus. A similar pattern was encountered under both dry-weather and wet-weather conditions in the previous year. Several potential sources of pathogens and nutrients exist in the incremental 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. Bracket sampling will continue at these sites in 2019 to monitor for anticipated changes in water quality.

- 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.

A second year of focus monitoring will be carried out in the Lemon Fair River and Lewis Creek in the year 2019. In the Lemon Fair, bracket monitoring stations will be monitored to confirm observed spatial patterns of nutrients and sediment over an additional range of flow conditions. In the Lewis Creek, ACRWC will continue bracket sampling in vicinity of the Tyler Bridge Road crossing to monitor for anticipated changes in water quality following livestock exclusion from the Creek.

ACRWC relies on partner agencies 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 Natural Resource Conservation District to support outreach to landowners and farmers in these watersheds and the design of Best Management Practices. ACRWC also shares its data with conservation commissions and planning boards in the Addison County towns to inform Town Plans and stormwater master plans.

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, Lewis Creek Association). Logistical and technical support were provided by Angie Allen of the VTDEC Monitoring, Assessment and 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 Burlington, VT, under direction of Guy Roberts, through an analytical services partnership grant under the coordination of Jim Kellogg.

Operational support was provided to ACRWC through annual contributions from 12 Addison County towns as well as private and corporate donations and in-kind services.

1.0 Introduction

This report provides a summary of the 2018 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, with the earliest monitoring efforts 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)

Since several years of baseline data now exist for the six ACRWC watersheds, the sampling schedule was revised, beginning with the 2010 season, to include longer-term temporal trend monitoring at a reduced number of key sites in each watershed (sentinel sites) with a reduced number of water quality parameters. These sentinel sites are combined with a more 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 testing parameters) than the sentinel sites, and is conducted to meet specific data needs of relevance to the chosen watershed.

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 2018 sampling season, Lewis Creek and the Lemon Fair River were selected to be focus watersheds (Figure 1, watersheds in bold outline). Therefore, rotational sites were scheduled for sampling in addition to the sentinel sites in these two watersheds during this focus year. Table 2 displays the schedule of sampling sites and parameters for the 2018 season; “R” denotes a rotational site, “S” for a sentinel site, and “O” for other. A somewhat different schedule of sampling parameters is indicated for spring versus summer months – i.e., *E. coli* was added to the list for summer events. Originally-scheduled *E.coli* and Turbidity analyses for highlighted 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.

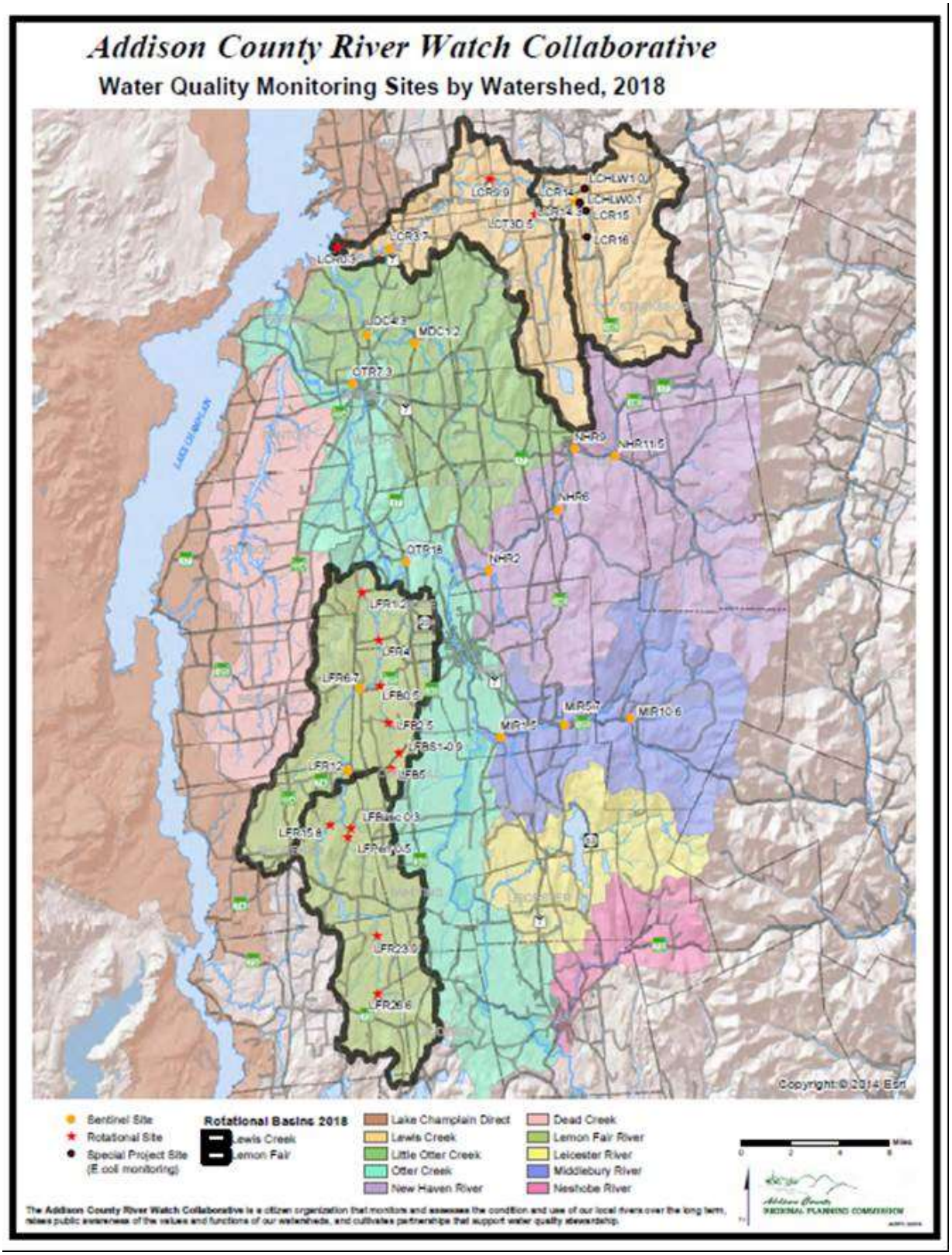


Figure 1. Location of ACRWC monitoring stations for 2018.

Table 2. 2018 Schedule of Sites / Parameters – Spring, Summer and Fall

Project Name: Addison County River Watch Collaborative

Project Number: **137-01**

Sample Year: **2018 - Revised**

				Spring Schedule (Apr, May)						Summer Schedule (Jun, Jul, Aug, Sep)						
										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	X				X	
R	Pond Brook	LCT3D.5	Silver Street culvert	X				X		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		X	X
R	Lemon Fair River	LFR4	Lemon Fair Rd bridge	X	X	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	X		X	X
S	Lemon Fair River	LFR12	Downstream of Route 74 bridge	X	X	X		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	X		X	X
R	Lemon Fair River	LFR23.9	Murray Road Bridge	X	X	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		X	X
R	Beaver Branch (LFR)	LFB0.5	Route 125 crossing	X	X	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	X		X	
R	Beaver Branch (LFR)	LFB5	Clark Rd bridge	X	X	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	X		X	
R	Bascom Brook (LFR)	LFBasc 0.3	Buttolph Rd crossing	X	X	X		X		X	X	X	X		X	
R	Perry Brook (LFR)	LFPerr 0.5	Buttolph Rd crossing	X	X	X		X		X	X	X	X		X	
S	Little Otter Creek	LOC4.3	Route 7 Bridge	X				X			X					
S	Mud Creek	MDC1.2	Wing Rd./Middlebrook Rd. (South)	X				X			X					
S	Middlebury River	MIR1.5	Shard Villa Road Bridge	X				X		X	X					
S	Middlebury River	MIR5.7	Midd. Gorge @ Rte 125 Bridge	X				X		X	X					
S	Middlebury River (Midd B	MIR10.6	Natural Turnpike Road	X				X			X					
S	New Haven River	NHR2	Muddy Branch confluence (just below)	X				X			X					
S	New Haven River	NHR6	Route 116 Bridge, Sycamore Park							X						
S	New Haven River	NHR9	South St. Bridge	X				X			X					
S	New Haven River	NHR11.5	Bartlett's Falls Pool							X						
S	Otter Creek	OTR7.3	Vergennes Falls / below outfall	X				X			X					
S	Otter Creek	OTR18	Twin Bridges Picnic Area	X				X			X					

"R" denotes a rotational site, "S" for a sentinel site, and "O" for other

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 2018 sampling data is provided as Appendix D. Samples were delivered to the Vermont Agricultural & Environmental Laboratory (VAEL) housed in the Hills Building at the University of Vermont campus in Burlington, Vermont.

During 2018, ACRWC volunteers collected grab samples in these 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 as the first Wednesday of each month (except in July to avoid the holiday week), and were not designed to capture any specific flow condition:

Scheduled Monthly Sampling – sentinel, rotational, and bracket sites

- April 4
- May 2
- June 6
- July 11
- August 1
- September 5

4.0 Precipitation Data

Precipitation data were compiled from existing weather stations in vicinity of the ACRWC watersheds (Table B-1). Overall, calendar year 2018 was a near-normal precipitation year, as recorded at regional weather stations in South Burlington (Airport) and Rutland. Near-normal snowfall was recorded for the South Burlington station during the winter of 2017-2018, while higher-than-normal snowfall was recorded at the Rutland station (Table B-2). July 2018 was the hottest July on record for the Burlington area (NOAA, https://www.weather.gov/media/btv/climo/extremes/topmonthlyavgmax.pdf), and lower-than-normal precipitation was recorded for this month at both South Burlington and Rutland stations. A hot and dry summer contributed to moderate drought conditions recorded by summer's end in northern Addison County (Figure 2; US Drought Monitor, 2018)

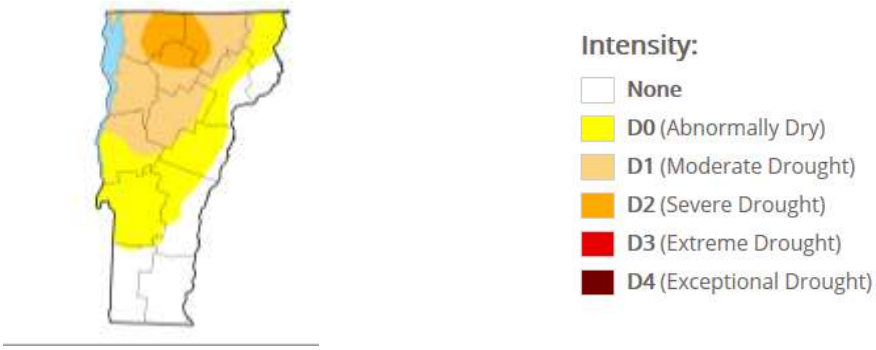


Figure 2. Drought condition in Vermont on September 25, 2018 at the close of the ARCWC regular monitoring season as recorded by U.S. Drought Monitor (excerpted from https://droughtmonitor.unl.edu/data/ png/20180925/20180925_VT_date.png)

5.0 Hydrologic Data

5.1 Seasonal Trends

Appendix B presents graphs of the instantaneous discharge record (provisional data) from calendar year 2018 for USGS flow gaging stations on the New Haven River, Lewis Creek, Little Otter Creek, and the Otter Creek at Middlebury stations. Ice-out conditions in the mountain watersheds came with warming temperatures, rain and snowmelt during the middle days of January (Figure 3), when the New Haven River and Lewis Creek experienced a flow approaching or meeting the 2-year flood recurrence interval (Olson, 2014). A second ice-out event occurred in late February for all four rivers. This second event was lower in flood stage than the January event in New Haven River and Lewis Creek, but was higher in magnitude for Little Otter Creek and Otter Creek.

Flows in these watersheds were near normal for much of the year, but trended below normal for the months of June, July, August and September, given the warm summer temperatures and drier-than-average precipitation in June and much of July. Flows were below the Low Median Monthly flow value for much of July, August and September (in Lewis Creek, Little Otter Creek, and New Haven River), and reached their lowest point for the year in early September (Lewis, Little Otter, New Haven) and July (Otter). Discharge was at or below the 7-day, 10-year, low flow statistic for a few days in the Otter Creek (late July) and Lewis Creek (July, August, September).

Figure 3. "Ice out" on Lewis Creek at Scott Pond Dam, Charlotte – 1 PM, January 12, 2018 (Photo credit: Terry Dinnan).

5.2 Flow Conditions During Sampling

During scheduled monthly sample dates, volunteers encountered a range of flow conditions. High-flow conditions in which water was actively rising or falling in response to recent rainfall or snow melt – i.e., freshet flows – were encountered during spring events in April and May (Table B-3). The June event represented moderate-flow, baseflow conditions 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]. The July, August, and September events coincided with low-flow, baseflow conditions, at or below the Low Median Monthly (LMM) flow, in all four gaged rivers.

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]

Figure 4 presents daily mean flows recorded at the USGS gage in Lewis Creek during the 2018 season. Sample dates are superimposed as orange circles for the six scheduled monthly sampling dates. During the dry-weather sampling events carried out in July, August and September, flow in the Lewis Creek exhibited base-flow characteristics below the Low Median Monthly flow (Table B-3).

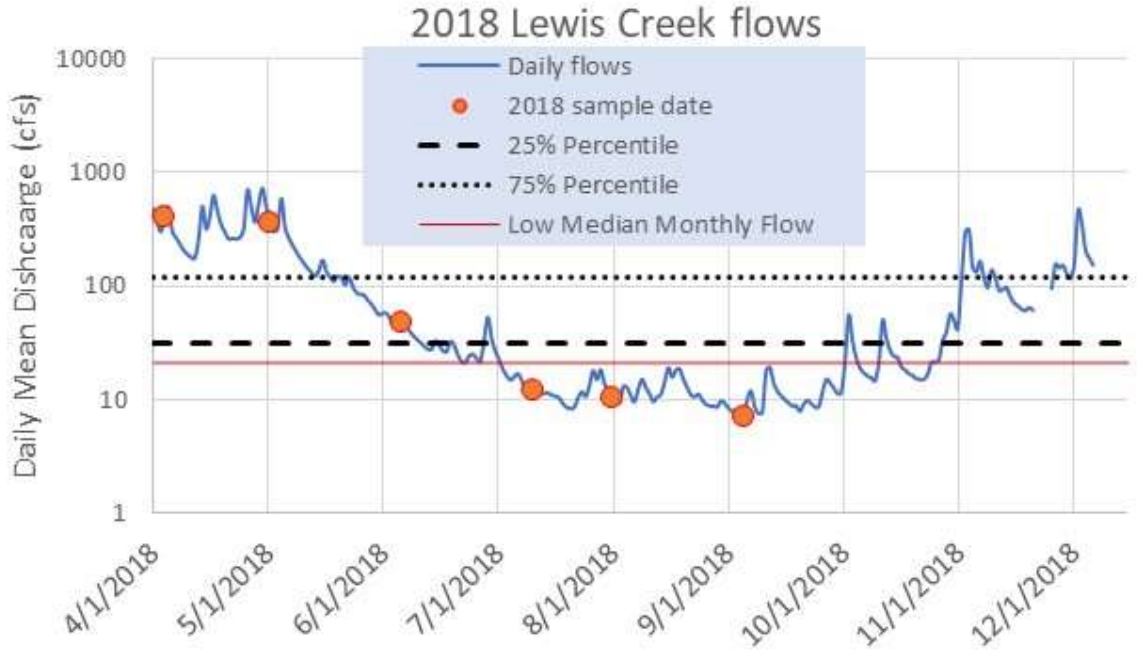


Figure 4. Daily mean flows measured at the USGS streamflow gaging station on Lewis Creek during the 2018 sampling season.

6.0 Monitoring Results

Appendix C contains quality-assured sample results for the 2018 season for the ACRWC watersheds. Attachments 1 through 6 summarize these results for each watershed. These attachments have been designed to serve as 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 2018. Therefore, sample results are presented for sentinel as well as rotational sites in these two watersheds.

In general, water quality results for 2018 were consistent with historic results and trends summarized in the 2009 Draft Water Quality Reports for each watershed (Hoadley, 2009). Expanded information has

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

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.

ACRWC stations are monitored to meet several objectives, including: (1) to evaluate health and safety at swimming holes and recreation sites; (2) to track temporal trends in key constituents; (3) to investigate spatial trends in constituents; (4) to build data sets for assessing the effectiveness of implemented treatments or management practices; and (5) to 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 in four of the six rivers exceeded the health-based standard of 235 organisms/ 100 mL at one or more stations during one or more summer sampling dates (14 out of 21 stations monitored) in Lemon Fair, Lewis Creek and Middlebury River. In contrast with past years, not 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 in Otter Creek or Little Otter Creek were tested for *E.coli*, and only the two recreational sites in New Haven River were tested. Generally, elevated *E.coli* detections 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 for budgetary reasons meant that we were unable to monitor for this parameter in Otter Creek.

During the summer of 2018, some of the region's popular recreation sites had one or more detections of *E. coli* above the health-based standard during the four dates sampled (Table 3). At the most frequented swimming holes (Bartlett's Falls and Sycamore Park on the New Haven River and the Middlebury River Gorge), *E.coli* values were below the health-based standard on all sample dates. Based on historic monitoring in these Addison County rivers, *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.

[2] https://anrweb.vt.gov/DEC/WWInventory/SewageOverflows.aspx

ACRWC posts 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). 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 standard at recreation sites and swimming holes in Summer of 2018
(Four sample dates: June 6, July 11, August 1, September 5)

River Name	Site ID	Site Location	Town	# Detections
Lewis Creek	LCR3.7	Old Route 7 Bridge	Ferrisburg	NA
	LCR14	Tyler Bridge	Monkton	3
Middlebury River	MIR1.5	Shard Villa Rd. Bridge	Middlebury	3
	MIR5.7	Midd. Gorge @ Rte 125 Bridge	Middlebury	0
New Haven River	NHR0.5	Dog Team Tavern (former)	New Haven	NS
	NHR2	Muddy Branch confluence (just below)	New Haven	NA
	NHR5	Munger Street Bridge	New Haven	NS
	NHR6	Route 116 Bridge, Sycamore Park	Bristol	0
	NHR9	South St. Bridge	Bristol	NA
	NHR11.5	Bartlett's Falls Pool	Bristol	0
	NHR15	S. Lincoln Bridge (Gap Rd.)	Lincoln	NS

* NS = Not Scheduled for Sampling
* NA= Not Analyzed due to a VAEL request to decrease analytical expenses

6.2 Trend Monitoring - Temporal

Water quality in the ACRWC watersheds varies over time, in response to year-to-year variations in climate, seasonal fluctuations in weather and vegetation, and daily to seasonal variations in flow stage. Sentinel stations (typically two or three stations in each watershed) have been established to track long-term annual-scale variations in water quality resulting from naturally-fluctuating weather and vegetation, but also human-influenced 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, 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 Longterm Tributary Monitoring Program[3]. The ACRWC reviews long-term trends at its sentinel stations on an approximate six- to ten-year cycle, depending on the availability of funding.

[3] https://anrweb.vermont.gov/dec/_dec/LongTermMonitoringTributary.aspx

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 2018 in the Lewis Creek and Lemon Fair River watersheds, and will continue for a second year in 2019, 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 Attachments 1 and 2. The following paragraphs highlight results which have helped to better define spatial trends in these watersheds.

6.3.1 Lewis Creek

As part of a bracket monitoring study to better define potential or suspected source(s) of pathogens that have been detected consistently at high levels over several years at the Tyler Bridge Road crossing of Lewis Creek (LCR14), a total of six stations was monitored, including sentinel station LCR14 and five temporary stations established upstream of this station (Figures 5, 6). Season 2018 was the second year of bracket monitoring at these sites, following a special project implemented in the 2017 season and reported separately (SMRC, 2018).

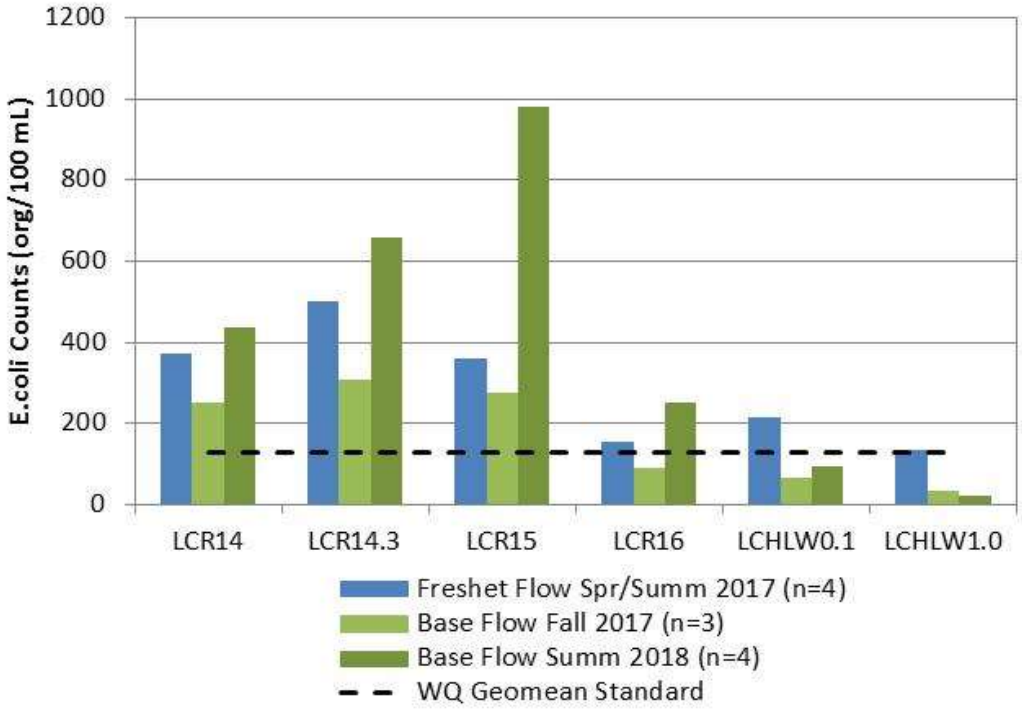


Figure 5. Geometric mean of E.coli monitoring results for Lewis Creek and Hollow Brook bracket monitoring stations during wet-weather, freshet flow events (in blue) versus dry-weather, baseflow events (in green) during 2017 and 2018.

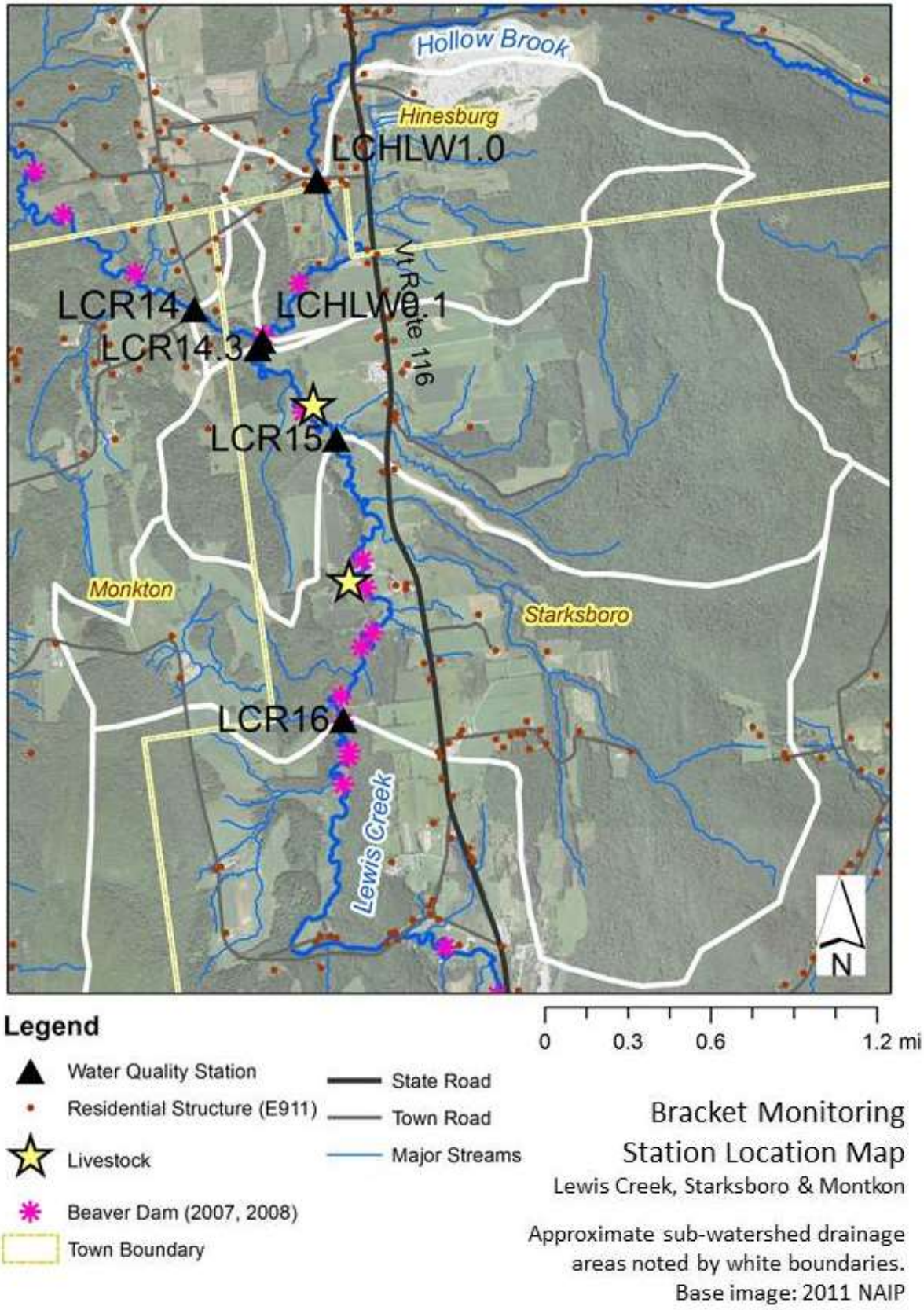


Figure 6. Location of Bracket Monitoring Sites on Lewis Creek

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 encountered in the summer of 2018 (Figure 5).

When proceeding downstream along the main stem, 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. A similar pattern was encountered under both dry-weather and wet-weather conditions in the previous year (Figure 5). Total Phosphorus concentrations were also elevated at LCR15 (see Attachment 2). These results indicate a contributing source(s) of bacteria and nutrients within the incremental drainage area for 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). A second conventional dairy farm, 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, as part of a farm transition and sale of the property. Bracket sampling will continue at these sites in 2019 to monitor for anticipated changes in water quality.

6.3.2 Lemon Fair River

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 (Figure 7). Mean concentrations of Turbidity (Figure 7A) and Total Phosphorus (Figure 7B) detected during dry-weather, baseflow conditions in the summer of 2018 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. TP was somewhat 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.

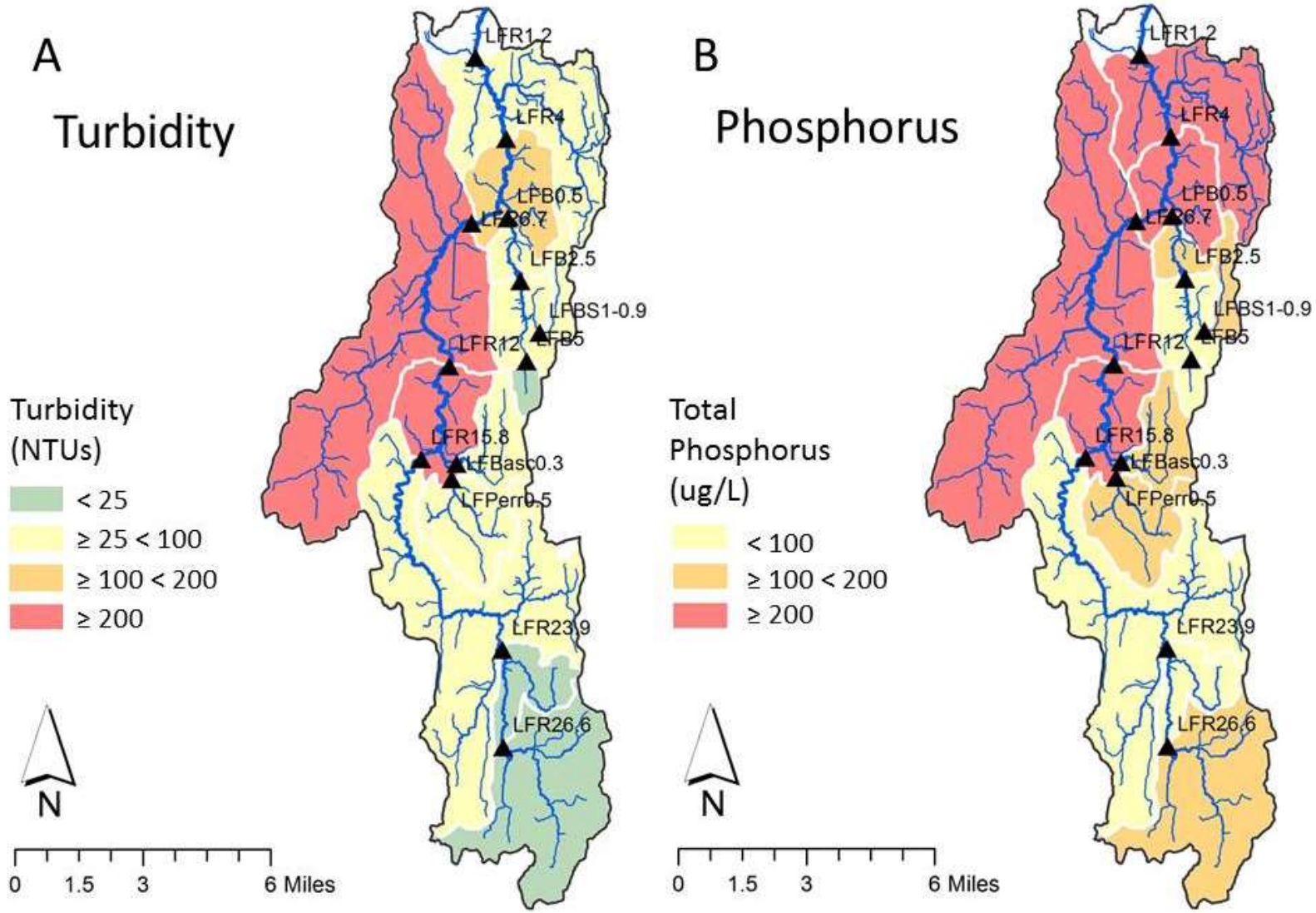


Figure 7. Mean values of (A) Turbidity detected during dry-weather, baseflow events (n=4) and (B) Total Phosphorus detected during baseflow conditions at or below the Low-Median-Monthly Flow in the Lemon Fair River watershed.

Regions with high concentrations of turbidity and phosphorus 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

ACRWC has periodically used its results to carry out analysis of treatment effectiveness for best management or restoration practices implemented by its partner agencies. As of October of 2018, dairy cattle with unrestricted access to the Lewis Creek between stations LCR16 and LCR15 were removed from the pasture as part of a farm transition. Future plans for this property include an approved river corridor easement and buffer planting project (estimated 2019). Additionally, a river corridor easement was approved for the downstream farm between stations LCR15 and LCR14.3. It is anticipated that livestock exclusion will result in a notable step-trend 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. The 2017-2018 bracket monitoring of *E.coli*, phosphorus and turbidity in vicinity of Tyler Bridge Road will continue at the same sites in 2019. Previous monitoring will serve as a baseline for future monitoring to quantify effectiveness of this completed livestock exclusion and anticipated riparian buffer enhancements.

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 occurring in the spring or fall months. The Vermont Department of Environmental Conservation monitors loading of constituents at the mouths of the Lewis Creek, Little Otter Creek and Otter Creek. 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 flow conditions at our sentinel and rotational sites will serve as a suitable proxy for constituent loading, and will help to prioritize watershed locations for restoration and conservation projects and practices.

7.0 Project Implementation

ACRWC relies on partner agencies 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 have been used to inform and develop priority implementation projects in watersheds monitored by the Collaborative. Sediment and nutrient concentration data (and coarse estimates of phosphorus yields, where available) have been used 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 have been prioritized within the context of River Corridor Plans and the Otter Creek 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, 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

Addison County River Watch Collaborative and South Mountain Research & Consulting, 2016, *Workshops and Analysis to Enhance Flood Resiliency of Headwater Forests*, Final Grant Summary Report, Grant Award #: WG224-16.

Olson, S.A., 2014, Estimation of flood discharges at selected annual exceedance probabilities for unregulated, rural streams in Vermont, *with a section on* Vermont regional skew regression, by Veilleux, A.G.: U.S. Geological Survey Scientific Investigations Report 2014–5078, 27 p. plus appendixes, *http://dx.doi.org/10.3133/sir20145078*.

NOAA Online Weather Data: Daily Almanac accessed in February 2018 at: http://www.weather.gov/climate/xmacis.php?wfo=btv

SMRC, 2017, *Analysis of Treatment Effectiveness at Historic Livestock Exclusion Sites in the Lewis Creek and Little Otter Creek Watersheds*, prepared for Vermont Agency of Natural Resources.

SMRC, 2018, *Bracket Monitoring to Identify Source Regions of E.coli in Vicinity of Tyler Bridge Road Lewis Creek Watershed*, prepared for Addison County River Watch Collaborative.

US Drought Monitor, accessed February 2018, http://droughtmonitor.unl.edu/Home/StateDroughtMonitor.aspx?VT

USGS, 2018, on-line surface water data, <http://waterdata.usgs.gov/vt/nwis>.

VTDEC, 2011, *Vermont Statewide Total Maximum Daily Load (TMDL) for Bacteria Impaired Waters*, prepared by FB Environmental Associates, Inc., Portland, ME. Including Appendices 2, 3, 4, 5 and 6.

VTDEC Water Quality Division, 2009 (August 18), *Proposed Nutrient Criteria for Vermont's Lakes and Wadeable Streams*. http://www.anr.state.vt.us/dec/waterq/lakes/docs/lp_2009nutrientcriteria.pdf

Vermont Watershed Management Division, 2016. *Vermont Water Quality Standards*. Effective 15 January 2017. Montpelier, VT. http://dec.vermont.gov/sites/dec/files/documents/wsmd_water_quality_standards_2016.pdf

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

Notes:

(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 (Airport)	*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
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

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
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

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 2/26/2019
Tr = Trace; M - Missing data

Table B-3. 2018 Daily Mean Flows recorded in Addison County 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	4/4/2018	153	H	FF	413	H	FF	889	H	FF	2,560	H	FF
(Daily Mean Flows)	5/2/2018	250	H	FF	367	H	FF	753	H	FF	3,030	H	FF
(cfs)	6/6/2018	11.8	M	BF	48.1	M	BF	92.3	M	BF	514	M	BF
* incidates	7/11/2018	3.6 *	L	BF	12.1 *	L	BF	38.0 *	L	BF	247 *	L	BF
flow < LMM	8/1/2018	3.9 *	L	BF	10.6 *	L	BF	39.4 *	L	BF	321 *	L	BF
	9/5/2018	2.6 *	L	BF	7.2 *	L	BF	29.9 *	L	BF	260 *	L	BF
	9/26/2018	3.9 *	L	BF	11.7 *	L	BF	39.8 *	L	BF	302 *	L	BF
Select sites in Lemon Fair River were sampled by Middlebury College students in late Fall.	10/3/2018	13.2	M	FF	55.9	M	FF	375	H	FF	1,050	M	FF
	10/30/2018	16.0	M	BF	57.2	M	BF	203	M	BF	1,080	M	BF
	11/6/2018	165	H	FF	134	H	FF	410	H	FF	1,920	H	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		

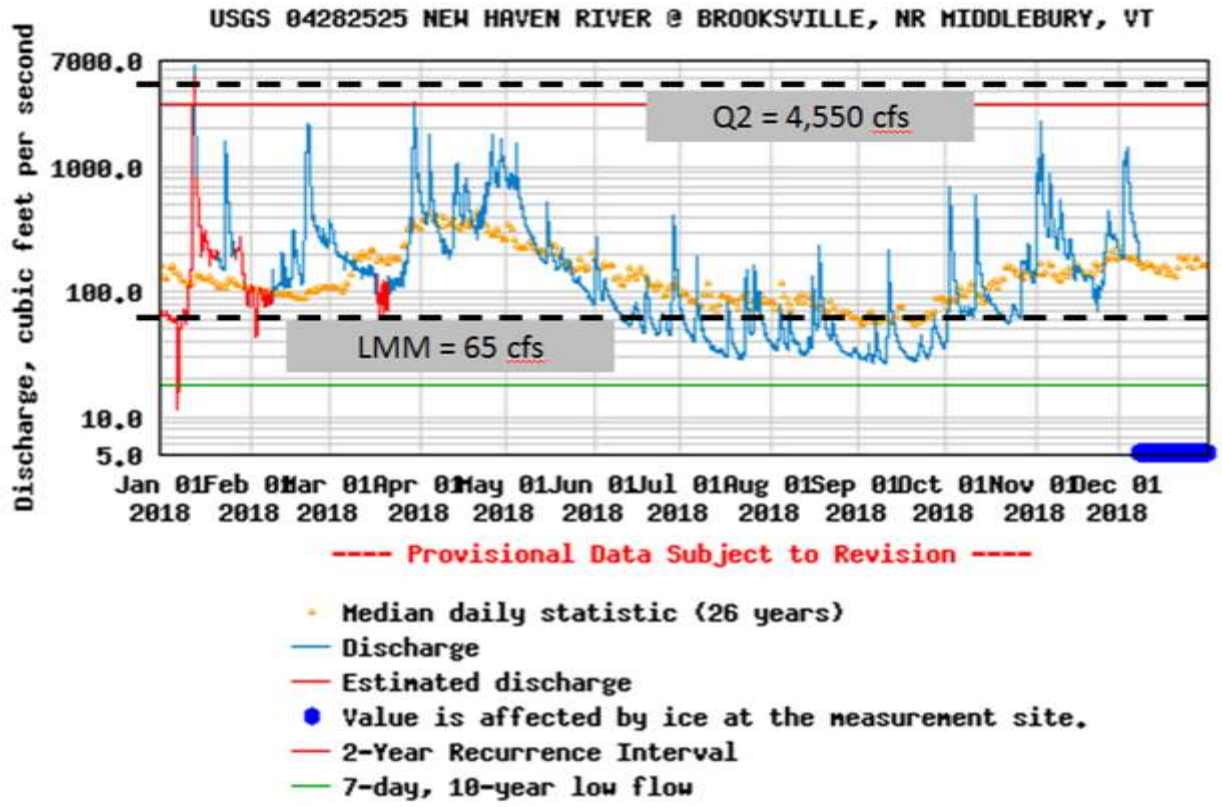
(Blaine Hastings, VWMD, Jan 2014; based on gaging records of variable lengths through water year 2012)

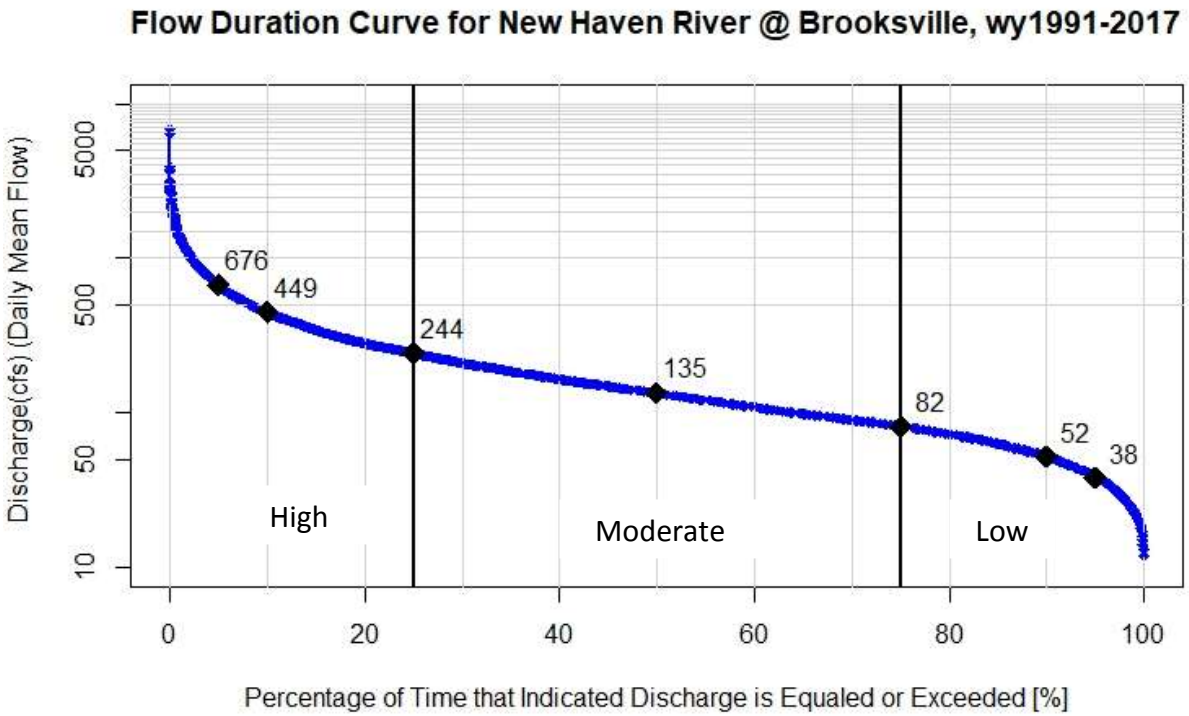
Source: USGS National Water Information System, https://waterdata.usgs.gov/vt/nwis, downloaded 1/3/2018

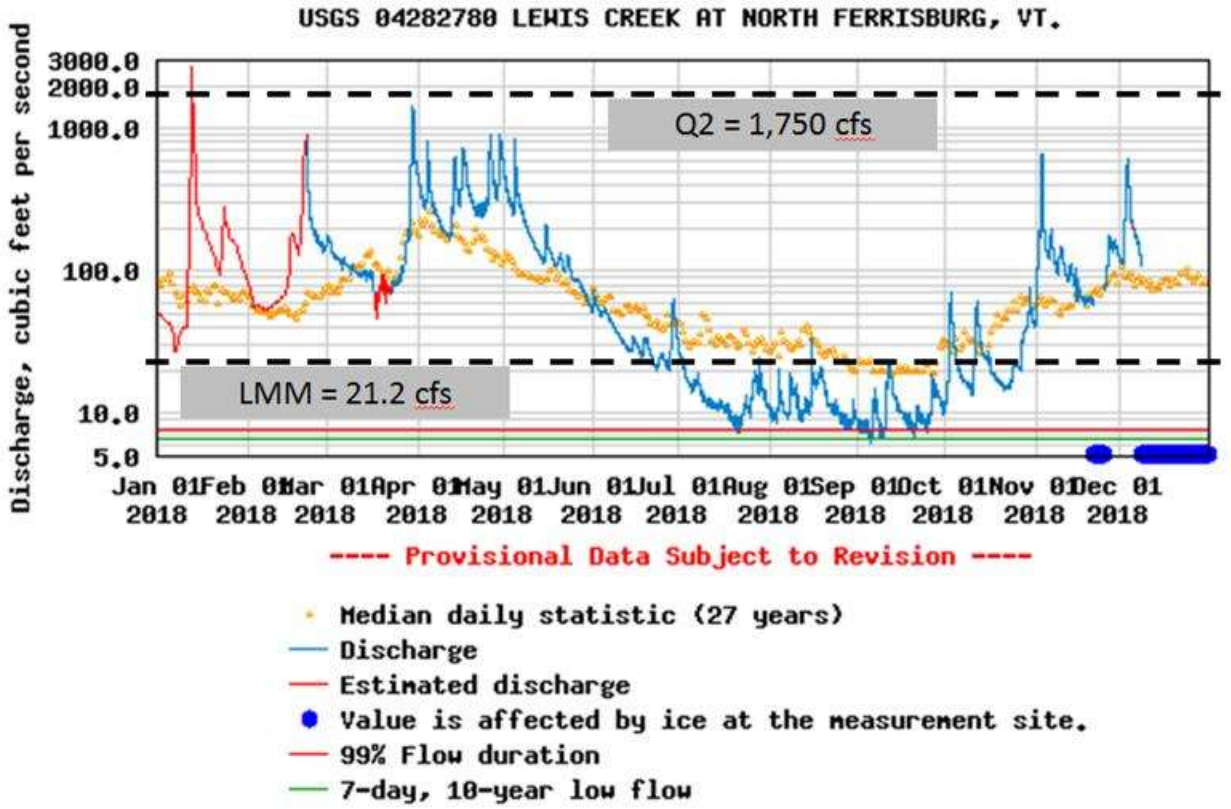
Abbreviations: Flow condition follows VTDEC Guidance:

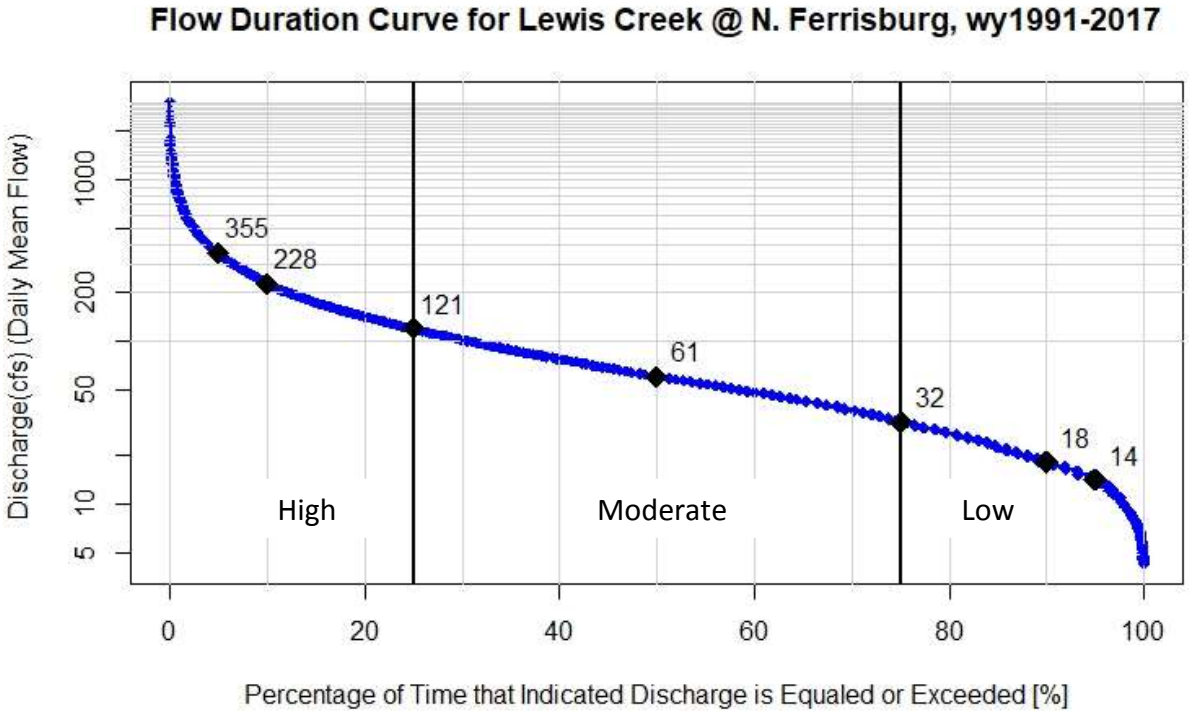
Flow Level: Fd - Flood (>bankfull flow), H - High (>p.75), M - Moderate (>p.25 ≤p.75), L - Low (≤ p.25), where p = percentile

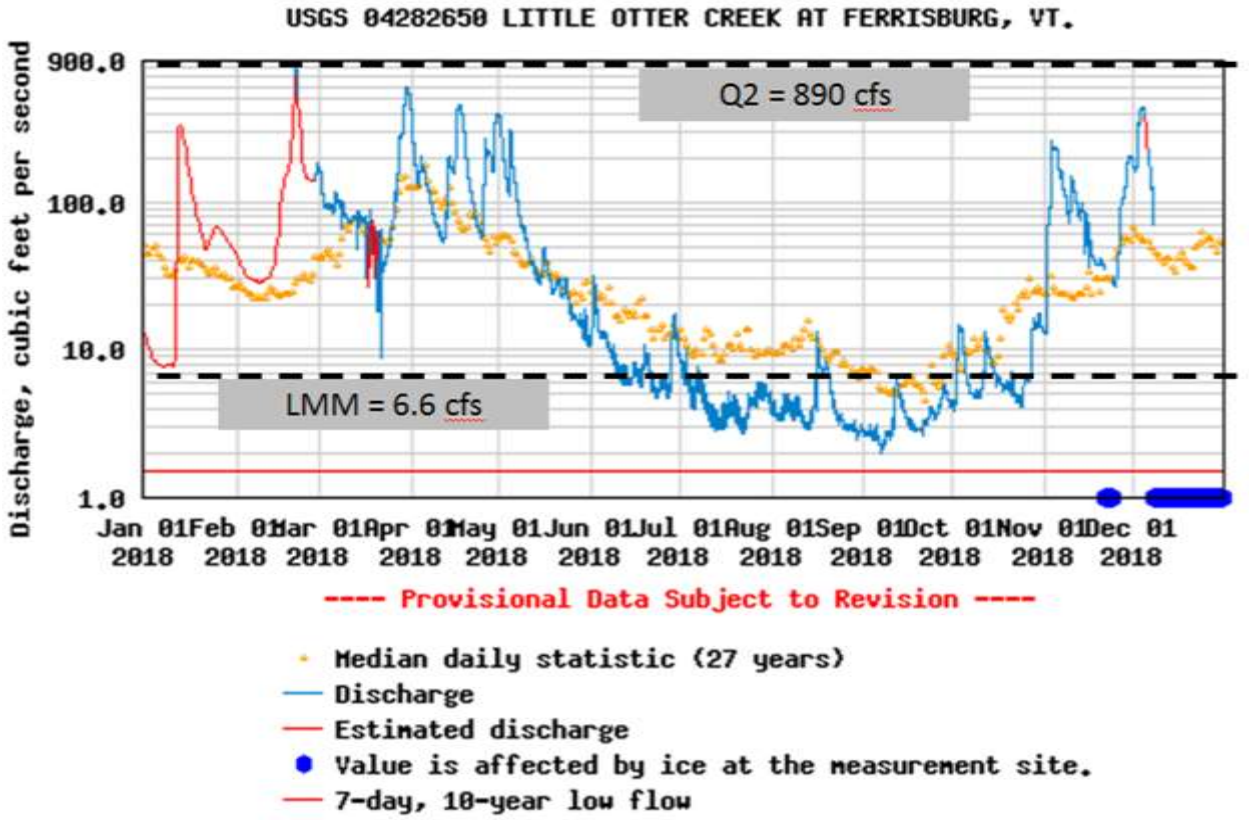
Flow Category: BF - Base Flow, FF - Freshet Flow, HF - Hydro Flow

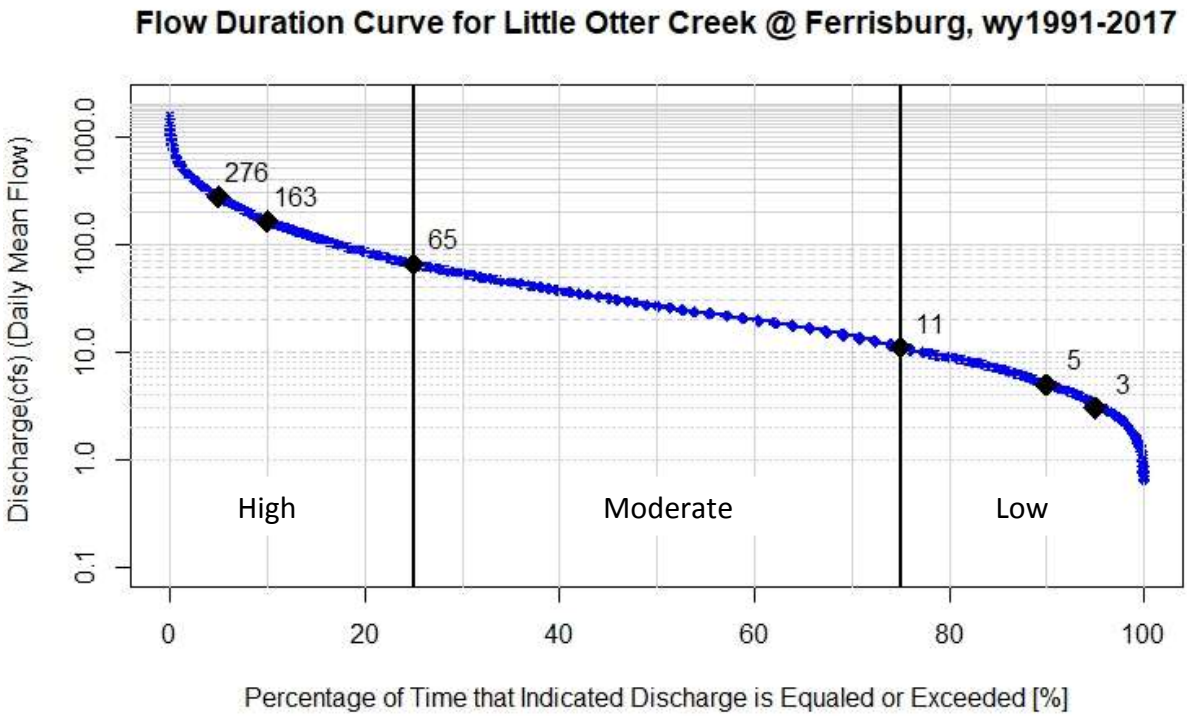

USGS 04282525 NEW HAVEN RIVER @ BROOKSVILLE, NR MIDDLEBURY, VT
Discharge, cubic feet per second
7000.0
1000.0
100.0
10.0
5.0
Q2 = 4,550 cfs
LMM = 65 cfs
Jan 01 2018
Feb 01 2018
Mar 01 2018
Apr 01 2018
May 01 2018
Jun 01 2018
Jul 01 2018
Aug 01 2018
Sep 01 2018
Oct 01 2018
Nov 01 2018
Dec 01 2018
---- Provisional Data Subject to Revision ----
Median daily statistic (26 years)
Discharge
Estimated discharge
Value is affected by ice at the measurement site.
2-Year Recurrence Interval
7-day, 10-year low flow

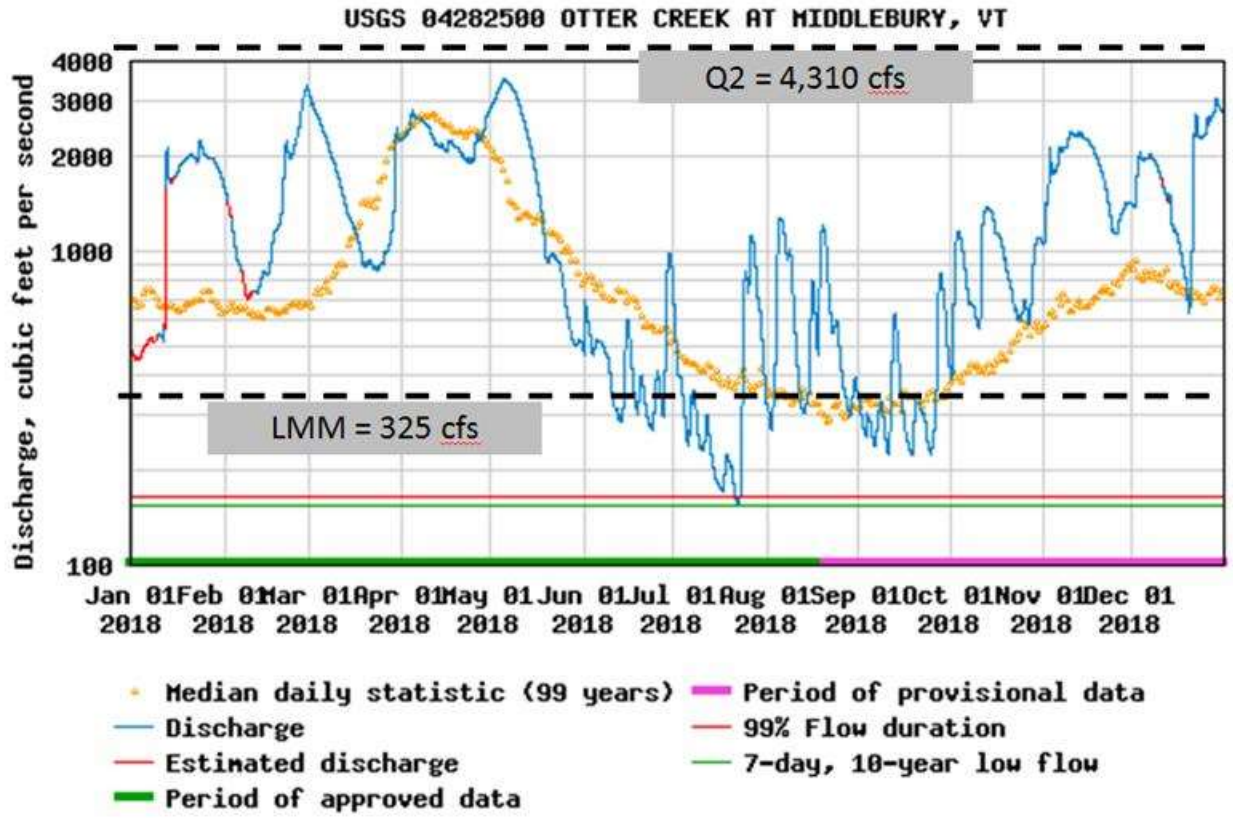

Flow Duration Curve for New Haven River @ Brooksville, wy1991-2017
Discharge(cfs) (Daily Mean Flow)
5000
500
50
10
676
449
244
135
82
52
38
High
Moderate
Low
0
20
40
60
80
100
Percentage of Time that Indicated Discharge is Equaled or Exceeded [%]

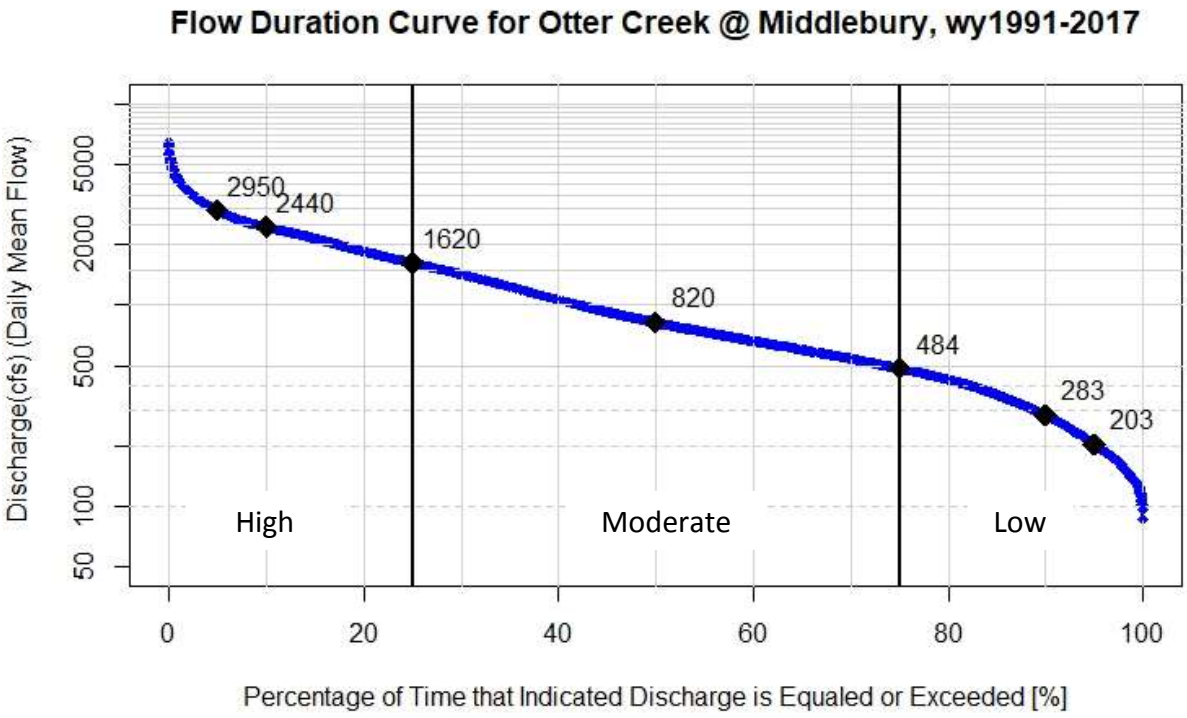

USGS 04282780 LEWIS CREEK AT NORTH FERRISBURG, VT.
Discharge, cubic feet per second
3000.0
2000.0
1000.0
100.0
10.0
5.0
Q2 = 1,750 cfs
LMM = 21.2 cfs
Jan 01 2018
Feb 01 2018
Mar 01 2018
Apr 01 2018
May 01 2018
Jun 01 2018
Jul 01 2018
Aug 01 2018
Sep 01 2018
Oct 01 2018
Nov 01 2018
Dec 01 2018
---- Provisional Data Subject to Revision ----
Median daily statistic (27 years)
Discharge
Estimated discharge
Value is affected by ice at the measurement site.
99% Flow duration
7-day, 10-year low flow


Flow Duration Curve for Lewis Creek @ N. Ferrisburg, wy1991-2017
Discharge(cfs) (Daily Mean Flow)
5
10
50
200
1000
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.
Discharge, cubic feet per second
900.0
100.0
10.0
1.0
Q2 = 890 cfs
LMM = 6.6 cfs
Jan 01 2018
Feb 01 2018
Mar 01 2018
Apr 01 2018
May 01 2018
Jun 01 2018
Jul 01 2018
Aug 01 2018
Sep 01 2018
Oct 01 2018
Nov 01 2018
Dec 01 2018
---- Provisional Data Subject to Revision ----
Median daily statistic (27 years)
Discharge
Estimated discharge
Value is affected by ice at the measurement site.
7-day, 10-year low flow


Flow Duration Curve for Little Otter Creek @ Ferrisburg, wy1991-2017
Discharge(cfs) (Daily Mean Flow)
0.1
1.0
10.0
100.0
1000.0
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
4000
3000
2000
1000
100
Q2 = 4,310 cfs
LMM = 325 cfs
Jan 01 2018
Feb 01 2018
Mar 01 2018
Apr 01 2018
May 01 2018
Jun 01 2018
Jul 01 2018
Aug 01 2018
Sep 01 2018
Oct 01 2018
Nov 01 2018
Dec 01 2018
Median daily statistic (99 years)
Discharge
Estimated discharge
Period of approved data
Period of provisional data
99% Flow duration
7-day, 10-year low flow


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)	Total Phosphorus (ug/L)	Dissolved Phosphorus (ug/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
LFR1.2	4/4/2018	A		0.73	82.9	37.7 JB	13	49.3
LFR1.2	5/2/2018	A		0.72	101	48.8	13.5	55.3
LFR1.2	6/6/2018	A		0.75	111	45	30.57	50.7
LFR1.2	7/11/2018	A		1.22	372.8	216	93.333	144.6
LFR1.2	8/1/2018	A		0.61	228.3	91.9	74	97.9
LFR1.2	9/5/2018	A		0.79	267.3	164	49.11	69.4
LFR4	4/4/2018	A		0.71	84.9	36 JB	15.5	49.2
LFR4	5/2/2018	A		0.82	128	44.7	73	88.2
LFR4	6/6/2018	A		0.81	129	42.7	67	83.3
LFR4	7/11/2018	A		1.24	238	131	70.5	117.8
LFR4	8/1/2018	A		0.7	183.9	85.1	80	101
LFR4	9/5/2018	A		0.75	204.9	93.1	113	118.4
LFR6.7	4/4/2018	A		0.71	83.5	40.5 JB	11.25	46.9
LFR6.7	5/2/2018	A		0.8	103	48.7	17	52.6
LFR6.7	6/6/2018	A	142.29	0.89	166	33.9	74	100
LFR6.7	7/11/2018	A	37.8	1.76	404	90.4	246	358
LFR6.7	8/1/2018	A	435.17	0.86	251.4	77.1	206	189
LFR6.7	9/5/2018	A	39.13	1.08	241.8	88	165	247.6
LFR12	4/4/2018	A		0.71	79	36.9 JB	17.6	47.1
LFR12	5/2/2018	A		0.81	128	58.7	28.5	93.7
LFR12	6/6/2018	A	53.81	0.82	131	35.1	18.33	115.8
LFR12	7/11/2018	A	55.79	1.1	376.8	95	221	280.5
LFR12	8/1/2018	A	93.35	0.7	298.2	59.3	156	245
LFR12	9/5/2018	A	15.16	0.9	312	76.8	211	248.4
LFR15.8	4/4/2018	A		0.73	87.8	34.5 JB	29	57.9
LFR15.8	5/2/2018	A		0.84	129.5	58.2	33	90.9
LFR15.8	6/6/2018	A	71.73	0.71	100	37.5	31.5	63.3
LFR15.8	7/11/2018	A	178.53	0.75	117	67.8	23.8	37.3
LFR15.8	8/1/2018	A	137.35	0.64	89.1	34.3	24.2	41.2
LFR15.8	9/5/2018	A	285.1	0.66	80.1	65.5	15.8	21.3
LFR23.9	4/4/2018	A		0.35	30.5	14.6 JB	9.6	19.4
LFR23.9	5/2/2018	A		0.4	39.6	19.6	14.8	28.7
LFR23.9	6/6/2018	A		0.59	58.3	24.3	25.33	27
LFR23.9	7/11/2018	A		1.71	76.1	30.9	7	12
LFR23.9	8/1/2018	A		1	92.6	22.9	22.4	19.4
LFR23.9	9/5/2018	A		1.05	127	40.7	13.33	14.4

Lemon Fair River (continued)

Location	Date	QA	E. Coli. (mpn/100ml)	Total Nitrogen (mg/L)	Total Phosphorus (ug/L)	Dissolved Phosphorus (ug/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
LFR26.6	4/4/2018	A		0.39	18.8	13.4 JB	< 2	8.13
LFR26.6	5/2/2018	A		0.35	22.1	13.7	4.38	9.23
LFR26.6	6/6/2018	A		0.47	37.3	27.3	4.38	6.72
LFR26.6	7/11/2018	A		1.06	123	51.2	15.2	14.4
LFR26.6	8/1/2018	A		0.7	54.8	28.4	12	13.6
LFR26.6	9/5/2018	A		1.17	128	27.1	20.5	20.5
LFB0.5	4/4/2018	A		0.33	43.5	18.4 JB		26.6
LFB0.5	5/2/2018	A		0.41	42.3	19.6		24.1
LFB0.5	6/6/2018	A	93.38	0.57	83.1	25.2		70.5
LFB0.5	7/11/2018	A	36.36	0.47	148	43.4		58.4
LFB0.5	8/1/2018	A	435.17	0.43	99.3	30.3		63.5
LFB0.5	9/5/2018	A	56.33	0.37	84.6	44.1		48.6
LFB2.5	4/4/2018	A		0.36	36.1	15.4 JB		17.6
LFB2.5	5/2/2018	A		0.41	40.5	20.2		18.2
LFB2.5	6/6/2018	A	272.3	0.59	69.4	26.6		45
LFB2.5	7/11/2018	A	45.19	0.69	111	37.4		51.9
LFB2.5	8/1/2018	A	23.51	0.34	58.9	17.5		28.4
LFB2.5	9/5/2018	A	9.51	0.3	66	39.1		23.4
LFB5	4/4/2018	A		0.48	34	12.4 JB		10.7
LFB5	5/2/2018	A		0.38	24.6	13.2		7.21
LFB5	6/6/2018	A	26.86	0.59	69	24.3		16.1
LFB5	7/11/2018	A	1011.16	0.66	78.6	37		30.5
LFB5	8/1/2018	A	461.11	0.66	63.4	29.7		14.6
LFB5	9/5/2018	A	206.35	0.64	52.2	38.1		3.31
LFBS1-0.9	4/4/2018	A		0.31	18.7	11.9 JB		5.95
LFBS1-0.9	5/2/2018	A		0.31	18.8	13.2		3.81
LFBS1-0.9	6/6/2018	A	185.01	0.4	38.6	31.2		8.09
LFBS1-0.9	7/11/2018	A	151.52	1.11	136	50.1		58.2
LFBS1-0.9	8/1/2018	A	517.21	0.72	116	46.6		38.2
LFBS1-0.9	9/5/2018	A	157.56	1.41	182.1	36		82.7

Lemon Fair River (continued)

Location	Date	QA	E. Coli. (mpn/100ml)	Total Nitrogen (mg/L)	Total Phosphorus (ug/L)	Dissolved Phosphorus (ug/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
LFBasc 0.3	4/4/2018	A		0.42	62.4	25.3 JB		41
LFBasc 0.3	5/2/2018	A		0.47	62.5	34.9		28
LFBasc 0.3	6/6/2018	A	137.61	0.55	69.1	23		45.9
LFBasc 0.3	7/11/2018	A	166.4	1.04	117	25.5		65.2
LFBasc 0.3	8/1/2018	A	816.41	0.8	80.1	15.8		42.8
LFBasc 0.3	9/5/2018	A	104.6	1.38	170.1	26		84.6
LFPerr 0.5	4/4/2018	A		0.63	70.1	36.4 JB		32.8
LFPerr 0.5	5/2/2018	A		0.57	106	76.5		21.7
LFPerr 0.5	6/6/2018	A	549.25	0.85	126	52.1		50.5
LFPerr 0.5	7/11/2018	A	378.44	0.77	212	80		102.4
LFPerr 0.5	8/1/2018	A	387.32	0.59	227.4	57		120
LFPerr 0.5	9/5/2018	A	172.16	0.64	143.1	59.9		68.9

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)	Total Phosphorus (ug/L)	Dissolved Phosphorus (ug/L)	Turbidity (NTU)
LCR0.3	4/4/2018	A			48.6		22.3
LCR0.3	5/2/2018	A			38		33.2
LCR0.3	6/6/2018	A			24.2		
LCR0.3	7/11/2018	A			41.8		
LCR0.3	8/1/2018	A			39.9		
LCR0.3	9/5/2018	A			42.5		
LCR3.7	4/4/2018	A			47.4		21.6
LCR3.7	5/2/2018	A			48.9		27.1
LCR3.7	6/6/2018	A			13.5		
LCR3.7	7/11/2018	A			14.7		
LCR3.7	8/1/2018	A			14.7		
LCR3.7	9/5/2018	A			17.6		
LCR9.9	4/4/2018	A			53.6		21.1
LCR9.9	5/2/2018	A			57.2		23.6
LCR9.9	6/6/2018	A	93.31		17.3		6.58
LCR9.9	7/11/2018	A	35.92		20.8		4.94
LCR9.9	8/1/2018	A	55.55		22		8.4
LCR9.9	9/5/2018	A	21.09		24		7.64
LCR14	4/4/2018	A		0.54	33.6	8.87	14.7
LCR14	5/2/2018	A		0.47	30	10	9.43
LCR14	6/6/2018	A	159.67	0.78	6.3	6.38	1.66
LCR14	7/11/2018	A	313.01	0.68	16.6	8.31	2.73
LCR14	8/1/2018	A	517.21	0.48	12.1	5.35	3.3
LCR14	9/5/2018	A	1413.61	0.63	31.5	8.16	7.07
LCR14.3	4/4/2018	A		0.58	48.7	9.38	18.5
LCR14.3	5/2/2018	A		0.52	40.5	8.81	8.67
LCR14.3	6/6/2018	A	139.58	0.87	8.24	7.2	1.64
LCR14.3	7/11/2018	A	501.2	0.8	20.9	9.14	5.25
LCR14.3	8/1/2018	A	1119.87	0.49	18.8	5.58	7.64
LCR14.3	9/5/2018	A	> 2419.6	0.7	31.5	9.43	9.18

Lewis Creek (continued)

Location	Date	QA	E. Coli. (mpn/100ml)	Total Nitrogen (mg/L)	Total Phosphorus (ug/L)	Dissolved Phosphorus (ug/L)	Turbidity (NTU)
LCR15	4/4/2018	A		0.58	31	11	9.61
LCR15	5/2/2018	A		0.49	46.9	7.56	8.63
LCR15	6/6/2018	A	436.04	0.95	10.1	7.94	2.17
LCR15	7/11/2018	A	1011.16	0.8	15.8	7.75	3.09
LCR15	8/1/2018	A	> 2419.6	0.98	69.9	15.1	23.6
LCR15	9/5/2018	A	866.44	0.82	132	7.54	4.16
LCR16	4/4/2018	A		0.53	15.6	7.07	4.48
LCR16	5/2/2018	A		0.47	28.7	6.43	4.47
LCR16	6/6/2018	A	157.56	0.82	< 5	6.71	0.58
LCR16	7/11/2018	A	166.4	0.8	11.5	7.8	1.29
LCR16	8/1/2018	A	272.3	0.72	7.63	5.11	1.68
LCR16	9/5/2018	A	547.5	0.66	22	8.09	2.46
LCHLW0.1	4/4/2018	A		0.48	12.4	6.99	1.86
LCHLW0.1	5/2/2018	A		0.42	11.1	10.3	1.91
LCHLW0.1	6/6/2018	A	156.48	0.65	< 5	5.05	0.34
LCHLW0.1	7/11/2018	A	52.04	0.57	9.69	8.44	0.81
LCHLW0.1	8/1/2018	A	85.74	0.5	6.99	< 5	1.65
LCHLW0.1	9/5/2018	A	113.7	0.51	7.81	14.9	1.02
LCHLW1.0	4/4/2018	A		0.45	11.3	7.39	1.91
LCHLW1.0	5/2/2018	A		0.39	9.55	6.69	1.67
LCHLW1.0	6/6/2018	A	29.17	0.73	< 5	5.64	0.21
LCHLW1.0	7/11/2018	A	23.78	0.64	8.56	8.81	0.35
LCHLW1.0	8/1/2018	A	19.67	0.6	6.28	6.14	0.86
LCHLW1.0	9/5/2018	A	18.29	0.67	6.48	7.08	< 0.2
LCT3D.5	4/4/2018	A			30.9		5.46
LCT3D.5	5/2/2018	A			42.3		5.78
LCT3D.5	6/6/2018	A	59.8		69.6		5.97
LCT3D.5	7/11/2018	A	59.08		62.7		2.15
LCT3D.5	8/1/2018	A	248.09		40.7		2.12
LCT3D.5	9/5/2018	A	115.28		41.2		1.65

Lewis Creek (continued)

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)	Total Phosphorus (ug/L)	Dissolved Phosphorus (ug/L)	Turbidity (NTU)
LOC4.3	4/4/2018	A			57.5		24.3
LOC4.3	5/2/2018	A			76.5		31.9
LOC4.3	6/6/2018	A			141		
LOC4.3	7/11/2018	A			136		
LOC4.3	8/1/2018	A			154		
LOC4.3	9/5/2018	A			88.7		
MDC1.2	4/4/2018	A			52.8		13
MDC1.2	5/2/2018	A			112		31.2
MDC1.2	6/6/2018	A			101		
MDC1.2	7/11/2018	A			183		
MDC1.2	8/1/2018	A			156		
MDC1.2	9/5/2018	A			803		

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)	Total Phosphorus (ug/L)	Dissolved Phosphorus (ug/L)	Turbidity (NTU)
MIR1.5	4/4/2018	A			20.1		4.98
MIR1.5	5/2/2018	A			17.9		
MIR1.5	6/6/2018	A	108.07		13.3		
MIR1.5	7/11/2018	A	238.22		26.8		
MIR1.5	8/1/2018	A	344.8		16.4		
MIR1.5	9/5/2018	A	410.58		20.7		
MIR5.7	4/4/2018	A			8.3		0.96
MIR5.7	5/2/2018	A			7.91		
MIR5.7	6/6/2018	A	12.23		< 5		
MIR5.7	7/11/2018	A	28.47		10.1		
MIR5.7	8/1/2018	A	2.02		7.76		
MIR5.7	9/5/2018	A	47.11		7.97		
MIR10.6	4/4/2018	A			10.6		0.76
MIR10.6	5/2/2018	A			7.82		
MIR10.6	6/6/2018	A			5.02		
MIR10.6	7/11/2018	A			20.4		
MIR10.6	8/1/2018	A			12.2		
MIR10.6	9/5/2018	A			13.9		

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)	Total Phosphorus (ug/L)	Dissolved Phosphorus (ug/L)	Turbidity (NTU)
NHR2	4/4/2018	A			36.4		15.7
NHR2	5/2/2018	A			16.3		
NHR2	6/6/2018	A			5.46		
NHR2	7/11/2018	A			7.43		
NHR2	8/1/2018	A			8.76		
NHR2	9/5/2018	A			16.1		
NHR6	6/6/2018	A	41.95				
NHR6	7/11/2018	A	66.31				
NHR6	8/1/2018	A	52.91				
NHR6	9/5/2018	A	29.54				
NHR9	4/4/2018	A			69.3		1.67
NHR9	5/2/2018	A			7.56		
NHR9	6/6/2018	A			< 5		
NHR9	7/11/2018	A			8.08		
NHR9	8/1/2018	A			5.3		
NHR9	9/5/2018	A			5.17		
NHR11.5	6/6/2018	A	90.75				
NHR11.5	7/11/2018	A	16.94				
NHR11.5	8/1/2018	A	15.79				
NHR11.5	9/5/2018	A	10.78				

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)

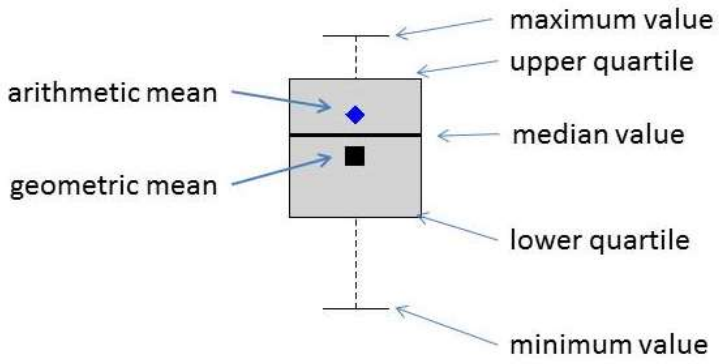
Location	Date	QA	E. Coli. (mpn/100ml)	Total Nitrogen (mg/L)	Total Phosphorus (ug/L)	Dissolved Phosphorus (ug/L)	Turbidity (NTU)
OTR7.3	4/4/2018	A			44.4		17.2
OTR7.3	5/2/2018	A			41.7		15.2
OTR7.3	6/6/2018	A			26.9		
OTR7.3	7/11/2018	A			41.8		
OTR7.3	8/1/2018	A			38.2		
OTR7.3	9/5/2018	A			28.6		
OTR18	4/4/2018	A			37.9		11.7
OTR18	5/2/2018	A			33		6.87
OTR18	6/6/2018	A			16.3		
OTR18	7/11/2018	A			32.5		
OTR18	8/1/2018	A			31.9		
OTR18	9/5/2018	A			29.5		

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.

Attachments

1 Lemon Fair River – 2018 Water Quality Summary
2 Lewis Creek – 2018 Water Quality Summary
3 Little Otter Creek – 2018 Water Quality Summary
4 Middlebury River – 2018 Water Quality Summary
5 New Haven River – 2018 Water Quality Summary
6 Otter Creek (Lower) – 2018 Water Quality Summary



Focus watershed:
2018 and 2019

Lemon Fair River - 2018 Water Quality Summary

Addison County River Watch Collaborative

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. Year 2018 was the first of 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.

During 2018, sampling occurred on two spring dates (April 4 and May 2) and four summer dates (June 6, July 11, August 1, and September 5). The year was characterized by near-normal precipitation, overall. Flows in the Lemon Fair River were near normal for much of the year, based on the streamflow records for the nearby USGS gaging station on Otter Creek at Middlebury. Following warm summer temperatures and drier-than-average conditions encountered during June and July, flow in area rivers trended below normal during these months. April and May sampling events took place during high flow conditions resulting from snowmelt and spring rains. The June event occurred during moderate-flow, baseflow conditions where river stage was not changing appreciably, and groundwater levels were relatively high following spring rains. The July, August, and September events coincided with low-flow, baseflow conditions. In the nearby Otter Creek these summer flows were at or below the Low Median Monthly (LMM) flow condition.

Samples from the Lemon Fair watershed were tested for *E.coli*, phosphorus (total and dissolved), total nitrogen, total suspended solids, and turbidity; *E.coli* was tested only on the summer dates.

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).

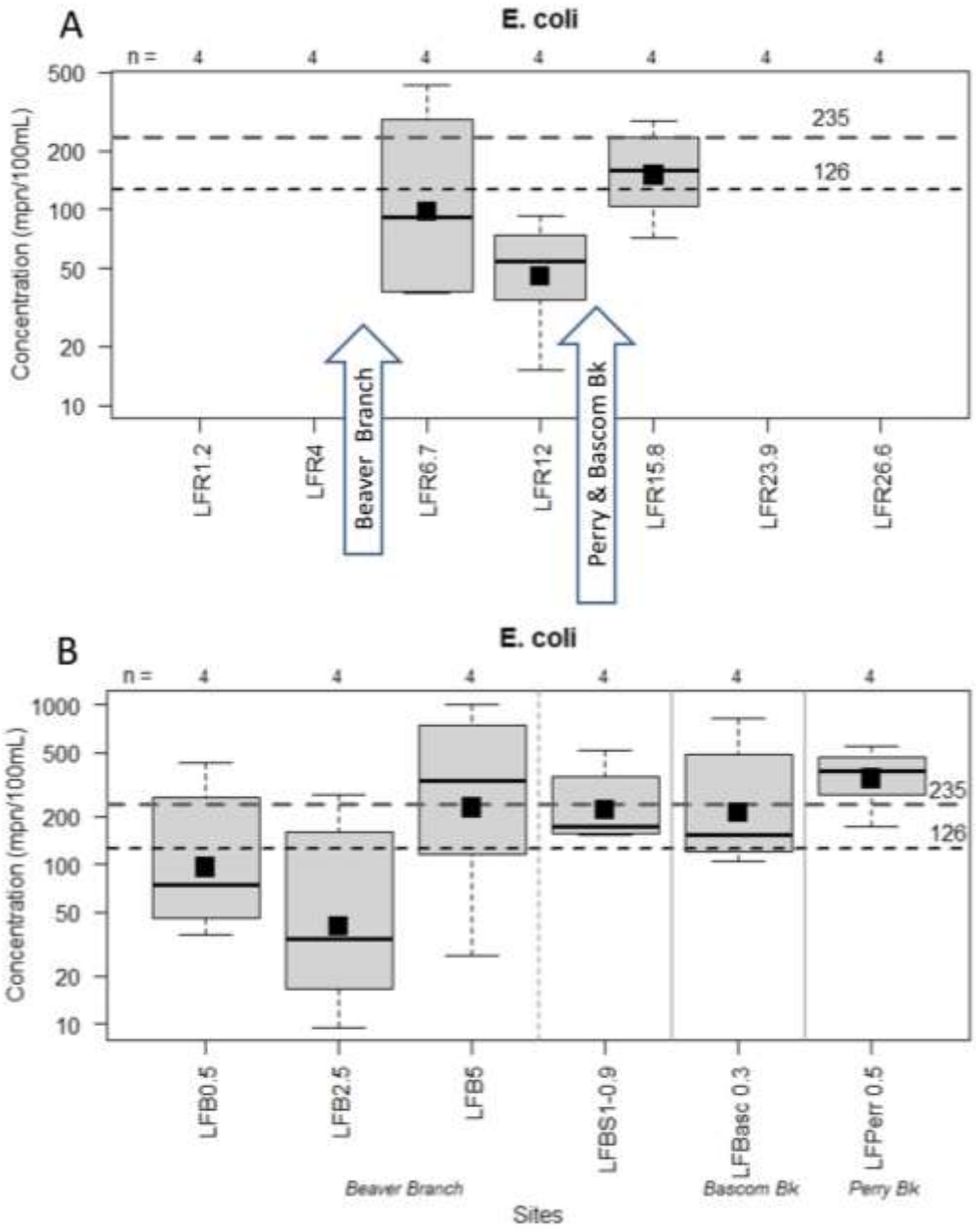


Figure 1. E.coli measured at sites on the Lemon Fair main stem (A) and tributaries (B) on four dry-weather, base-flow events between June and September in 2018. The whiskers extend to the maximum and minimum values, while the gray-shaded box represents the middle 50% of values. The median value is marked 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.

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).

Phosphorus was detected at moderate to high levels during the six spring and summer sampling dates of 2018, with concentrations ranging from 19 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. 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 82% during the six 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).

Nitrogen levels were detected at low to moderate concentrations at most stations during the 2018 spring and summer sampling dates, ranging from 0.3 to 1.8 mg/L. Highest nitrogen concentrations were detected during baseflow conditions at or below the Low Median Monthly flow. 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.

2019: Focus monitoring will continue in the Lemon Fair River for a second year in 2019. The Collaborative will continue with bracket monitoring sites established on the Beaver Branch, Bascom Brook and Perry Brook tributaries to further define sources of elevated nutrients and sediment detected along the main stem between established stations at Shacksboro Rd in Shoreham and Route 125 in Cornwall.

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

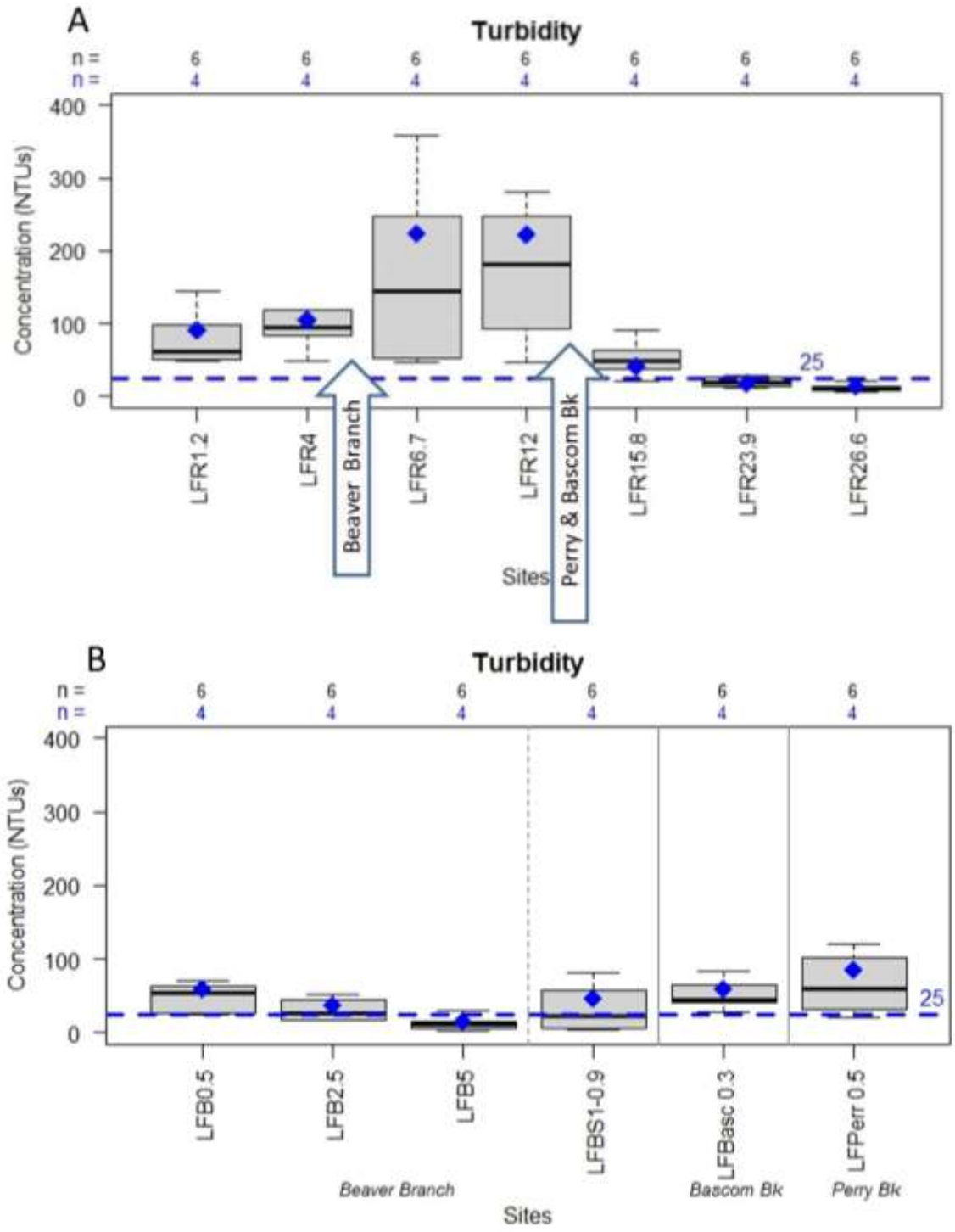


Figure 2. Summary of Turbidity measured at sites on the Lemon Fair main stem (A) and tributaries (B) in 2018. The whiskers extend to the maximum and minimum values detected over six sampling events, while the gray-shaded box represents the middle 50% of values. The median value is marked by the dark horizontal line. The blue diamond marks the mean of that subset of samples collected during dry-weather, base-flow conditions, with the corresponding number of samples (n) indicated in blue along the top of the chart.

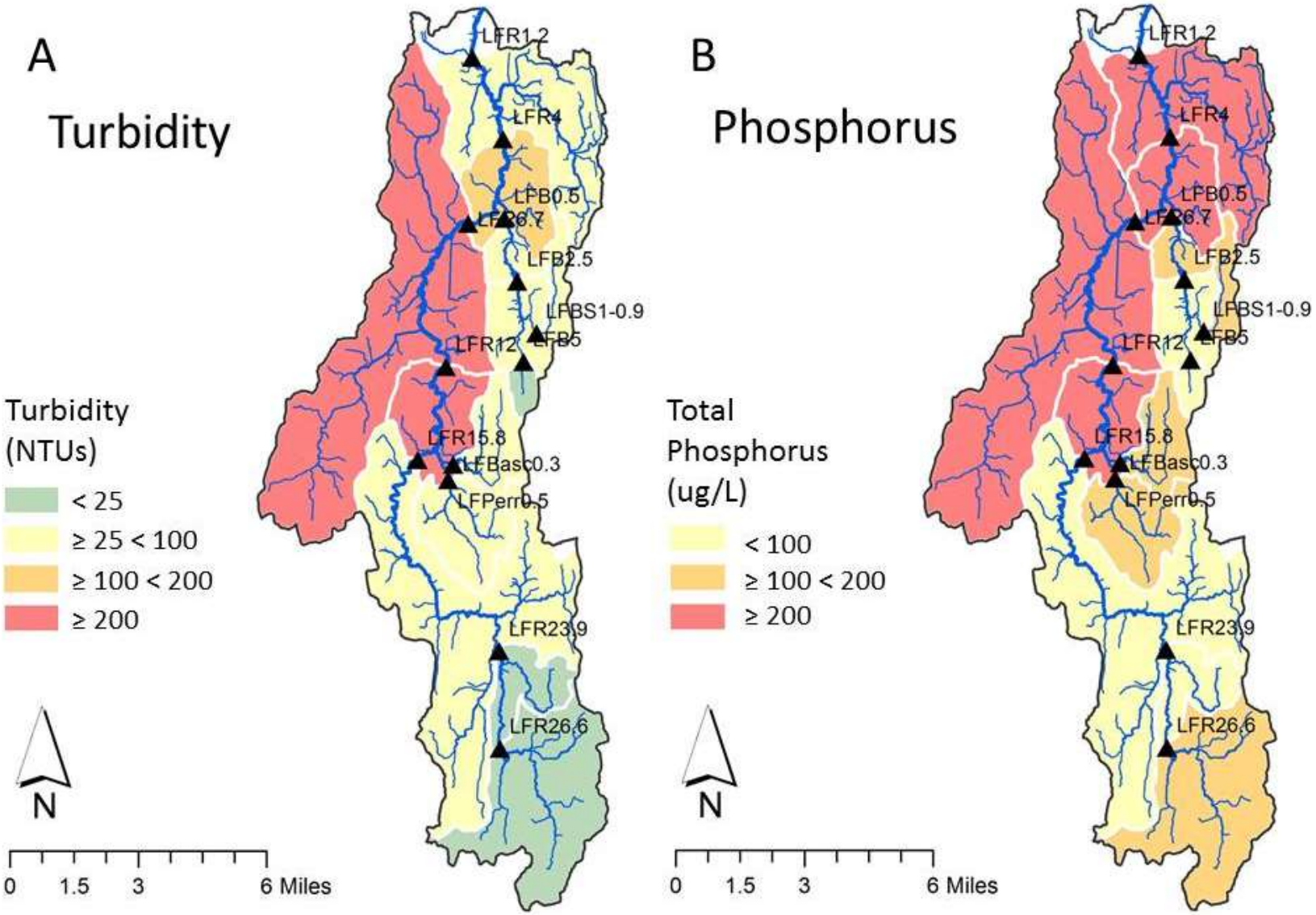


Figure 3. Mean values of (A) Turbidity detected during dry-weather, baseflow events (n=4) and (B) Total Phosphorus detected during baseflow conditions at or below the Low-Median-Monthly Flow in the Lemon Fair River watershed.

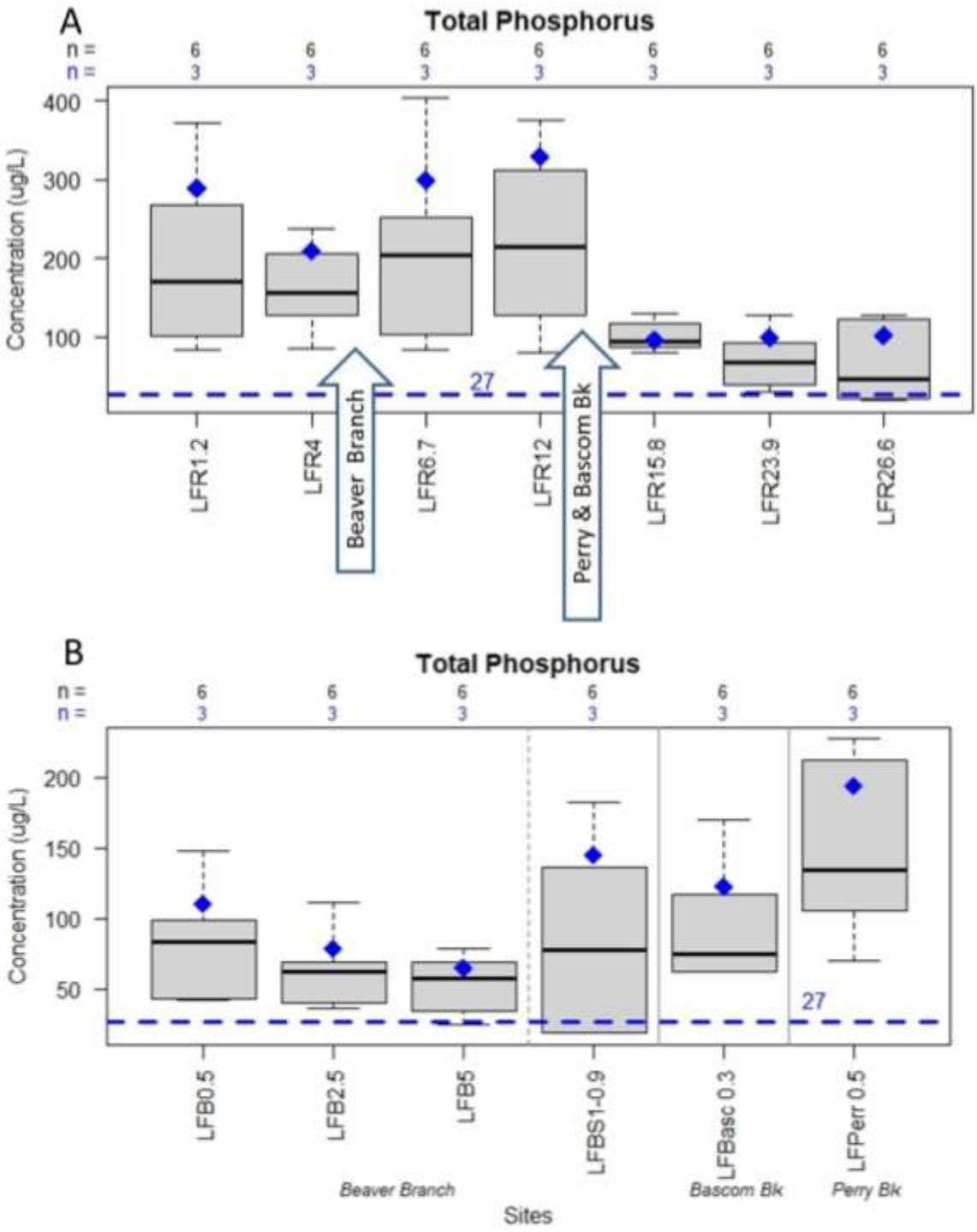


Figure 4. Summary of Total Phosphorus measured at sites on the Lemon Fair main stem (A) and tributaries (B) in 2018. The whiskers extend to the maximum and minimum values detected over six sampling events, while the gray-shaded box represents the middle 50% of values. The median value is marked by the dark horizontal line. The blue diamond marks the mean of that subset of samples (n=3) collected during base-flow conditions at or below the Low Median Monthly Flow.

Focus watershed:
2018 and 2019

Lewis Creek - 2018 Water Quality Summary

Addison County River Watch Collaborative (ACRWC), Lewis Creek Association (LCA)
Prepared by 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. Year 2018 was the first of a two-year , more intensive monitoring focus in the Lewis Creek, 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 year 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.[4]

During 2018, sampling occurred on two spring dates (April 4 and May 2) and four summer dates (June 6, July 11, August 1, and September 5). The year was characterized by near-normal precipitation, overall. 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. The June event occurred during moderate-flow, baseflow conditions where river stage was not changing appreciably, and groundwater levels were relatively high following spring rains. The July, August, and September events coincided with low-flow, baseflow conditions, at or below the Low Median Monthly (LMM) flow.

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.

E.coli counts at the bracket stations (Figure 1) ranged from 18 to >2420 organisms/100 mL for the four summer sampling dates in 2018. 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 summer of 2018 (Figure 3).

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

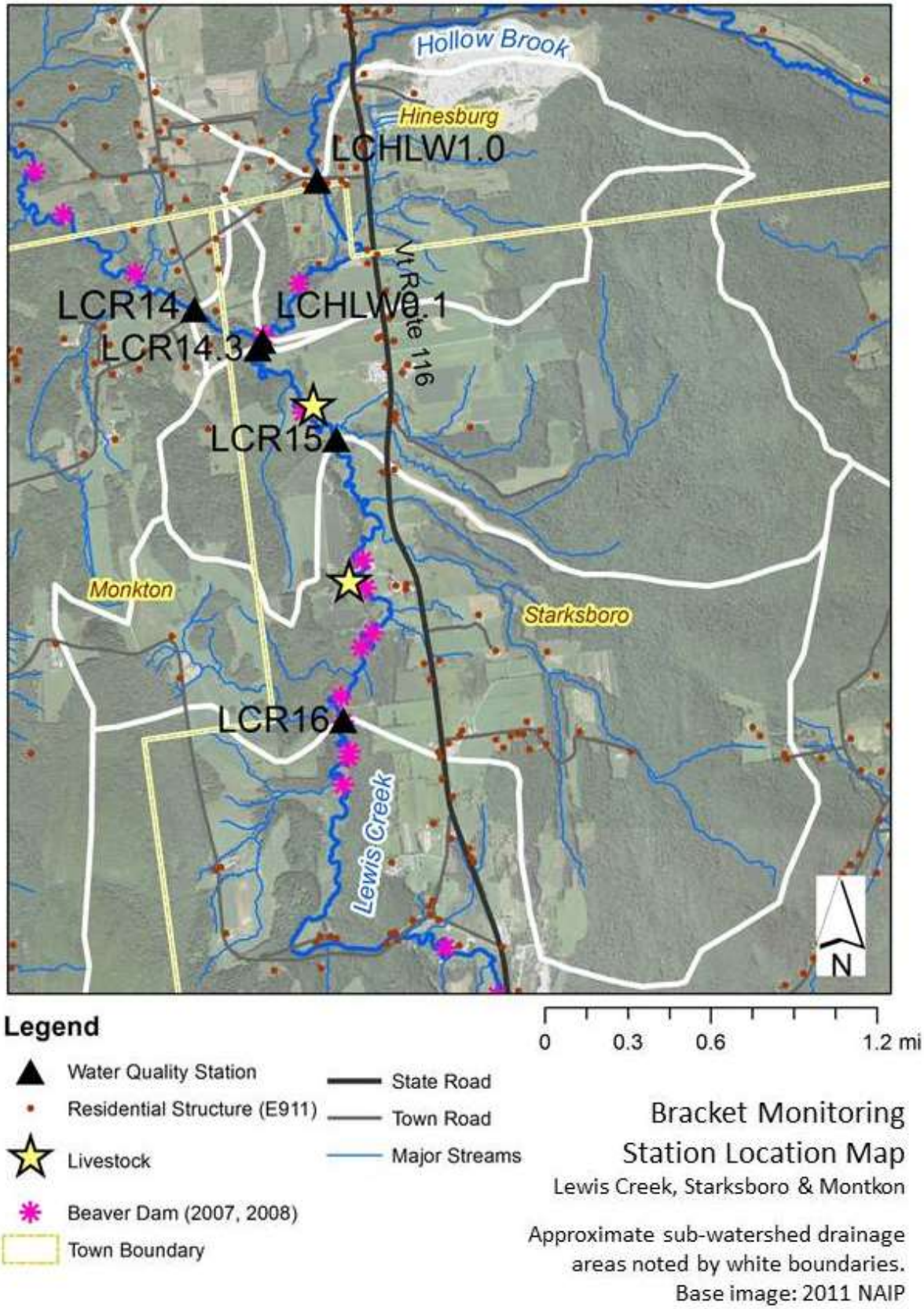


Figure 1. Location of Bracket Monitoring Sites

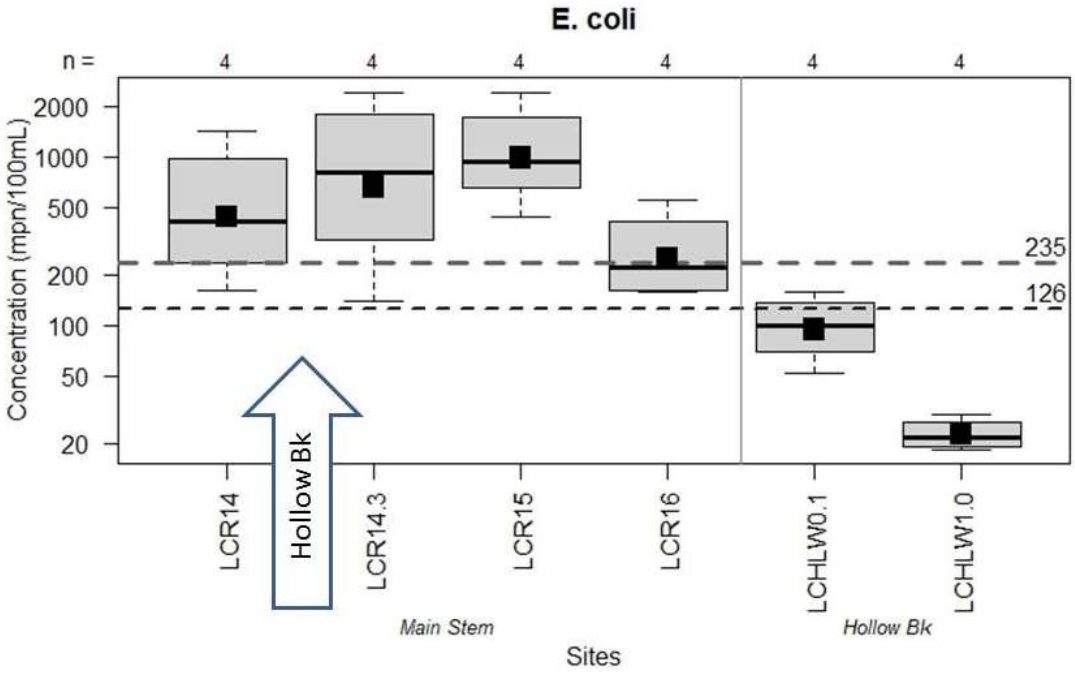


Figure 2. E.coli measured at Lewis Creek and Hollow Brook bracket monitoring stations on four dry-weather, base-flow events between June and September in 2018. The whiskers extend to the maximum and minimum values, while the gray-shaded box represents the middle 50% of values. The median value is marked 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.

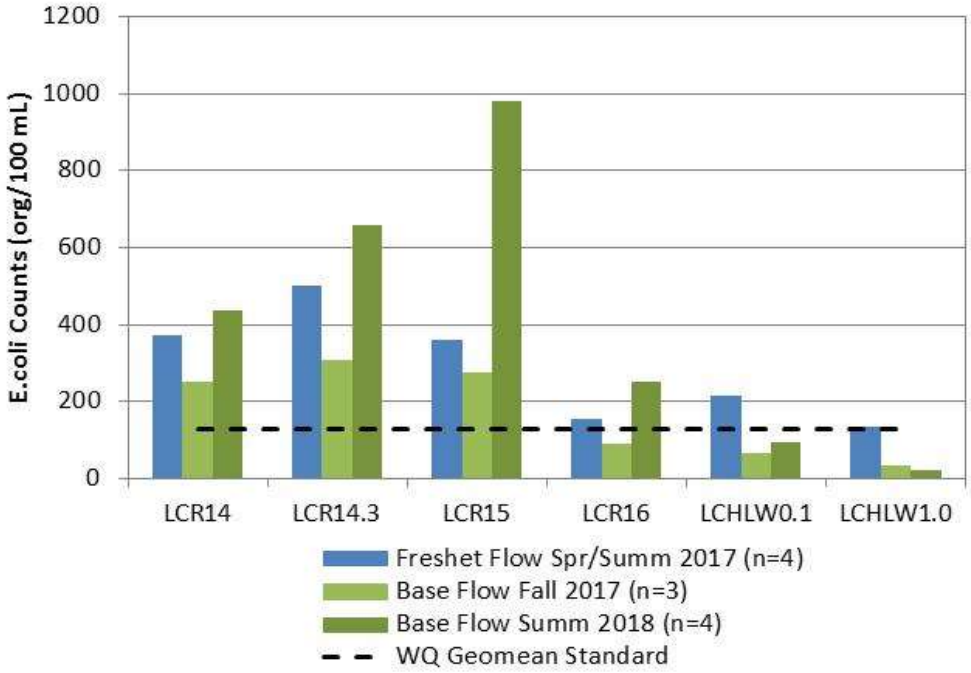


Figure 3. Geometric mean of E.coli monitoring results for Lewis Creek and Hollow Brook bracket monitoring stations during wet-weather, freshet flow events (in blue) versus dry-weather, baseflow events (in green) during 2017 and 2018.

When proceeding downstream along the main stem, 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. A similar pattern was encountered under both dry-weather and wet-weather conditions in the previous year(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 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, 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, as part of a farm transition and sale of the property. Bracket sampling will continue at these sites in 2019 to monitor for anticipated changes in water quality.

Turbidity levels at the Lewis Creek stations ranged from <0.2 to 33 NTUs for the six 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. The mean concentrations were below the standard at all sites (Figure 4). Based on past years' sampling results, turbidity can be elevated at times of increased flow – during a summer thunderstorm, or during spring runoff conditions – especially in the lower reaches of the river. An increasing trend in turbidity with distance downstream is generally observed during all flow conditions.

Phosphorus was detected at low to high concentrations during the six Spring and Summer sampling dates, ranging from <5 to 132 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 July, August, and September sample dates. Detected concentrations of phosphorus on these 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.

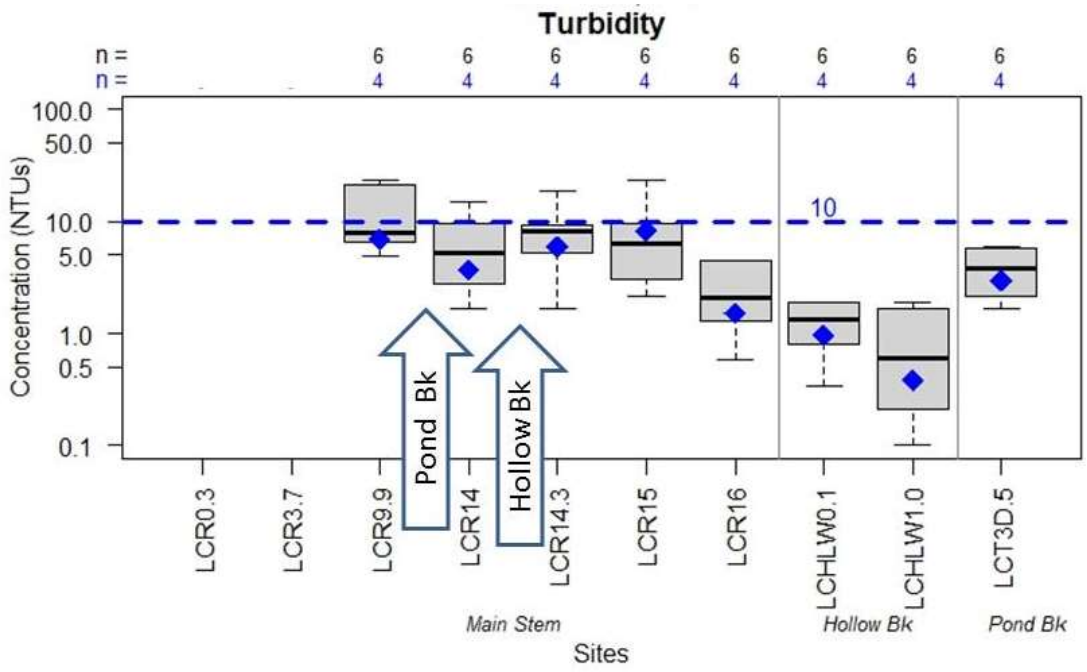


Figure 4. Summary of Turbidity results for Lewis Creek, 2018. The whiskers extend to the maximum and minimum values detected over six sampling events, while the gray-shaded box represents the middle 50% of values. The median value is marked by the dark horizontal line. The blue diamond marks the mean 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.

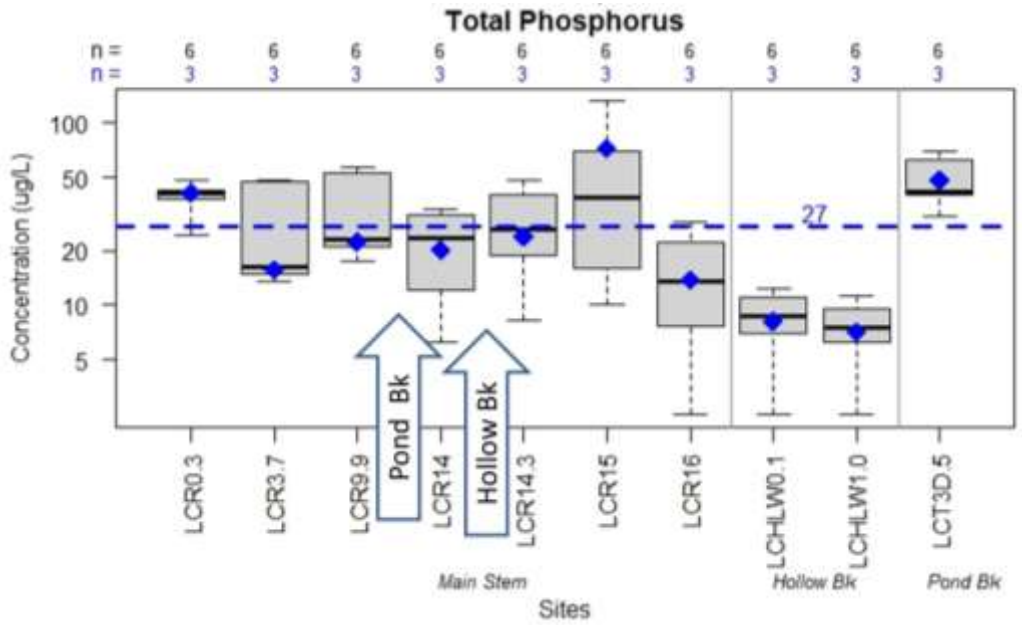


Figure 5. Summary of Total Phosphorus results for Lewis Creek, 2018. The whiskers extend to the maximum and minimum values detected over six sampling events, while the gray-shaded box represents the middle 50% of values. The median value is marked by the dark horizontal line. The blue diamond marks the mean of that subset of samples (n=3) collected during base-flow conditions at or below the Low Median Monthly Flow.

2019: Focus monitoring will continue in the Lewis Creek for a second year in 2019. The Collaborative will continue with bracket monitoring at stations in vicinity of the Tyler Bridge Road crossing to gain a better understanding of water quality patterns following livestock removal from the Creek as part of a farm transition that occurred in October 2018. Focus-monitoring results will inform ongoing municipal-level discussions and basin-planning efforts regarding water quality management and classification.

For more information, contact the Lewis Creek sampling coordinator:
Louis DuPont, 453 5538, ldupont@gmavt.net
Lewis Creek Association: Kate Kelly, lewiscreekorg@gmail.com
Addison County River Watch Collaborative: Matt Witten, 434 3236, mwitten@gmavt.net

Or, go to LewisCreek.org

Little Otter Creek – 2018 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 2018, sampling occurred on two spring dates (April 4 and May 2) and four summer dates (June 6, July 11, August 1, and September 5). The year was characterized by near-normal precipitation, overall. 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. The June event occurred during moderate-flow, baseflow conditions where river stage was not changing appreciably, and groundwater levels were relatively high following spring rains. The July, August, and September events coincided with low-flow, baseflow conditions, at or below the Low Median Monthly (LMM) flow.

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 mid-season request from the LaRosa Volunteer Monitoring program to reduce analytical costs, turbidity testing was suspended after the May event and *E.coli* was not tested in 2018.

Turbidity levels reported for the Little Otter Creek sentinel stations ranged from 13 to 32 NTUs during the two spring events. The Vermont water quality standard for cold-water fisheries is 10 NTUs. However, this standard is applicable only during dry-weather, baseflow conditions which were not relevant to these two sample dates. Based on historic results for additional stations, Turbidity can become elevated at times of increased flow – during a Summer thunderstorm, or during Spring runoff conditions. Turbidity values also tend to increase with distance downstream along the main stem of the river. The lower reaches of the Little Otter Creek drain regions underlain by fine-grained silt and clay soils derived from glacial lake deposits, which are easily eroded and transported by a range of flows.

Phosphorus was detected at low to high concentrations on the Little Otter Creek during the spring and summer sampling dates in 2018. Concentrations ranged from 53 to 803 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 July, August and September events took place when flows in the river were below the LMM. The mean phosphorus concentrations for these three summer sampling dates (126 and 381 µg/L) exceeded the instream nutrient standard of 27 µg/L at both sentinel stations (LOC4.3 and MDC1.2, respectively).

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

For more information, contact the Little Otter Creek sampling coordinator:
Deb Healey, 475-2944, lumiere@gmavt.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

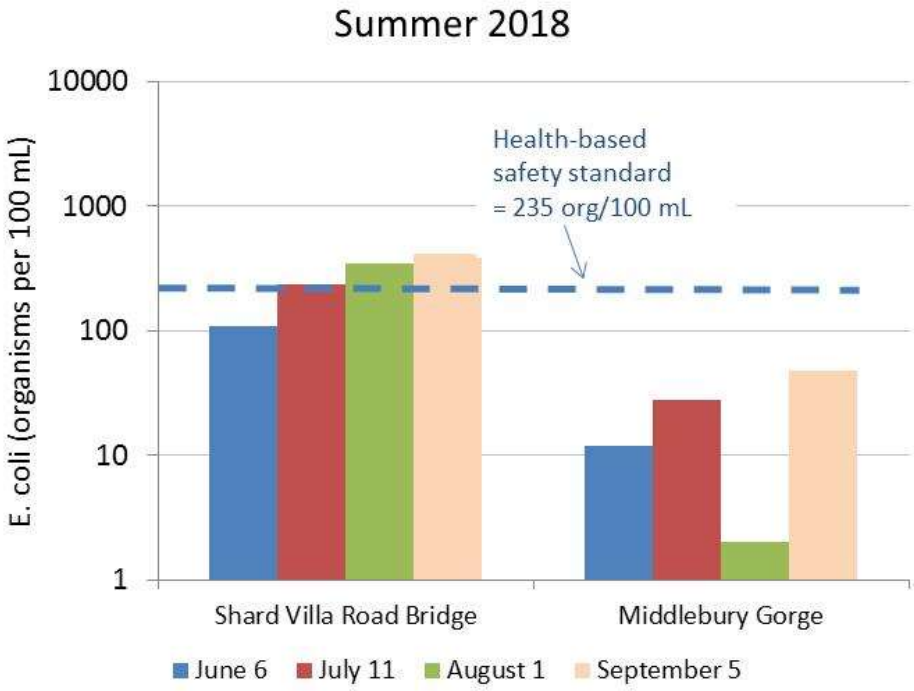
Middlebury River – 2018 Water Quality Summary
Addison County River Watch Collaborative

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 2018, sampling occurred on two spring dates (April 4 and May 2) and four summer dates (June 6, July 11, August 1, and September 5). The year was characterized by near-normal precipitation, overall. Based on streamflow gaging records from the nearby USGS streamflow gage on the New Haven River, April and May sampling events took place during high flow conditions resulting from snowmelt and spring rains. The June event occurred during moderate-flow, baseflow conditions where river stage was not changing appreciably, and groundwater levels were relatively high following spring rains. The July, August, and September events coincided with low-flow, baseflow conditions, at or below the Low Median Monthly (LMM) flow.

Samples were tested for *E.coli*, total phosphorus, and turbidity. Turbidity testing was suspended after April due to a mid-season 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 2.0 to 411 organisms/ 100 mL. 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 the Shard Villa Road Bridge site contained *E. coli* in excess of the 235 org/100 mL health-based standard during the July, August and September events. The geometric mean of values from this site exceeded the geometric mean standard of 126 org/100 mL. At the popular Middlebury Gorge swimming site (MIR5.7), *E.coli* values were below the health-based standard on all sample dates.

Based on previous years' monitoring results that include additional sites, *E.coli* counts 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.

Turbidity levels for the Middlebury River sentinel stations MIR1.5, MIR5.7 and MIR10.6, were reported at 5.0, 1.0 and 0.8 NTUs, respectively, during the April event. The Vermont water quality standard for cold-water fisheries is 10 NTUs. However, this standard is applicable only during dry-weather, baseflow conditions which were not encountered on this sample date. Based on past years' sampling results, turbidity can become elevated at times of increased flow – during a summer thunderstorm, or during spring runoff conditions - especially in the lower reaches of the river below the Route 7 bridge.

Phosphorus was detected at relatively low levels during the six spring and summer sampling dates of 2018. Concentrations ranged from <5 to 27 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 encountered during the July, August and September sample dates. Mean Total Phosphorus concentrations were below the instream phosphorus criterion during each sample date. Historic sampling results, which have included additional sites, show a gradually increasing trend in phosphorus concentrations with distance downstream from the Middlebury Gorge.

2019: 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 2019. An increased number of parameters and additional monitoring sites will be evaluated when a more intensive monitoring focus rotates back to the Middlebury River for a two-year period beginning in the year 2020. 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 – 2018 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 4 and May 2) and four summer dates (June 6, July 11, August 1, and September 5). The year was characterized by near-normal precipitation, overall. 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 Brooksville. The June event occurred during moderate-flow, baseflow conditions where river stage was not changing appreciably, and groundwater levels were relatively high following spring rains. The July, August, and September events coincided with low-flow, baseflow conditions, at or below the Low Median Monthly (LMM) flow.

Samples were tested for *E.coli*, total phosphorus, and turbidity. Turbidity testing was suspended after April due to a mid-season 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.

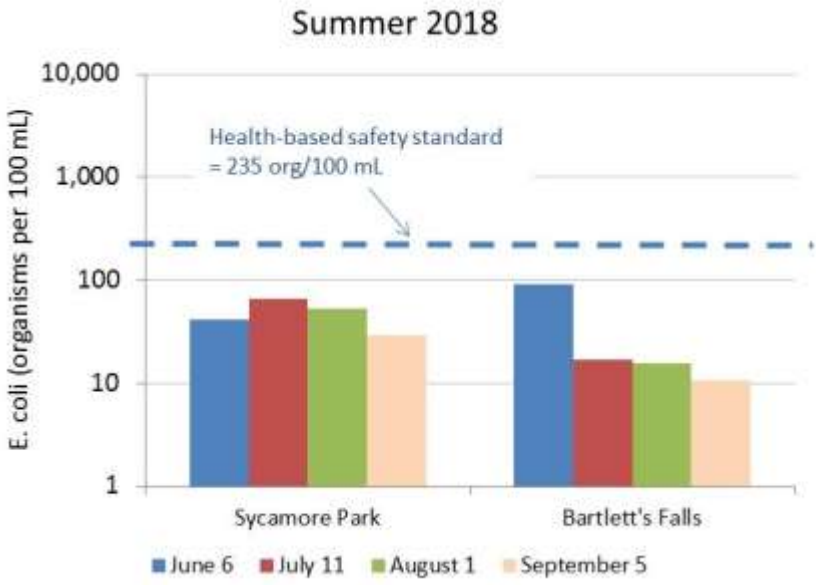


Figure 1. E.coli measured at recreation sites along the New Haven River main stem on four summer dates in 2018.

E.coli counts at the recreational sites ranged from 11 to 91 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 below this health-based standard on all summer dates (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 well below the geometric mean standard of 126 org/100 mL. 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.

Turbidity levels for the New Haven River sentinel stations, NHR2 and NHR9, were reported at 16 and 1.7 NTUs, respectively, during the April event. The Vermont water quality standard for cold-water fisheries is 10 NTUs. However, this standard is applicable only during dry-weather, baseflow conditions which were not encountered on this sample date. Based on past years' sampling results, turbidity can become elevated at times of increased flow – during a summer thunderstorm, or during spring runoff conditions.

Phosphorus levels at New Haven River sentinel stations ranged from <5 to 69 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 July, August and September events took place when flows in the river were below the LMM. The mean phosphorus concentrations for these three summer sampling dates (11 and 6.2 µg/L) were below the instream nutrient standard of 27 µg/L at both sentinel stations (NH2 and NHR9, respectively).

2019: The Addison County River Watch Collaborative will continue to monitor for *E.coli* and 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 2019. 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:
Richard Butz, 453-6052, butzra@yahoo.com
Addison County River Watch Collaborative managing director:
Matt Witten, 434-3236, mwitten@gmavt.net
or visit our web page at: www.acrpc.org/acrwc

Otter Creek – 2018 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 2018, sampling occurred on two spring dates (April 4 and May 2) and four summer dates (June 6, July 11, August 1, and September 5). The year was characterized by near-normal precipitation, overall. Flows in the Otter Creek were near normal for much of the year, but trended below normal for the months of June and July, given the warm summer temperatures and drier-than-average conditions encountered during these months. Discharge was at or below the 7-day, 10-year, low flow statistic for a few days in the Otter Creek in late July, but then rebounded to above-normal conditions in October and November in response to fall rains. April and May sampling events took place during high flow conditions resulting from snowmelt and spring rais. The June event occurred during moderate-flow, baseflow conditions where river stage was not changing appreciably, and groundwater levels were relatively high following spring rains. The July, August, and September events coincided with low-flow, baseflow conditions, at or below the Low Median Monthly (LMM) flow.

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 mid-season request from the LaRosa Volunteer Monitoring program to reduce analytical costs, turbidity testing was suspended after the May event and *E.coli* was not tested in 2018.

Turbidity levels reported for the Otter Creek sentinel stations ranged from 6.9 to 17 NTUs during the two spring events. The Vermont water quality standard for warm-water fisheries is 25 NTUs. However, this standard is applicable only during dry-weather, baseflow conditions which were not relevant to these two sample dates. Based on past years' sampling results, turbidity can become elevated at times of increased flow – during a summer thunderstorm, or during spring runoff conditions.

Phosphorus levels at Otter Creek stations ranged from 16 to 44 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 July, August and September events took place when flows in the river were below the LMM. The mean phosphorus concentrations for these three summer sampling dates (36 and 31 µg/L) exceeded the instream nutrient standard of 27 µg/L at both sentinel stations (OTR7.3 and OTR18, respectively).

2019: 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 2019. An increased number of parameters and additional monitoring sites will be evaluated when a more intensive monitoring focus rotates back to the Otter Creek for a two-year period beginning in the year 2020.

For more information, the Otter Creek 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