Summary Report: 2015 Sampling Results
Addison County River Watch Collaborative

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www.acrpc.org/acrwc

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1.0 Introduction

This report provides a brief summary of the 2015 sampling results for the Addison County River Watch Collaborative (ACRWC). Sampling was carried out by a network of volunteers, with logistical and technical support provided by Ethan Swift 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 LaRosa Analytical Laboratory in Burlington, VT, through an analytical services partnership grant.

The reader is referred to a series of water quality reports prepared by Dr. Bill Hoadley in 2009 for an analysis of historical water quality results in each of these watersheds. This summary report is intended to be a brief synopsis of the 2015 season, with reference to these more technical reports for historical context and trend analysis.

Section 6.0 provides a one-page summary of sampling results for each of the ACRWC watersheds. These summaries are formatted to serve as a one-page handout for each watershed that can be distributed to the public in relevant towns.

2.0 Background

The ACRWC has been monitoring water quality (including sediment, phosphorus, nitrates, and *E.coli*) in six watersheds in Addison County (Figure 1) for two 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)

During a hiatus from sampling in the 2009 season, the ACRWC conducted a programmatic review of their water quality monitoring goals and objectives, and met with various state and regional groups to identify opportunities for collaboration and data sharing. With input from Dr. Bill Hoadley (2009 Draft Water Quality Reports), historical sample results and trends were analyzed to refine the overall sampling design for each of these six watersheds, in light of updated goals and objectives.

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 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 to be combined with a more focused monitoring effort in two of the six watersheds that will rotate for a period of two years on and four years off (Table 1). The focused evaluation will involve a greater number of sites (and testing parameters) than the sentinel sites, and will be conducted to meet specific data needs of relevance to the chosen watershed.

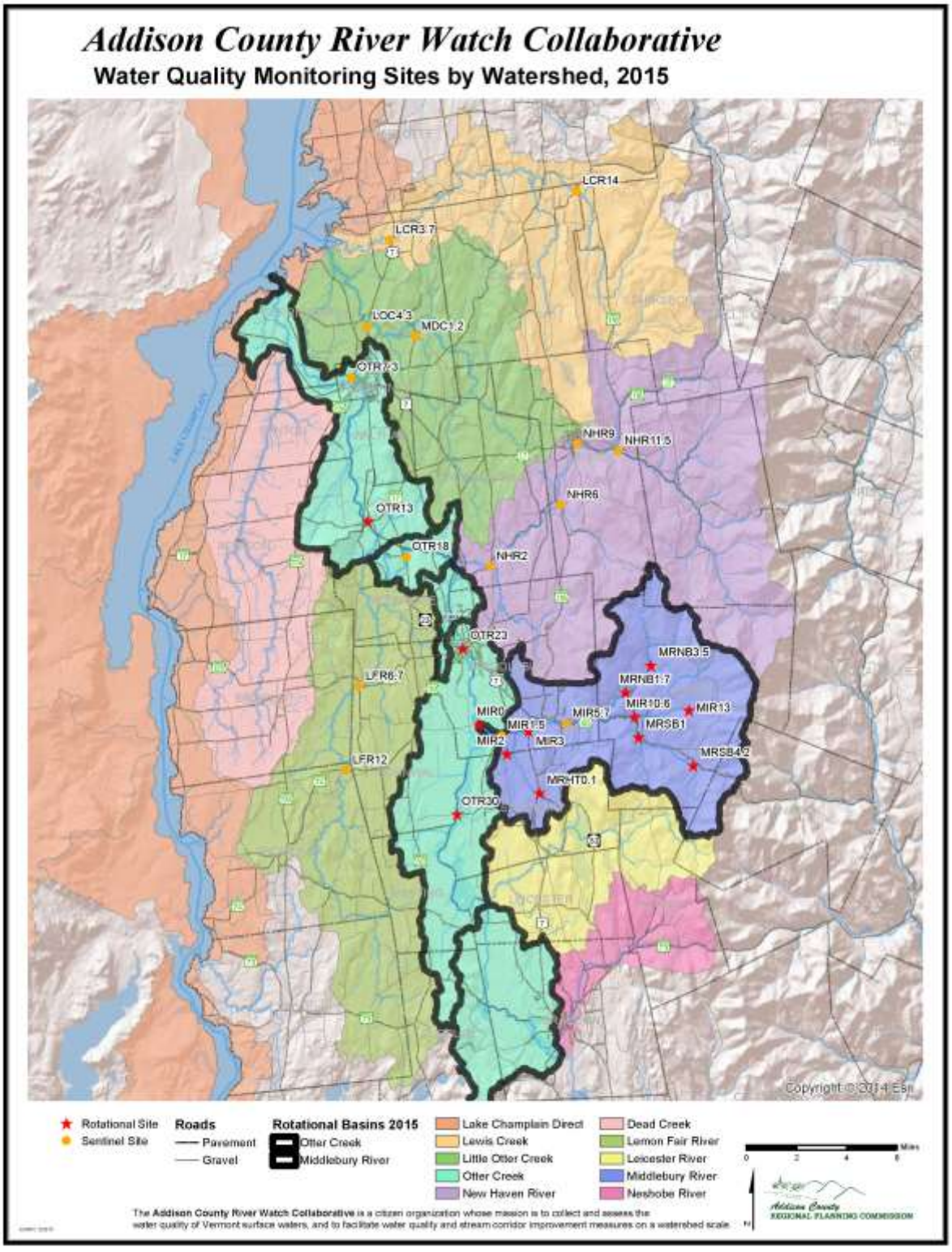
Addison County River Watch Collaborative
Water Quality Monitoring Sites by Watershed, 2015
LCR14
LCR3.7
LOC4.3
MDC1.2
OTR7.3
NHR9
NHR11.5
NHR6
OTR13
OTR18
NHR2
OTR23
MRNB3.5
MRNB1.7
LFR6.7
MIR10.6
MIR13
MIR0
MIR5.7
MIR1.5
MRSB1
MIR2
MIR3
LFR12
MRSB4.2
MRHT0.1
OTR30
Copyright © 2014 Esri
Rotational Site
Sentinel Site
Roads
Pavement
Gravel
Rotational Basins 2015
Otter Creek
Middlebury River
Lake Champlain Direct
Lewis Creek
Little Otter Creek
Otter Creek
New Haven River
Dead Creek
Lemon Fair River
Leicester River
Middlebury River
Neshobe River
Miles
0
2
4
6
Addison County
REGIONAL PLANNING COMMISSION
The Addison County River Watch Collaborative is a citizen organization whose mission is to collect and assess the water quality of Vermont surface waters, and to facilitate water quality and stream corridor improvement measures on a watershed scale.

Figure 1.

Table 1. Rotational Schedule for Focused Monitoring

2012 – 2013	2014 - 2015	2016 - 2017
Lewis Creek	Middlebury River	Little Otter Creek
Lemon Fair	Otter Creek	New Haven River

Beginning with the 2014 sampling season, Otter Creek and the Middlebury 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. Table 2 displays the schedule of sampling sites and parameters for the 2015 season; "R" denotes a rotational site, "S" for a sentinel site. A slightly different schedule of sampling parameters is indicated for Spring versus Summer months – i.e., *E. coli* and Alkalinity were added to the list for Summer events.

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 2015 sampling data was submitted under separate cover. Samples were delivered to the LaRosa Analytical Laboratory housed in the Hills Building in the University of Vermont campus in Burlington, Vermont.

During 2015, ACRWC volunteers collected grab samples in these six watersheds at 25 sites during two Spring events (April and May) and at 27 sites during four Summer events (June, July, August and September). Sampling dates were pre-determined as the first Wednesday of each month, and were not designed to capture any specific flow condition:

- April 8 (postponed from April 1 due to persistent ice cover)
- May 6
- June 3
- July 1
- August 5
- September 2

Table 2. 2015 Schedule of Sites / Parameters – Spring and Summer

Project Name: Addison County River Watch Collaborative

Project Number: **137-01**

Sample Year: **2015**

				Spring Schedule (Apr, May)					Summer Schedule (Jun, Jul, Aug, Sep)						
				PARAMETERS											
Type	**River Name**	**Site ID**	**Site Location**	**TP**	**DP**	**TN**	**Turbidity**	**TSS**	***E.coli***	***ALK***	**TP**	**DP**	**TN**	**Turbidity**	**TSS**
S	Lewis Creek	LCR3.7	Old Route 7 Bridge	X			X		X		X			X	
S	Lewis Creek	LCR14	Tyler Bridge	X			X		X		X			X	
S	Lemon Fair River	LFR6.7	Route 125 bridge.	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
S	Little Otter Creek	LOC4.3	Route 7 Bridge	X	X		X	X	X		X	X		X	X
S	Mud Creek	MDC1.2	Wing Rd./Middlebrook Rd. (South)	X	X		X	X	X		X	X		X	X
R	Middlebury River	MIR0	Mouth of Middlebury River	X		X	X		X		X		X	X	
S	Middlebury River	MIR1.5	Shard Villa Road Bridge	X		X	X		X		X		X	X	
R	Middlebury River	MIR2	Blake Roy Road Bridge	X		X	X		X		X		X	X	
R	Middlebury River	MIR3	Route 7 Access	X		X	X		X		X		X	X	
S	Middlebury River	MIR5.7	Midd. Gorge @ Rte 125 Bridge	X		X	X		X		X		X	X	
R	North Branch MR	MRNB1.7	Dugway Road Bridge	X			X		X	X	X			X	
R	North Branch MR	MRNB3.5	Norton Farm Rd Bridge	X			X		X	X	X			X	
R	Middlebury River (Midd Br)	MIR10.6	Natural Turnpike Road	X			X		X	X	X			X	
R	Middlebury River (Midd Br)	MIR13	Wagon Wheel Rd Bridge	X			X		X	X	X			X	
R	South Branch MR	MRSB1	Goshen Road Bridge	X			X		X	X	X			X	
R	South Branch MR	MRSB4.2	Brook Road Bridge	X			X		X	X	X			X	
R	Halnon Brook MR	MRHT0.1	Upstream of Route 7 crossing	X			X		X	X	X			X	
S	New Haven River	NHR2	Muddy Branch confluence (just below)	X			X		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		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	X		X		X	X	X	X	
R	Otter Creek	OTR13	Route 17 Bridge	X	X	X	X		X		X	X	X	X	
S	Otter Creek	OTR18	Twin Bridges Picnic Area	X	X	X	X		X		X	X	X	X	
R	Otter Creek	OTR23	Frog Hollow	X	X	X	X		X		X	X	X	X	
R	Otter Creek	OTR30	Swamp Road Bridge	X	X	X	X		X		X	X	X	X	
			Total # sites per event	25	9	10	25	4	27	7	25	9	10	25	4

Site Types: R = Rotational; S = Sentinel; O = Other (special project).

4.0 Precipitation Data

Precipitation data were compiled from existing weather stations in vicinity of the ACRWC watersheds (Table B-1). Overall, calendar year 2015 was a near-normal precipitation year, as recorded at regional weather stations in South Burlington (Airport) and Rutland. In general, June and July saw greater than normal precipitation, while August and November were below normal. Snowfall in the winter of 2014–2015 was near normal at the Burlington airport and somewhat above normal at the Rutland station (Table B-2). Weather records at the South Lincoln station were incomplete.

5.0 Hydrologic Data

Flow data were compiled from available USGS gaging stations in vicinity of the ACRWC watersheds. Four of the six watersheds sampled by the ACRWC have USGS gaging stations which record instantaneous flow at fifteen minute intervals. Gages on Lewis Creek, Little Otter Creek, and New Haven River are near the downstream end of the main stem. A nearby gage on Otter Creek (at Middlebury) is located mid-basin, recording conditions at 66.5 % of this 944 square mile basin.

Flow records are available for the past 25 years at Little Otter Creek, New Haven River, and Lewis Creek gaging stations. Mean annual flows recorded at these stations over that time period are summarized in Table 5, along with data from the Otter Creek at Middlebury station. Data are summarized by water year – which begins October 1st of the previous calendar year and extends through September 30th of the indicated year. Based on 25 years of record, mean annual flows in these ACRWC watersheds for water year 2015 were near normal.

Table 5. Mean Annual Flows, 1991 – 2015, ACRWC watersheds.

Watershed	Little Otter Creek		New Haven River		Lewis Creek		Otter Creek at Middlebury	
Drainage Area (sq mi)		73		116		81		944
Gaged Area (sq mi)		57.1		115		77.2		628
Min (1991-2015)	*2002*	27	*1995*	129	*1995*	54	*1995*	672
Max (1991-2015)	*2011*	145	*2011*	378	*2011*	214	*2011*	1912
Mean (1991-2015)		**N/A**		**N/A**		**109**		**N/A**
Water Year 2015		**N/A**		**N/A**		**117**		**N/A**

Source: USGS, 2016, on-line surface water data, <http://waterdata.usgs.gov/vt/nwis>.
Note: As of 2/29/2016, water year 2015 MAF data were unavailable for highlighted watersheds.

Appendix B presents graphs of the instantaneous discharge record (provisional data) from calendar year 2015 for USGS flow gaging stations on the New Haven River, Lewis Creek, Little Otter Creek, and the Otter Creek at Middlebury stations. While the mean annual flows in these watersheds were near normal in 2015, monthly flows were somewhat above normal for much of June and July and below normal in August, September, October and November.

Peak flows for water year 2015 were associated with the higher-than-normal rains in June. (June had the 3rd highest rainfall on record for the National Weather Service station at Burlington airport). Flows in the New Haven River, Lewis Creek and Little Otter Creek were near the estimated 2-year storm magnitude (Olson, 2014) at each gaging station on June 1 or June 2, associated with wide-spread rains. On June 9 and 10, more than 2 inches of rain fell on saturated ground in northern Addison, Chittenden and Lamoille Counties. The Lewis Creek experienced a peak flow above the estimated 5-year magnitude. This same event led to a second 2-year storm event in Little Otter Creek by June 10.

Flows in these four rivers reached their lowest point for the year in September and spent most of the month below the Low Median Monthly flow. Flows in Little Otter Creek approached the 7-day 10-year low flow stage, while flows in the Otter Creek measured at Middlebury dropped below the 7Q10 for multiple days in mid to late September.

Table B-3 presents a summary of flow conditions for each sample date following VTDEC *Guidance on Streamflow Observations at time of Water Quality Sampling of Rivers and Streams*. A flow duration curve is also presented in Appendix B for each gaged watershed based on daily mean flows recorded over 25 years from water years 1991 through 2014. High flow levels and a "Freshet" flow category were encountered in each watershed on April 8 (associated with snow melt and spring runoff) and on June 3 and July 1 (associated with rainfall from summer storm events falling on saturated ground). High flows levels are defined as those flow conditions which are equaled or exceeded only 25% of the time. The May 6 sample event represented moderate flow levels (equaled or exceeded between 25 and 75% of the time) in all four gaged watershed, exhibiting base-flow characteristics (i.e., relatively stable flow stage, not significantly rising or falling in response to a rainfall or snowmelt event). The August 5 sample event represented moderate flow levels in all gaged watersheds, except for Otter Creek. Flows in New Haven River, Lewis Creek and Little Otter Creek were receding from an earlier Aug 4/5 peak in response to a series of isolated, thunderstorms in previous days. The hydrograph in Otter Creek did not appear to respond significantly above Low-Baseflow conditions to these same events or contributions from these watersheds. The September 2 sampling event coincided with low flow levels (equaled or exceeded more than 75% of the time) which exhibited base-flow characteristics

6.0 Sample Results

Appendix C contains quality-assured sample results for the 2015 season for the ACRWC watersheds. Attachments 1 through 6 summarize these results on a single page for each watershed. These attachments have been designed to serve as a handout for use in future outreach events to watershed stakeholders and relevant town boards. As discussed in Section 2.0, the Middlebury River and the lower Otter Creek were chosen as focus watersheds for 2015. Therefore, sample results are presented for sentinel as well as rotational sites in these watersheds.

The Vermont Agency of Natural Resources (VTANR) updated the Vermont Water Quality Criteria, effective October 2014. There is now a revised standard for *E.coli* "for the protection of waters for swimming for consistency with the U.S. Environmental Protection Agency's (EPA) guidance under Section 304(a) of the federal Clean Water Act (CWA)" (VWMD, 2014). A new standard has been approved for phosphorus in wadeable streams "to comply with EPA's National Strategy for the Development of Regional Nutrient Criteria promulgated under Section 304(a) of the CWA" (VWMD, 2014). The turbidity standard was clarified to apply to "an annual average under dry weather base-flow conditions" (VWMD, 2014). In the past the Collaborative has made reference to proposed nutrient criteria and proposed standards for nitrogen (VTWQD, 2009) – but these have been eliminated from recent updates to the VT water quality standards (see Technical Support documentation). Updated water quality standards relevant to each watershed are detailed in the footnotes in Appendix C.

In general, water quality results for 2015 were consistent with historic results and trends summarized in the 2009 Draft Water Quality Reports for each watershed (Hoadley, 2009). *E.coli* counts in each river exceeded the VT Water Quality Standard (VWQS) of 235 organisms/ 100 mL at one or more stations during one or more summer sampling dates. Generally, elevated *E.coli* detections were associated with developed land uses including nearby agriculture and livestock with direct access to the river. Wildlife sources of *E.coli* also exist in these rivers, including beaver, deer, and waterfowl. Some of the region's popular swimming sites had one or more detections of *E. coli* above the standard this past summer, including Nash Bridge on the New Haven River (NHR2), Blake Roy Rd bridge on the Middlebury River (MIR2), and Tyler Bridge Rd on Lewis Creek (LCR14). Highest *E.coli* counts tended to be associated with the Moderate-flow sampling event of August 5, on the receding limb of isolated summer thunderstorms and during the High-flow sampling event of June 3 as flows were receding from a bankfull event. However, *E.coli* can also be elevated during low flows –as was apparent at select stations on the Lemon Fair (LFR6.7) and lower Middlebury River (MIR2, MIR1.5, MIR0) during Baseflow conditions on September 2. The Vermont Agency of Natural Resources has published EPA-approved Total Maximum Daily Load (TMDL) plans for the Lewis Creek (and Pond Brook), Little Otter Creek, Middlebury River, and Otter Creek (VTDEC, 2011). These TMDL plans include recommendations for further assessment and mitigation of *E.coli* sources in these waters. In 2015, ACRWC began posting monthly provisional *E.coli* results at popular recreation sites on the New Haven River, using funding from a Maple Run grant and volunteer services. These physical postings at existing kiosks in four Bristol town parks (Eagle Park, Bartlett's Falls, Saunders River Access and Sycamore Park) were supplementary to notices posted

electronically on Front Porch Forum. In 2016, posting will be expanded to seven additional recreation sites on the Middlebury River, Lewis Creek and Otter Creek.

Turbidity concentrations in the ACRWC watersheds vary, in part depending on geologic setting and flow stage. In the mountainous watersheds of Lewis Creek, Middlebury River, and New Haven River (shaded yellow in Table A-1), turbidity tends to become elevated during high flows – such as occurred during the June 3 and July 1 storm events and the April 8 snow melt event in these watersheds. The water quality standard in these cold-water Class B streams is 10 NTUs, but is applicable only under dry weather base-flow conditions (WMD, 2014). On the two sampling dates that could be classified as base-flow conditions (May 6 and September 2), average turbidity concentrations did not exceed the standard of 10 NTUs in these watersheds, except at the new Middlebury River station on Halnon Brook (MRHT0.3). In the valley watersheds (Little Otter Creek and Lemon Fair, shaded light blue in Table A-1), the turbidity standard (10 NTUs for the designated cold-water fishery of Little Otter and 25 NTUs for the warm-water fishery of Lemon Fair) tends to be exceeded on a more frequent basis. During base-flow sampling events in 2015, turbidity at both sentinel stations in Lemon Fair and the Little Otter Creek exceeded the standard (except for LOC station on Mud Creek, MCD1.2 on May 6) . As noted in Table A-1 the valley watersheds have a much higher percentage of silt / clay soils derived from glacial lake sediments, which contributes to the higher turbidity in these rivers. The Otter Creek represents a mixed water with contributions from both the mountainous and valley watersheds. During 2015 base-flow events, the turbidity standard (25 NTUs) at the sentinel and rotational stations on Otter Creek was not exceeded. While the turbidity standard is intended to be applied at base-flow conditions only, elevated turbidity at other times of the year during high-flow conditions is a concern due to aesthetics, water clarity, and nutrient loading associated with fine sediments carried in suspension.

Nitrogen was monitored in two of the Addison County watersheds in 2015: Middlebury River and Otter Creek. Values were relatively low – ranging from 0.24 to 1.04 mg/L . A past standard for nitrogen as nitrate (5 mg/L) was eliminated during the 2014 update of the Vermont Water Quality Standards.

Phosphorus is monitored in the Addison County watersheds with respect to two main objectives. First, total phosphorus concentrations are compared to newly-adopted instream nutrient standards (VWMD, 2014) to identify potential impacts to Aquatic Life Support and Aesthetics uses of these waters. Elevated phosphorus can lead to enhanced algae production and other changes in water quality that reduce the river's capacity to support macroinvertebrates, fish and other aquatic organisms. These changes also have the potential to impact aesthetics and recreational uses of these waters. VTANR recommends that the mean phosphorus concentration of at least three samples collected at low median monthly (LMM) flow on non-consecutive days from June through October be compared to the relevant proposed phosphorus standard[1]. Only one of the Summer sampling events from 2015 could be

[1] Within this context, VTANR defines low flow as the median monthly flow for that month having the lowest median monthly (LMM) flow. LMM flows for ACRWC watersheds have been calculated by Blaine Hastings of VTANR and are presented in Table B-3. This definition differs somewhat from the "Low Flows" presented in the context of a Flow Duration Curve (i.e., flow conditions which are exceeded more than 75% of the time).

classified as low flow near the LMM value: September 2 (see Table B-3). Total phosphorus concentrations for this low-flow date exceeded the standard of 27 ug/L for the warm-water medium gradient (WWMG) wadeable stream ecotype for a Class B waters at the following stations:

- both sentinel stations of Lemon Fair and Little Otter Creek;
- the new station on Halnon Brook, tributary to Middlebury River (MRHT0.3); and
- a sentinel station of the Otter Creek (OTR7.3).

A second reason to monitor for phosphorus at the subwatershed level in Addison County watersheds is to evaluate relative contributions of phosphorus to Lake Champlain. Each of the watersheds monitored by the Collaborative 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. In 2010 and 2011, the Collaborative carried out a flow / loading study in the Little Otter Creek through its member organization and fiscal agent, Lewis Creek Association. A similar study was completed by Lewis Creek Association in 2012 on the Pond Brook tributary of Lewis Creek. Results are reported separately and are available at www.lewiscreek.org.

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 phosphorus 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.

7.0 References

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NOAA Online Weather Data: Daily Almanac accessed in January 2016 at: http://www.weather.gov/climate/xmacis.php?wfo=btv

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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, 2014. *Vermont Water Quality Standards*. Effective 30 October 2014. Montpelier, VT. http://www.watershedmanagement.vt.gov/rulemaking/docs/wrprules/wsmd_wqs2014.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.

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*	2010	2.41	2.13	2.85	3.08	1.52	5.87	2.25	3.51	4.17	6.24	3.10	3.60	40.73
20 miles N	*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
	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
	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
South Lincoln, VT	*1*	1971-2000	2.92	2.10	3.14	4.20	4.31	4.58	4.24	5.22	4.44	4.39	3.98	3.13	46.65
	2	1981-2010	2.81	2.27	3.12	3.71	4.24	4.75	4.83	5.11	4.13	5.02	3.99	3.41	47.39
1,370 ft amsl	*2*	2010	2.88	3.69	4.65	4.17	2.21	7.50	7.18	5.61	3.36	11.56	2.13	3.08	58.02
13.6 miles SE	*2*	2011	1.26	2.04	4.04	1.23	3.95	1.22	2.06	10.71	1.66	1.09	2.19	2.83	34.28
	2	2012	2.19	0.83	1.90	3.64	6.29	3.12	2.88	4.77	4.94	7.02	1.38	3.92	42.88
	2	2013	1.79	1.44	2.78	2.40	6.33	9.90	8.02	5.54	4.47	2.86	4.15	3.75	53.43
	2	2014	3.63	3.31	3.29	3.54	4.84	4.15	6.08	3.31	2.13	M	M	5.04	46.12
	2	2015	2.49	1.45	1.29	2.02	4.24	9.43	5.45	2.21	4.89	3.95	2.33	4.31	44.06
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*	2010	2.22	2.83	4.69	3.04	2.87	3.00	5.35	4.14	1.95	9.76	2.28	3.66	45.79
40 miles SSE	*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
	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	M	M

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, http://www.weather.gov/climate/index.php?wfo=btv

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

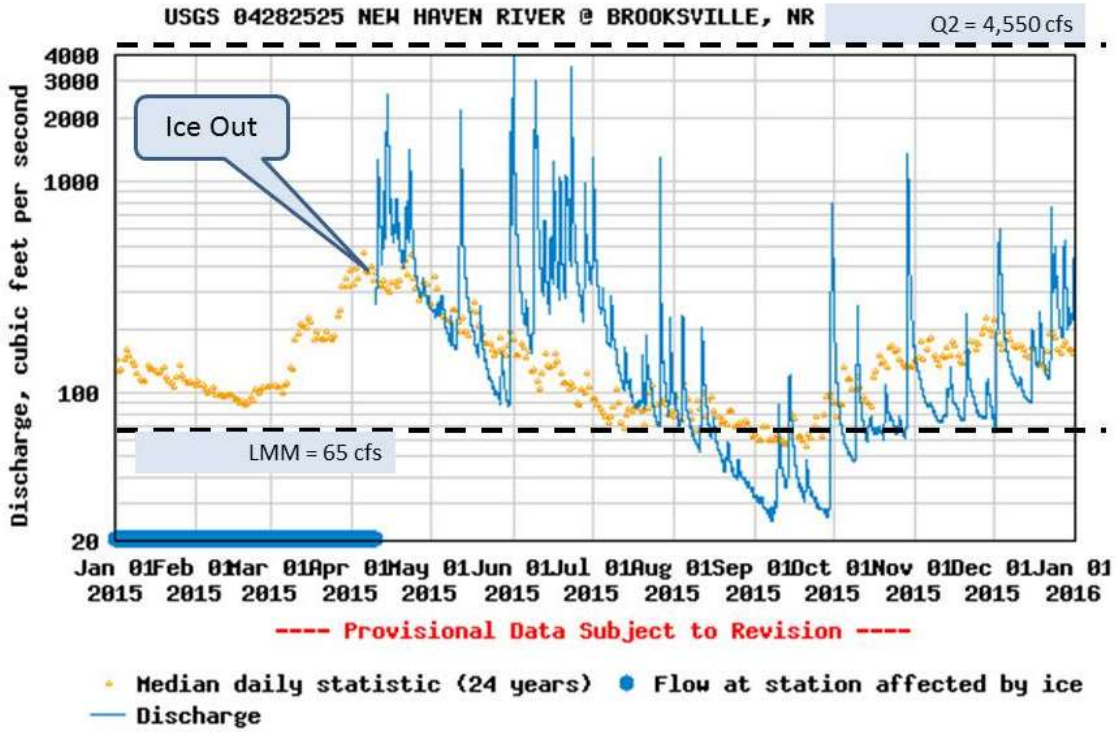
	Time Period	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Season
So. Burlington, VT	1971-2000	0.0	0.0	0.0	0.3	7.2	17.1	20.9	15.3	15.4	5.8	0.0	0.0	81.9
	1981-2011	0.0	0.0	0.0	0.3	5.1	19.1	21.9	16.9	15.6	4.6	0.0	0.0	83.6
(Airport)	2009-2010	0.0	0.0	0.0	0.0	0.0	17.7	48.4	24.0	0.9	5.5	0.0	0.0	96.5
	2010-2011	0.0	0.0	0.0	0.1	0.3	27.9	26.9	43.1	29.3	0.8	0.0	0.0	128.4
	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
South Lincoln, VT	1981-2000	0.0	0.0	0.0	2.2	13.9	26.9	29.6	22.8	24.5	10.5	0.7	0.0	131.1
	1981-2011	0.0	0.0	0.0	2.3	11.4	28.6	27.3	24.0	21.5	9.4	0.6	0.0	125.0
	2009-2010	0.0	0.0	0.0	0.1	1.1	26.0	22.5	33.0	3.2	10.0	1.0	0.0	96.9
	2010-2011	0.0	0.0	0.0	2.2	4.0	39.5	42.3	40.2	26.2	1.8	0.0	0.0	156.2
	2011-2012	0.0	0.0	0.0	2.4	4.9	24.3	18.4	12.0	11.6	0.0	0.0	0.0	73.6
	2012-2013	0.0	0.0	0.0	0.0	4.8	25.8	14.4	11.9	21.3	1.3	0.0	0.0	79.5
	2013-2014	0.0	0.0	0.0	0.7	M	15.8	17.2	M	30.1	Tr	0.0	0.0	M
	2014-2015	0.0	0.0	0.0	M	M	27.3	M	M	8.9	M	0.0	0.0	M
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
	2009-2010	0.0	0.0	0.0	0.0	0.0	18.2	15.9	19.9	0.1	2.1	0.0	0.0	56.2
	2010-2011	0.0	0.0	0.0	0.0	0.9	21.3	26.8	37.2	14.6	0.9	0.0	0.0	101.7
	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

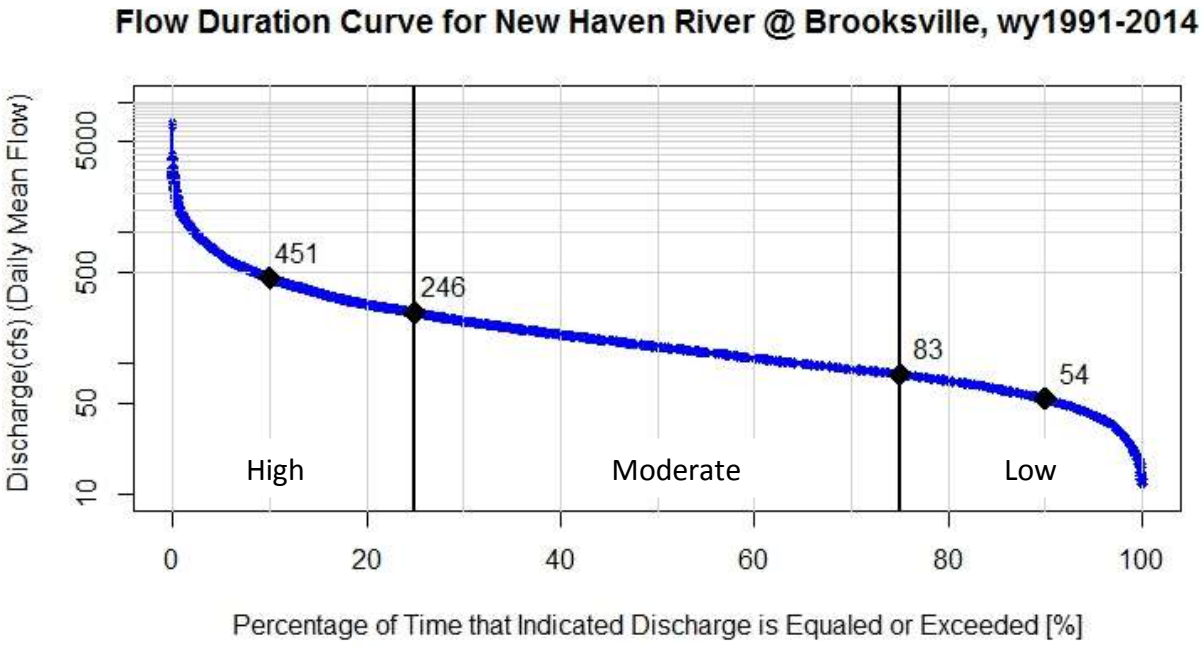
Total snowfall in inches. Values for 1971-2000 and 1981-2011 periods reflect averages for the time period. Values for seasons are totals.
Source: http://www.weather.gov/climate/xmacis.php?wfo=btv data available as of Jan 2016
Tr = Trace; M - Missing data

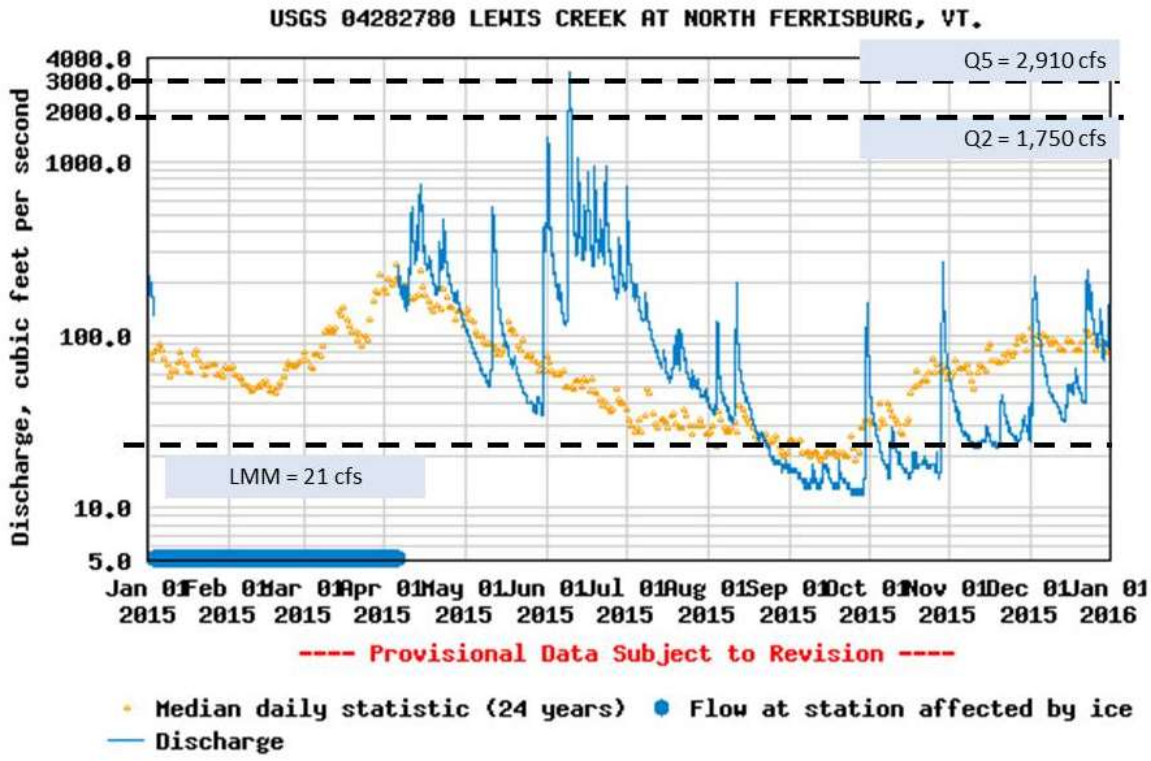
Table B-3. 2015 Flows recorded in Addison County rivers on sample dates, with reference to estimated peak flows and low median monthly flows.

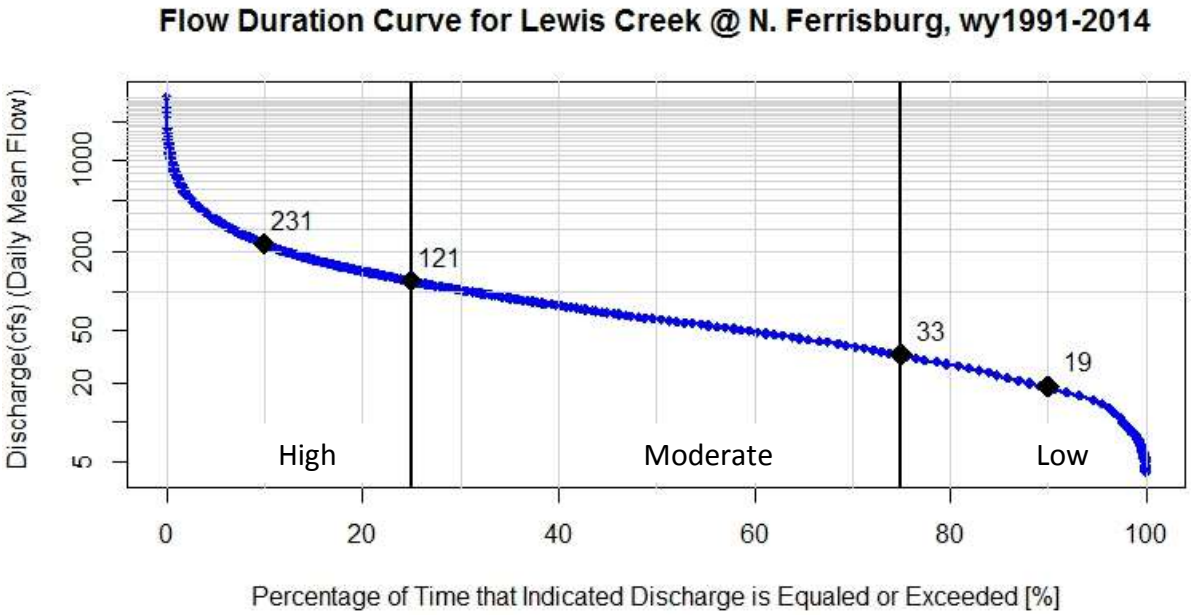
	River	Little Otter Ck		Lewis Creek		New Haven River		Otter Ck MB	
	USGS Gage #	#04282650		#04282780		#04282525		#04282500	
	Drainage Area (sq mi)	57.1		77.4		115		630	
Sample Dates	4/8/2015	119	H-FF	176	H-FF	Ice (~500)	H-FF	2,080	H-FF
(Daily Mean Flows)	5/6/2015	24	M-BF	70	M-BF	223	M-BF	1,590	M-BF
(cfs)	6/3/2015	594	H-FF	293	H-FF	412	H-FF	1,870	H-FF
	7/1/2015	187	H-FF	363	H-FF	663	H-FF	2,330	H-FF
	8/5/2015	15	M-FF	77	M-FF	128	M-FF	374	L-BF
	9/2/2015	3.2	L-BF	16	L-BF	31	L-BF	175	L-BF
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 Flows (Blaine Hastings, VWMD)		6.6		21.2		65.0		325	

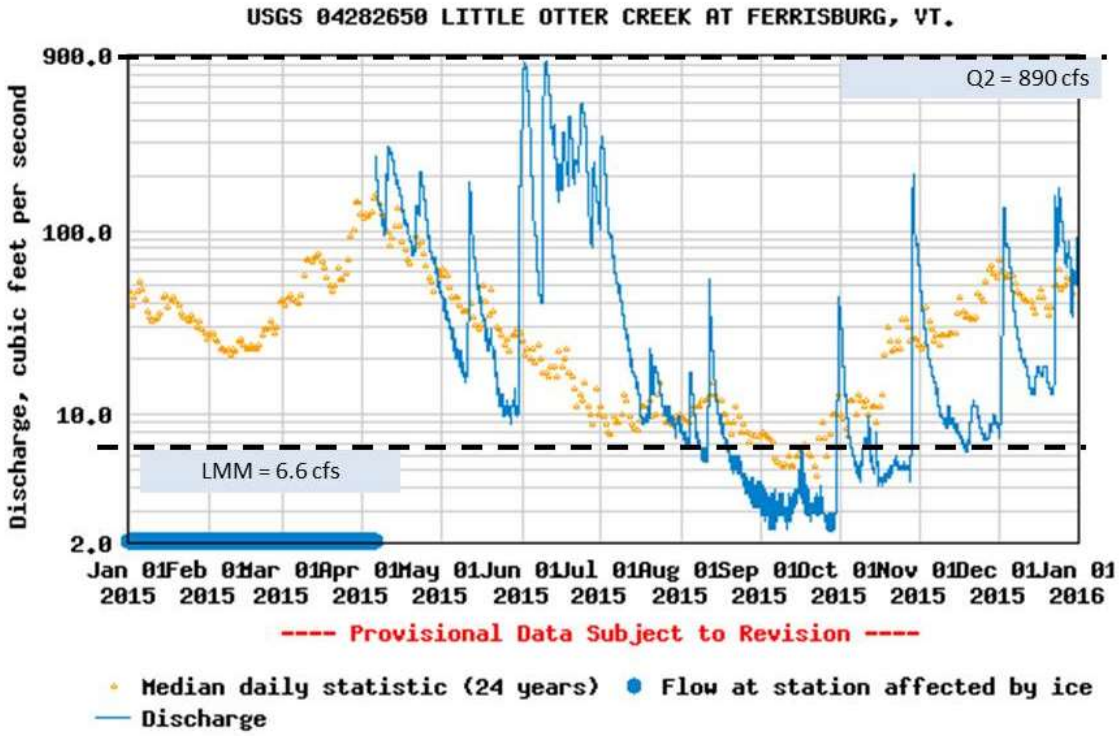
Abbreviations: Flow condition follows VTDEC Guidance:
Flow Level: Fd - Flood (>bankfull flow), H - High (>p.75), M - Moderate (>p.25 ≤p.75), L - Low (≤ p.25), where p = percentile
Flow Category: BF - Base Flow, FF - Freshet Flow, HF - Hydro Flow

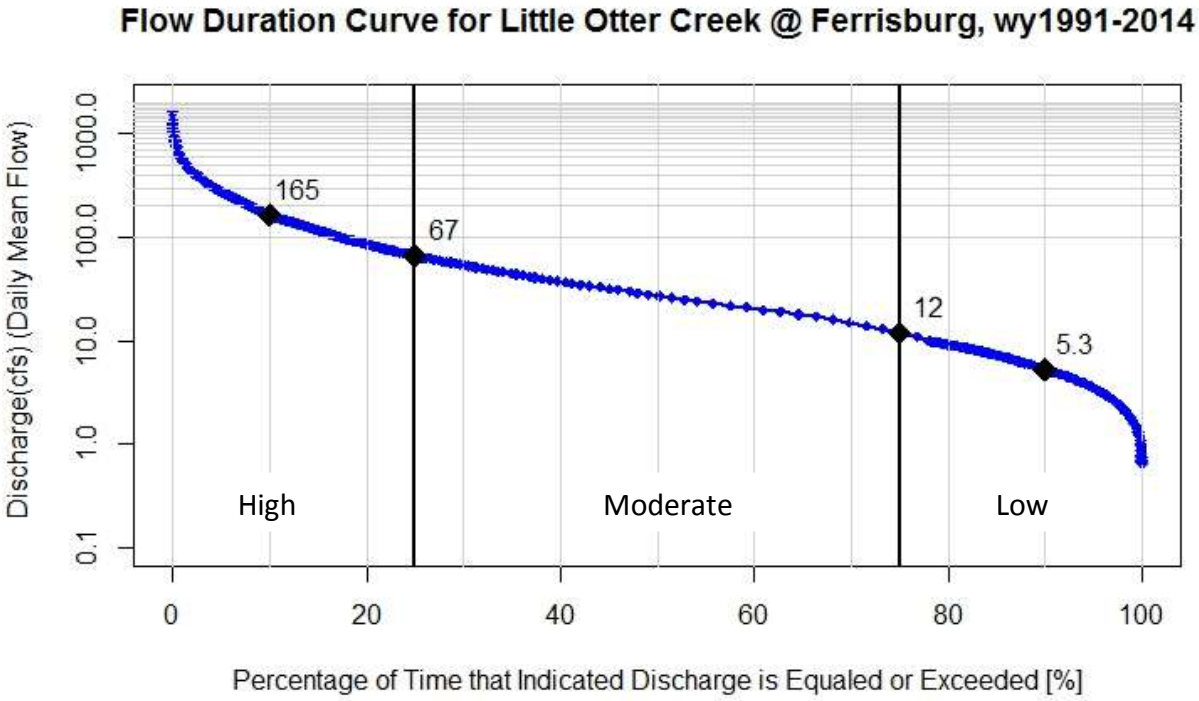

USGS 04282525 NEW HAVEN RIVER @ BROOKSVILLE, NR
Q2 = 4,550 cfs
Ice Out
LMM = 65 cfs
Discharge, cubic feet per second
4000
3000
2000
1000
100
20
Jan 01 2015
Feb 01 2015
Mar 01 2015
Apr 01 2015
May 01 2015
Jun 01 2015
Jul 01 2015
Aug 01 2015
Sep 01 2015
Oct 01 2015
Nov 01 2015
Dec 01 2015
Jan 01 2016
---- Provisional Data Subject to Revision ----
Median daily statistic (24 years)
Flow at station affected by ice
Discharge

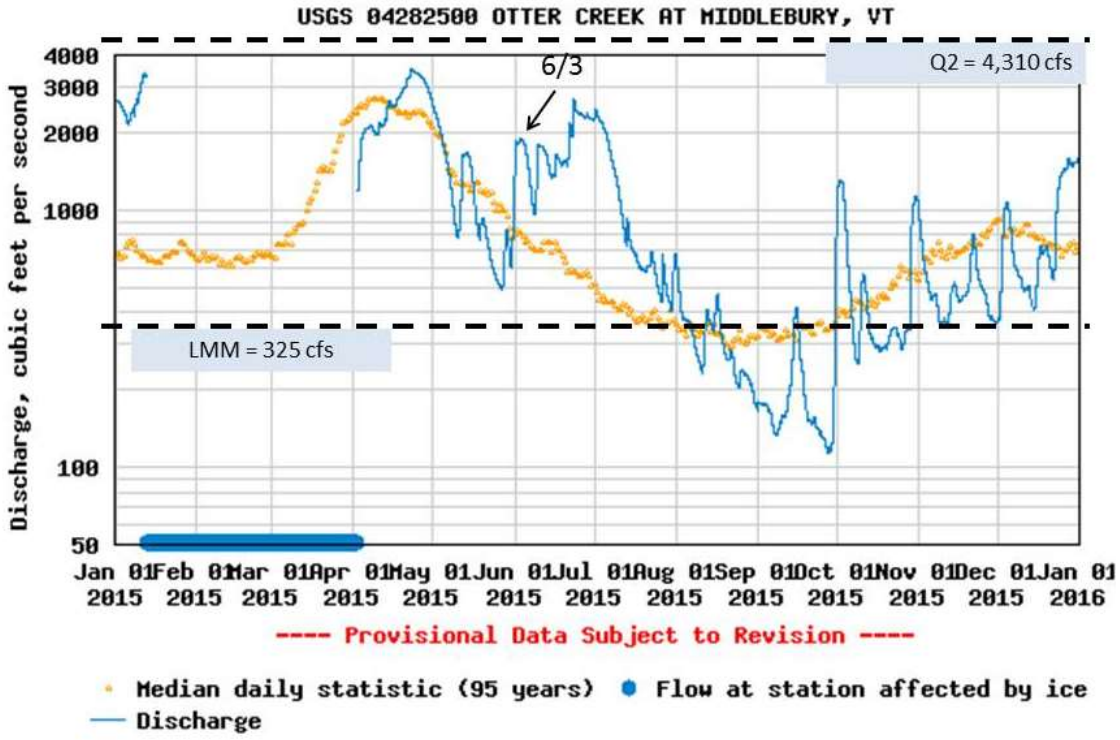

Flow Duration Curve for New Haven River @ Brooksville, wy1991-2014
Discharge(cfs) (Daily Mean Flow)
5000
500
50
10
451
246
83
54
High
Moderate
Low
0
20
40
60
80
100
Percentage of Time that Indicated Discharge is Equaled or Exceeded [%]

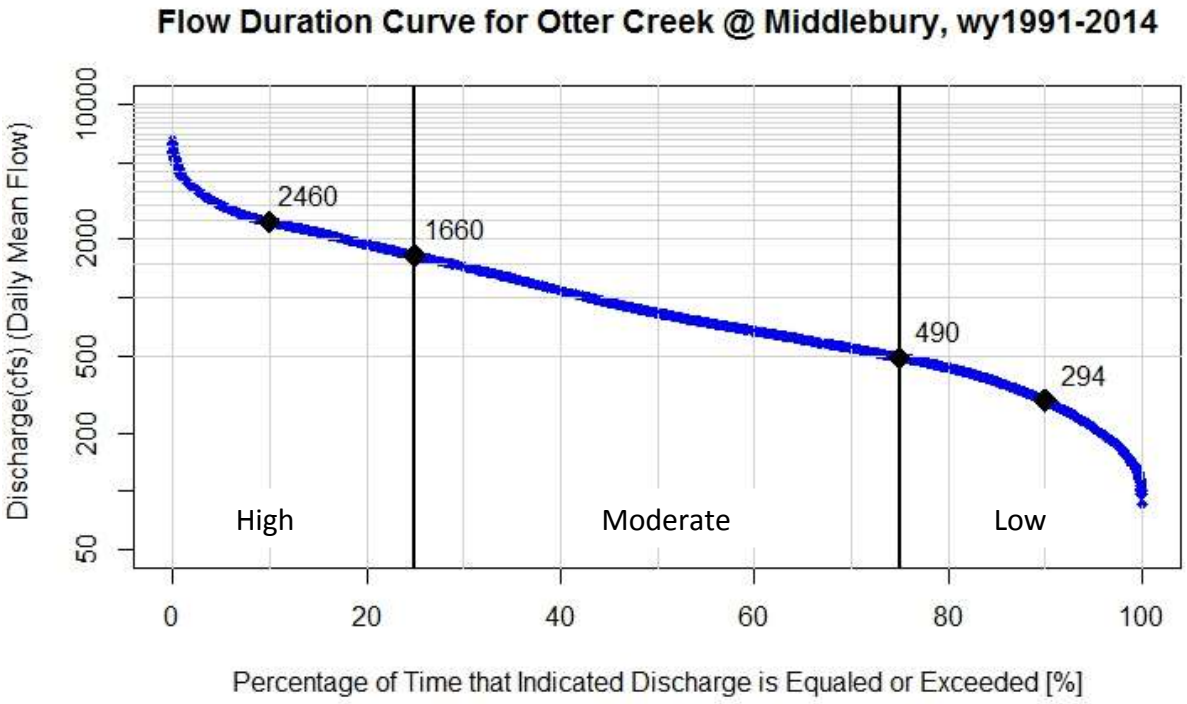

USGS 04282780 LEWIS CREEK AT NORTH FERRISBURG, VT.
Discharge, cubic feet per second
4000.0
3000.0
2000.0
1000.0
100.0
10.0
5.0
Q5 = 2,910 cfs
Q2 = 1,750 cfs
LMM = 21 cfs
Jan 01 2015
Feb 01 2015
Mar 01 2015
Apr 01 2015
May 01 2015
Jun 01 2015
Jul 01 2015
Aug 01 2015
Sep 01 2015
Oct 01 2015
Nov 01 2015
Dec 01 2015
Jan 01 2016
---- Provisional Data Subject to Revision ----
Median daily statistic (24 years)
Flow at station affected by ice
Discharge


Flow Duration Curve for Lewis Creek @ N. Ferrisburg, wy1991-2014
Discharge(cfs) (Daily Mean Flow)
5
20
50
200
1000
231
121
33
19
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
2.0
Q2 = 890 cfs
LMM = 6.6 cfs
Jan 01 2015
Feb 01 2015
Mar 01 2015
Apr 01 2015
May 01 2015
Jun 01 2015
Jul 01 2015
Aug 01 2015
Sep 01 2015
Oct 01 2015
Nov 01 2015
Dec 01 2015
Jan 01 2016
---- Provisional Data Subject to Revision ----
Median daily statistic (24 years)
Flow at station affected by ice
Discharge


Flow Duration Curve for Little Otter Creek @ Ferrisburg, wy1991-2014
Discharge(cfs) (Daily Mean Flow)
1000.0
100.0
10.0
1.0
0.1
165
67
12
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
50
6/3
Q2 = 4,310 cfs
LMM = 325 cfs
Jan 01 2015
Feb 01 2015
Mar 01 2015
Apr 01 2015
May 01 2015
Jun 01 2015
Jul 01 2015
Aug 01 2015
Sep 01 2015
Oct 01 2015
Nov 01 2015
Dec 01 2015
Jan 01 2016
---- Provisional Data Subject to Revision ----
Median daily statistic (95 years)
Flow at station affected by ice
Discharge


Flow Duration Curve for Otter Creek @ Middlebury, wy1991-2014
Discharge(cfs) (Daily Mean Flow)
10000
2000
500
200
50
2460
1660
490
294
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
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 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	E. Coli (mpn/100ml)	Total Phosphorus (ug/L)	Total Dissolved Phosphorus (ug/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
LFR6.7	4/8/2015		98.2	59	11.8	29.7
LFR12	4/8/2015		102	64.2	12.2	31.2
LFR6.7	5/6/2015		147	35	102	99.9
LFR12	5/6/2015		112	37.9	59.6	65.9
LFR6.7	6/3/2015	307.6	138	97	21.6	26.4
LFR12	6/3/2015	344.8	138	93.7	33.4	29.4
LFR6.7	7/1/2015	52.1	216	152	12.7	15.4
LFR12	7/1/2015	137.4	163	111	27	50.8
LFR6.7	8/5/2015	160.7	165	58.6	74.4	97.5
LFR12	8/5/2015	36.7	105	52	207	275
LFR6.7	9/2/2015	524.7	168	59.3	72	113
LFR12	9/2/2015	12.1	266	54.5	194	214

VT Water Quality Standards (effective October 2014):

- **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	E. Coli (mpn/100ml)	Total Phosphorus (ug/L)	Total Dissolved Phosphorus (ug/L)	Total Suspended Solids (mg/L)	Turbidity (NTU)
LCR3.7	4/8/2015		71.2			28.2
LCR14	4/8/2015		43.9			10.9
LCR3.7	5/6/2015		21.8			2.56
LCR14	5/6/2015		17.3			2.45
LCR3.7	6/3/2015	307.6	97.3			25.5
LCR14	6/3/2015	410.6	64.4			7.6
LCR3.7	7/1/2015	150.0	42			7.17
LCR14	7/1/2015	307.6	22.6			2.75
LCR3.7	8/5/2015	> 2419.6	60.6			11.9
LCR14	8/5/2015	1553.1	35.8			5.04
LCR3.7	9/2/2015	178.9	16.6			5.58
LCR14	9/2/2015	166.4	15			3.9

VT Water Quality Standards (effective October 2014):

- **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.

Little Otter Creek

Location	Date	E. Coli (mpn/100ml)	Total Phosphorus (ug/L)	Total Dissolved Phosphorus (ug/L)	Total Suspended Solids (mg/L)		Turbidity (NTU)
LOC4.3	4/8/2015		89.7	47.4	17.8		27.3
MDC1.2	4/8/2015		98.9	65.6	5.3		11
LOC4.3	5/6/2015		61.9	23.3	19.8		24.1
MDC1.2	5/6/2015		49.3	40.7	2.2		2.3
LOC4.3	6/3/2015	228.2	125	82.3	21.3		35.8
MDC1.2	6/3/2015	63.8	145	112	15.8		34.9
LOC4.3	7/1/2015	59.4	208	107	42.3	JD	51
MCD1.2	7/1/2015	25.3	228	162	7.4	JD	6.7
LOC4.3	8/5/2015	980.4	142	56.7	135		75.2
MDC1.2	8/5/2015	517.2	181	130	12.2		19
LOC4.3	9/2/2015	22.3	77.4	44.2	24.3		27.2
MDC1.2	9/2/2015	6.3	188	61.7	50		34.8

VT Water Quality Standards (effective October 2014):

- **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.

Middlebury River

Location	Date	QA	Alkalinity (mg/L)	E. Coli (mpn/100ml)	Total Nitrogen (mg/L)	Total Phosphorus (ug/L)	Turbidity (NTU)
MIR0	4/8/2015				0.52	33.1	8.02
MIR1.5	4/8/2015				0.52	32	6.12
MIR2	4/8/2015				0.4	12.5	1.77
MIR3	4/8/2015				0.5	27.4	4.95
MIR5.7	4/8/2015				0.46	10.4	1.24
MRNB1.7	4/8/2015					11.5	1.08
MRNB3.5	4/8/2015					11.7	1.01
MIR10.6	4/8/2015					13.2	1.04
MIR13	4/8/2015					NS	NS
MRSB1	4/8/2015					8.78	0.98
MRSB4.2	4/8/2015					6.77	0.68
MRHT0.1	4/8/2015					84.6	14.9
MIR0	5/6/2015				0.39	16.8	2.66
MIR1.5	5/6/2015				0.4	16.8	2.14
MIR2	5/6/2015				0.4	15.5	2.06
MIR3	5/6/2015				0.38	9.81	0.94
MIR5.7	5/6/2015				0.38	9.29	0.89
MRNB1.7	5/6/2015					11.8	0.84
MRNB3.5	5/6/2015					13.7	1.38
MIR10.6	5/6/2015					12.6	0.64
MIR13	5/6/2015					9.68	0.53
MRSB1	5/6/2015					9.36	0.66
MRSB4.2	5/6/2015					8.9	0.9
MRHT0.1	5/6/2015					104	12.9

VT Water Quality Standards (effective October 2014):

- **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.

Middlebury River (continued)

Location	Date	QA	Alkalinity (mg/L)	E. Coli (mpn/100ml)	Total Nitrogen (mg/L)	Total Phosphorus (ug/L)	Turbidity (NTU)
MIR0	6/3/2015	A		178.9	0.39	24.7	3.05
MIR1.5	6/3/2015	A		88.4	0.4	25.9	3.26
MIR2	6/3/2015	A		107.6	0.38	21.7	1.7
MIR3	6/3/2015	A		25.0	0.27	8.6	0.54
MIR5.7	6/3/2015	A		18.3	0.27	9.55	0.95
MRNB1.7	6/3/2015	A	12	24.6		11.3	0.84
MRNB3.5	6/3/2015	A	13	73.3		15.1	0.98
MIR10.6	6/3/2015	A	13	21.1		13.9	0.29
MIR13	6/3/2015	A	10	7.5		11.1	0.95
MRSB1	6/3/2015	A	13	9.7		7.97	0.54
MRSB4.2	6/3/2015	A	9.5	7.4		7	0.43
MRHT0.1	6/3/2015	A	165	148.3		135	16.2
MIR0	7/1/2015	A		151.5	0.33	25.4	3.16
MIR1.5	7/1/2015	A		107.6	0.36	28.1	5.21
MIR2	7/1/2015	A		50.4	0.33	20.6	2.77
MIR3	7/1/2015	A		20.3	0.24	9.33	0.7
MIR5.7	7/1/2015	A		43.5	0.24	10.2	0.71
MRNB1.7	7/1/2015	A	16.5	39.3		12.5	0.97
MRNB3.5	7/1/2015	A	20.5	73.3		14.5	0.92
MIR10.6	7/1/2015	A	18	24.3		11.5	0.44
MIR13	7/1/2015	A	13	16.0		10	0.29
MRSB1	7/1/2015	A	14	16.9		7.58	0.39
MRSB4.2	7/1/2015	A	11	13.1		8.21	0.25
MRHT0.1	7/1/2015	A	171	1,553.1		95.1	17.5

VT Water Quality Standards (effective October 2014):

- **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.

Middlebury River (continued)

Location	Date	QA	Alkalinity (mg/L)	E. Coli (mpn/100ml)	Total Nitrogen (mg/L)	Total Phosphorus (ug/L)	Turbidity (NTU)
MIR0	8/5/2015	A		209.8	0.25	16.8	2.49
MIR1.5	8/5/2015	A		145.5	0.27	22.2	3.22
MIR2	8/5/2015	A		129.1	0.27	16.2	2.79
MIR3	8/5/2015	A		28.2	0.28	6.4	0.44
MIR5.7	8/5/2015	A		31.3	0.28	6.63	0.26
MRNB1.7	8/5/2015	A	27	24.6		10.8	0.73
MRNB3.5	8/5/2015	A	31	65.7		12.1	0.88
MIR10.6	8/5/2015	A	31	8.6		9.74	0.43
MIR13	8/5/2015	A	25	4.1		16	0.26
MRSB1	8/5/2015	A	23	17.3		6.92	0.38
MRSB4.2	8/5/2015	A	16	31.8		6.97	0.58
MRHT0.1	8/5/2015	A	173	> 2419.6		102	14.4
MIR0	9/2/2015	A		461.1	0.24	17.2	3.74
MIR1.5	9/2/2015	A		344.8	0.27	19.5	4.38
MIR2	9/2/2015	A		248.9	0.3	22.3	5.02
MIR3	9/2/2015	A		31.5	0.24	6.01	0.28
MIR5.7	9/2/2015	A		4.1	0.24	6.68	< 0.2
MRNB1.7	9/2/2015	A	32	5.2		9.32	0.57
MRNB3.5	9/2/2015	A	38	32.3		11.7	0.64
MIR10.6	9/2/2015	A	38	6.3		12.3	< 0.2
MIR13	9/2/2015	A	31	15.6		16.2	0.22
MRSB1	9/2/2015	A	30	9.7		6.55	0.27
MRSB4.2	9/2/2015	A	21.5	209.8		7.3	0.41
MRHT0.1	9/2/2015	A	169	133.3		82.9	12.1

VT Water Quality Standards (effective October 2014):

- **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	E. Coli (mpn/100ml)	Total Nitrogen (mg/L)	Total Phosphorus (ug/L)	Total Dissolved Phosphorus (ug/L)	Turbidity (NTU)
NHR2	4/8/2015			32.9		8.7
NHR9	4/8/2015			13.5		1.5
NHR2	5/6/2015			13.7		1.6
NHR9	5/6/2015			9.4		1.0
NHR2	6/3/2015	67.0		15.9		2.9
NHR6	6/3/2015	50.4				
NHR9	6/3/2015	24.1		8.4		1.1
NHR11.5	6/3/2015	101.9				
NHR2	7/1/2015	50.4		16.2		2.8
NHR6	7/1/2015	29.2				
NHR9	7/1/2015	39.3		7.7		0.5
NHR11.5	7/1/2015	32.3				
NHR2	8/5/2015	517.2		19.1		5.6
NHR6	8/5/2015	222.4				
NHR9	8/5/2015	161.6		9.6		1.6
NHR11.5	8/5/2015	131.4				
NHR2	9/2/2015	193.5		17.1		5.9
NHR6	9/2/2015	54.6				
NHR9	9/2/2015	26.2		5.7		0.2
NHR11.5	9/2/2015	13.2				

VT Water Quality Standards (effective October 2014):

- **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	E. Coli (mpn/100ml)	Total Nitrogen (mg/L)	Total Phosphorus (ug/L)	Total Dissolved Phosphorus (ug/L)		Turbidity (NTU)
OTR7.3	4/8/2015		0.65	56.9	22.5		16.8
OTR13	4/8/2015		0.63	55.6	20		14.5
OTR18	4/8/2015		0.58	46.9	16.3		11.2
OTR23	4/8/2015		0.55	44.3	15.5		11.3
OTR30	4/8/2015		0.55	39.5	13.6		7.76
OTR7.3	5/6/2015		0.47	38	16.5	JB	7.19
OTR13	5/6/2015		0.5	34.8	16.4	JB	6.2
OTR18	5/6/2015		0.5	35.4	18.1	JB	3.5
OTR23	5/6/2015		0.48	33.9	20.6	JB	3.39
OTR30	5/6/2015		0.48	37.9	19.6	JB	3.28
OTR7.3	6/3/2015	488.4	1.04	69	39.4		16.6
OTR13	6/3/2015	435.2	0.75	56.4	30.2		15.4
OTR18	6/3/2015	517.2	0.49	39.5	16.7		9.48
OTR23	6/3/2015	1,299.7	0.46	52.2	17.2		16.2
OTR30	6/3/2015	1,046.2	0.44	53.8	16.8		10.7
OTR7.3	7/1/2015	118.7	0.48	57.5	37.9		9.6
OTR13	7/1/2015	416.0	0.48	60.1	34		11.1
OTR18	7/1/2015	178.2	0.43	42	22.8		7.96
OTR23	7/1/2015	178.9	0.43	47.2	22.9		7.61
OTR30	7/1/2015	196.8	0.41	43.5	21.4		6.44

VT Water Quality Standards (effective October 2014):

- **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.

Otter Creek (Lower) – (continued)

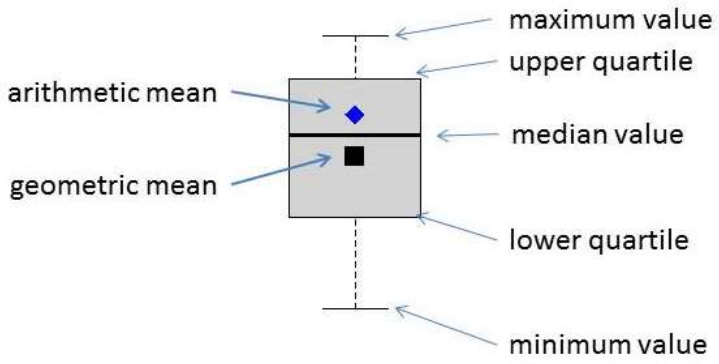
Location	Date	E. Coli (mpn/100ml)	Total Nitrogen (mg/L)	Total Phosphorus (ug/L)	Total Dissolved Phosphorus (ug/L)	Turbidity (NTU)
OTR7.3	8/5/2015	51.2	0.43	25.4	9.2	7.12
OTR13	8/5/2015	62.7	0.48	24.6	11.6	6.37
OTR18	8/5/2015	93.3	0.45	17.8	10.1	2.36
OTR23	8/5/2015	160.7	0.79	19.4	12.1	2.45
OTR30	8/5/2015	57.6	0.46	19.5	11.4	1.54
OTR7.3	9/2/2015	15.5	0.34	27.2	10.5	9.13
OTR13	9/2/2015	14.6	0.44	21.3	10.8	11.8
OTR18	9/2/2015	29.5	0.49	18.2	10.4	1.89
OTR23	9/2/2015	148.3	0.55	20.8	10	3.36
OTR30	9/2/2015	60.9	0.67	18.5	10.5	1.88

VT Water Quality Standards (effective October 2014):

- **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 – 2015 Water Quality Summary
2 Lewis Creek – 2015 Water Quality Summary
3 Little Otter Creek – 2015 Water Quality Summary
4 Middlebury River – 2015 Water Quality Summary
5 New Haven River – 2015 Water Quality Summary
6 Otter Creek (Lower) – 2015 Water Quality Summary



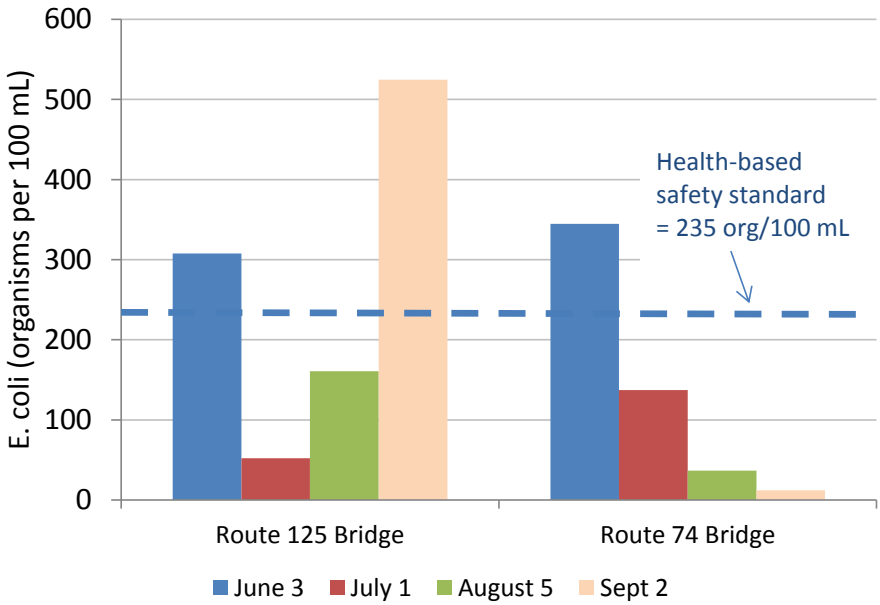
Lemon Fair River - 2015 Water Quality Summary
Addison County River Watch Collaborative

Site	Location	Town
LFR6.7	Route 125 bridge.	Cornwall
LFR12	Downstream of Route 74 bridge	Shoreham

The Addison County River Watch Collaborative has been monitoring water quality in the Lemon Fair River since 2003. For years 2014 through 2017, the number of sampling locations in this watershed has been reduced to two sentinel stations, LFR6.7 and LFR12.

During 2015, sampling occurred on two spring dates (April 8 and May 6) and four summer dates (June 3, July 1, August 5, and September 2). The April event occurred during a time of snow melt and represented high flow conditions on the river, based on streamflow gaging records for a similar river (Otter Creek and Little Otter Creek). High flow conditions were also captured in June and July associated with summer rain fall events falling on saturated ground. The May event occurred during moderate flow conditions on the river, while the September event captured a low, baseflow condition. The August event represent low-baseflow conditions, if the adjacent Otter Creek at Middlebury gage is used as a proxy for flow conditions on the Lemon Fair. If the nearby Little Otter Creek and more mountainous watersheds (New Haven River, Lewis Creek) are instead referenced, they indicated a moderate flow condition as flows in these watersheds were receding in response to isolated thunderstorms. On an average annual basis, flows in 2015 were near normal in the Addison County watersheds monitored by the Collaborative.

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



E.coli counts in the Lemon Fair watershed at the two sentinel sites exceeded the state standard of 235 organisms/ 100 mL on a June 3, and the standard was again exceeded on September 2 at the Route 125

Bridge site. The geometric mean of summer sampling results was 192 org/100mL at LFR6.7 and 68 org/100mL at LFR12; the geomean value at LFR6.7 exceeded the state's geomean standard of 126 organisms/ 100 mL. Detected E.coli counts were largely consistent with historic monitoring results which indicate chronic exceedances of the water quality standard at these two sites.

Turbidity levels at the sampled stations in Lemon Fair watershed ranged from 15.4 to 275 NTUs, with a mean of 87.3 NTUs. Highest concentrations were detected during low- to moderate-flow conditions on August 5 and September 2. The Vermont state standard of 25 NTUs (for Class B warm-water fisheries) is applicable during low-flow conditions. Detected concentrations were well above the standard on both low-flow sampling dates at each sentinel station.

Phosphorus was detected at moderate levels during the six spring and summer sampling dates of 2015. Concentrations ranged from 98 to 266 ug/L. The mean of the results available for the two low-flow, summer sampling dates (August and September) at each station exceeded the recently approved instream phosphorus criterion of 27 ug/L for warm-water medium gradient (WWMG) wadeable stream ecotype in Class B waters. It is possible that 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 for the slow-winder ecotype.

2016: The Addison County River Watch Collaborative will continue to monitor for E.coli, phosphorus (total and dissolved), total suspended sediments, and turbidity at these two sentinel sites in 2016. An increased number of parameters and additional monitoring sites will be evaluated when a more intensive monitoring focus rotates back to the Lemon Fair for a two-year period beginning in the year 2018.

For more information, contact the Lemon Fair sampling coordinator:
Barb Otsuka, 388-6829, botsuka@sover.net
Addison County River Watch Collaborative coordinator: Matt Witten, 434-3236, mwitten@gmavt.net
or visit our web page at: www.acrpc.org/acrwc

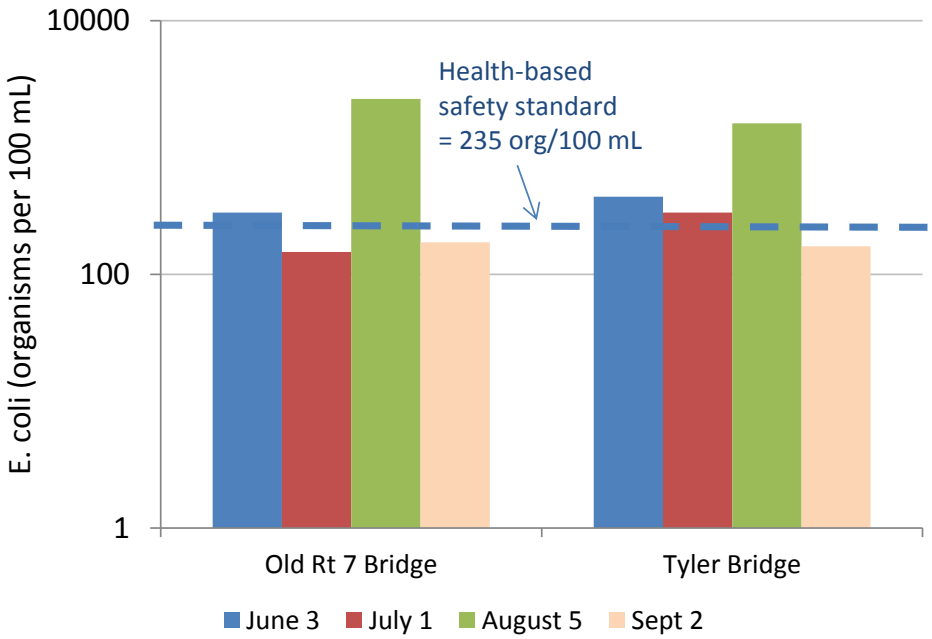
Lewis Creek - 2015 Water Quality Summary
Addison County River Watch Collaborative

Site	Location	Town
LCR3.7	Old Route 7 Bridge	Ferrisburgh
LCR14	Tyler Bridge	Monkton

The Addison County River Watch Collaborative has been monitoring water quality in the Lewis Creek since 1992. For years 2014 through 2017, the number of sampling locations in this watershed has been reduced to two sentinel stations, LCR3.7 and LCR14.

During 2015, sampling occurred on two spring dates (April 8 and May 6) and four summer dates (June 3, July 1, August 5, and September 2). The April event occurred during a time of snow melt and represented high flow conditions on the river, based on streamflow gaging records from the USGS streamflow gage located at the Route 7 crossing. High flow conditions were also captured in June and July associated with summer rain fall events falling on saturated ground. May and August events occurred during moderate flow conditions on the river, while the September event captured a low, baseflow condition. On an average annual basis, flows in 2015 were near normal in the Addison County watersheds monitored by the Collaborative.

Samples from the Lewis Creek watershed were tested for E.coli, total phosphorus, and turbidity; E.coli was tested only on the summer dates.



E.coli counts in the Lewis Creek at the two sentinel stations exceeded the recently modified state standard of 235 organisms/100 mL on most of the sample dates. The geomean value at each site exceeded the state's geomean standard of 126 organisms/ 100 mL. Detected E.coli counts at these sites in the 2015 season were largely consistent with historic results, which indicate chronic exceedances of the water quality standard at these two sites. Station LCR14 is located downstream of a dairy pasture

where livestock have direct access to the stream. This station is also located downstream of the confluence with Hollow Brook which flows through wetlands populated by beavers.

Turbidity levels in the Lewis Creek at the sampled stations ranged from 2.5 to 28 NTUs, with a mean level of 9.5 NTUs for the six sample dates. Highest turbidity concentrations were observed during high-flow events on April 8 (28.2 NTUs) and June 3 (25.5 NTUs) at station LCR3.7 near the Route 7 bridge. 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. The Vermont state standard of 10 NTUs (for Class B cold-water fisheries) is applicable during low-flow conditions. The turbidity standard was not exceeded on the one low-flow sampling date (September 2) at either station.

Phosphorus was detected at low to moderate concentrations during the six Spring and Summer sampling dates, ranging from 15 to 97 ug/L, with an average of 42.4 ug/L. Highest phosphorus concentrations were associated with the April 8 and June 3 high-flow events at both stations, LCR3.7 and LCR14. The Total Phosphorus concentration for the one available low-flow summer sample date (September 2) did not exceed the approved instream nutrient standard of 27 ug/L for the warm-water medium gradient (WWMG) wadeable stream ecotype in Class B waters. Historic results for both sentinel and rotational sites have shown an increasing trend in phosphorus concentration with distance downstream.

2016: The Addison County River Watch Collaborative will continue to monitor for E.coli, total phosphorus, and turbidity at these two sentinel sites in 2016. An increased number of parameters and additional monitoring sites will be evaluated when a more intensive monitoring focus rotates back to the Lewis Creek for a two-year period beginning in the year 2018. Water quality data from the previous focus period (2012-2013) are being used by VTDEC biomonitoring teams to evaluate the health of several headwaters reaches. These data will inform ongoing municipal-level discussions and basin-planning efforts regarding water quality management classification.

For more information, contact the Lewis Creek sampling coordinator:
Louis DuPont, 453-5538, ldupont@gmavt.net
Addison County River Watch Collaborative coordinator: Matt Witten, 434-3236, mwitten@gmavt.net
or visit our web page at: www.acrpc.org/acrwc

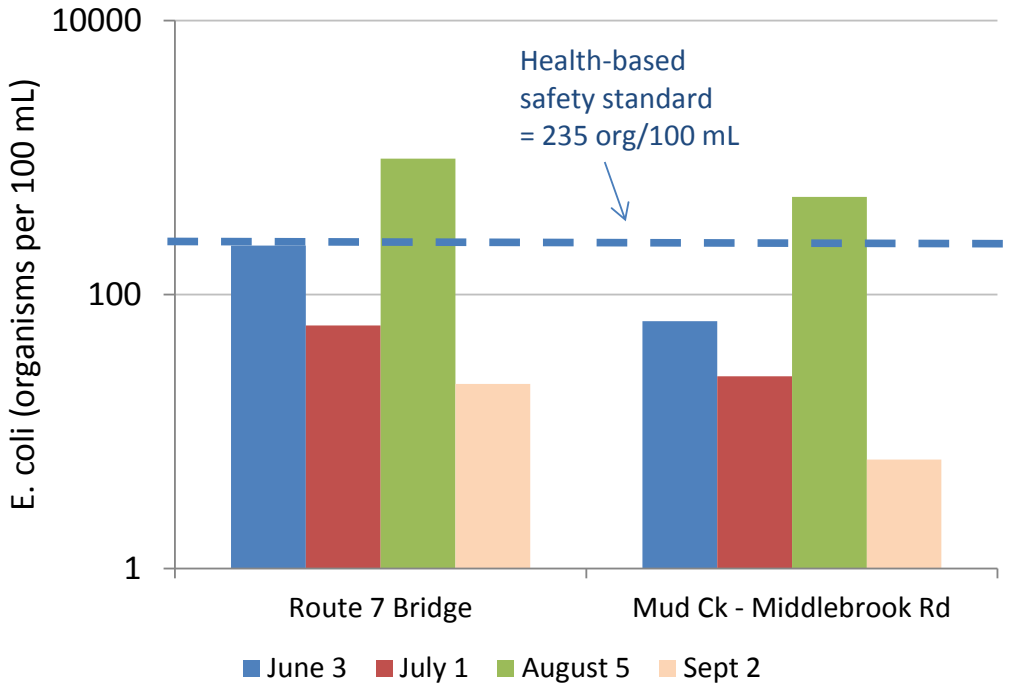
Little Otter Creek - 2015 Water Quality Summary
Addison County River Watch Collaborative

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 2012 through 2015, the number of sampling locations in this watershed has been reduced to two sentinel stations, LOC4.3 and MDC1.2.

During 2015, sampling occurred on two spring dates (April 8 and May 6) and four summer dates (June 3, July 1, August 5, and September 2). The April event occurred during a time of snow melt and represented high flow conditions on the river, based on streamflow gaging records from the USGS streamflow gage located at the Route 7 crossing. High flow conditions were also captured in June and July associated with summer rain fall events falling on saturated ground. May and August events occurred during moderate flow conditions on the river, while the September event captured a low, baseflow condition. On an average annual basis, flows in 2015 were near normal in the Addison County watersheds monitored by the Collaborative.

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



E.coli counts at the two sentinel stations exceeded the recently modified state standard of 235 organisms/100 mL on August 5, which was characterized by moderate flows in response to summer thunderstorms. The geomean value at each site exceeded the state's geomean standard of 126

organisms/ 100 mL. Detected E.coli counts at these sites in the 2014 season were largely consistent with historic results.

Turbidity levels in the Little Otter Creek at the two sentinel stations ranged from 2.3 to 75 NTUs, with a mean level of 29 NTUs for the six sample dates. Highest turbidity concentrations were observed during moderate- to high-flow summer events, and during low, base-flow conditions on September 2 at both sentinel stations. Turbidity results for 2015 at these two stations were largely consistent with historic trends. Based on past years' sampling results, turbidity can become elevated at times of increased flow – during a Summer thunderstorm, or during Spring runoff conditions. Turbidity can also be elevated during low-flow conditions, possibly due to instream algae blooms. The Vermont state standard of 10 NTUs (for Class B cold-water fisheries) is applicable during low-flow conditions. The turbidity standard was exceeded at both sentinel stations on the one available low-flow sampling date (September 2).

Phosphorus levels were detected at low to moderate concentrations during the six spring and summer sampling dates, ranging from 49 to 228 ug/L, with an average of 133 ug/L. Total Phosphorus concentrations detected in 2015 were generally consistent with historic data. The concentration of Total Phosphorus for the one available low-flow summer sample date (September) at each sentinel station exceeded the approved instream nutrient standard of 27 ug/L for the warm-water medium gradient (WWMG) wadeable stream ecotype in Class B waters.

2016: Beginning in 2016, the Little Otter Creek will become the focus of more detailed evaluation for a two-year period. An increased number of parameters and additional monitoring sites will be evaluated.

For more information, contact the Little Otter Creek sampling coordinator:
Deb Healey, 475-2944, lumiere@gmavt.net
Addison County River Watch Collaborative coordinator: Matt Witten, 434-3236, mwitten@gmavt.net
or visit our web page at: www.acrpc.org/acrwc

Focus watershed:
2014 and 2015

Middlebury River – 2014 and 2015 Water Quality Summary

Addison County River Watch Collaborative

River Name	Site	Location	Town
Middlebury River	MIR0	Mouth of Middlebury River	Middlebury
Middlebury River	MIR1.5	Shard Villa Rd. Bridge	Middlebury
Middlebury River	MIR2	Blake Roy Rd. Bridge	Salisbury
Middlebury River	MIR3	Route 7 Access	Middlebury
Middlebury River	MIR5.7	Midd. Gorge @ Rte 125 Bridge	Middlebury
North Branch MR	MRNB1.7	Dugway Road Bridge	Ripton
North Branch MR	MRNB3.5	Norton Farm Rd Bridge	Ripton
MR (Middle Branch)	MIR10.6	Natural Turnpike Road	Ripton
MR (Middle Branch)	MIR13	Wagon Wheel Rd Bridge	Ripton
South Branch MR	MRSB1	Goshen Road Bridge	Ripton
South Branch MR	MRSB4.2	Brook Road Bridge	Ripton
Halnon Brook MR	MRHT0.1	Upstream of Route 7 crossing	Salisbury

The Addison County River Watch Collaborative has been monitoring water quality in the Middlebury River since 1993. For the 2014 and 2015 seasons, the Middlebury River has been the subject of a more intensive monitoring focus, where rotational as well as sentinel stations were monitored and additional parameters were tested. Seven new water quality monitoring stations were established on tributaries in the Middlebury River watershed during years 2014 and 2015. Two new stations (MIR10.6 and MIR13) are located on the Middle Branch of the Middlebury River which is essentially an extension of the main stem of the river. Two new stations (MRSB1 and MRSB4.2) were established on the South Branch tributary coincident with biomonitoring stations maintained by the VTDEC. The South Branch joins the main stem of the Middlebury River in Ripton village downstream of station MIR10.6 (Natural Turnpike crossing) and well upstream of station MIR5.7 at the East Middlebury Gorge. Two stations (MRNB1.7 and MRNB3.5) were located on the North Branch, which also joins the main stem between sites MIR10.6 and MIR5.7, although well below the village of Ripton along Rt 125. One additional site on a small tributary to Halnon Brook was established to assess the potential influence of a fish hatchery. This site is located east of Route 7 along the road leading to Lake Dunmore. Below this station, the brook crosses Route 7 to join Halnon Brook, which itself meanders through agricultural lands and wetlands to join the Middlebury River main stem immediately upstream of the Blake Roy Rd bridge (site MIR2). These seven tributary stations were monitored along with five rotational and sentinel stations distributed along the main stem downstream from the Gorge to the confluence with Otter Creek.

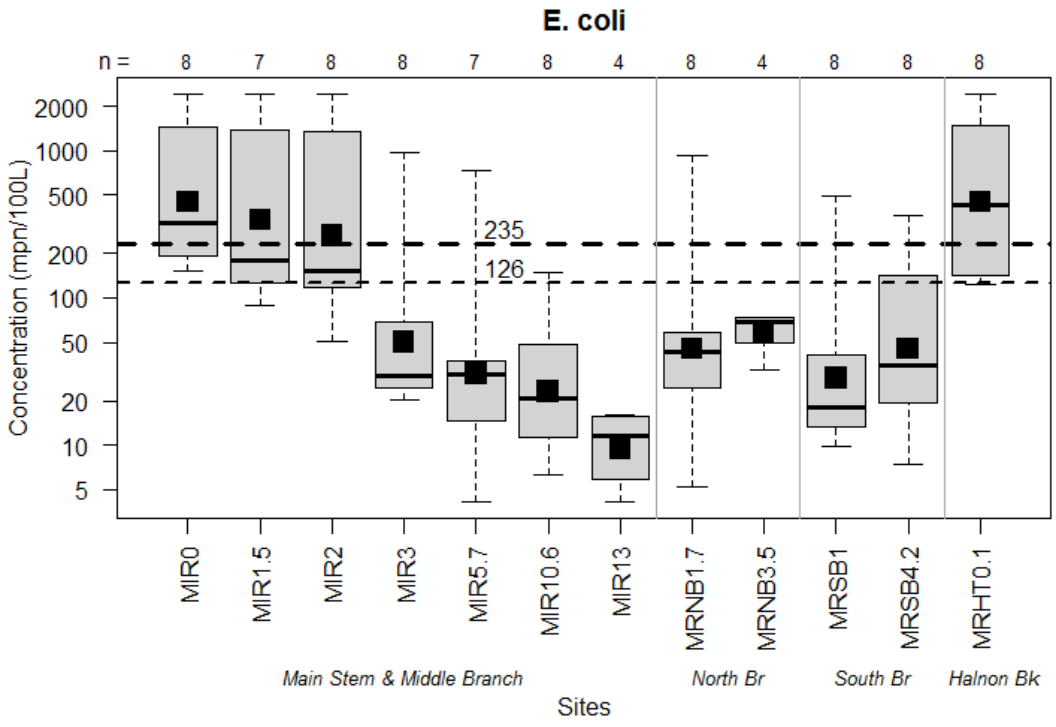
Table 1 (next page) summarizes the flow conditions captured during scheduled sample dates in 2014 and 2015, based on streamflow gaging records from nearby gages on the New Haven River and Lewis Creek. Generally, April events captured high flows coincident with snowmelt each year. Three baseflow events were sampled: one in 2014 on July 2, and two in 2015 on May 6 and September 2. The remaining events ocurred during moderate to high flow conditions resulting from higher-than-normal rainfall in the spring and early summer months and isolated storm events. On an average annual basis, flows in both 2014 and 2015 were near normal in the Addison County watersheds monitored by the Collaborative.

Table 1. Streamflow conditions during sampling events, 2014-2015. (per VTDEC Guidance on Streamflow Observations at time of Water Quality Sampling of Rivers and Streams)

Year	Sample Date	Flow Condition	Flow Category
2014	April 9	High	Freshet Flow/ Snowmelt
	May 7	High	Freshet Flow
	June 4	Moderate	Freshet Flow
	July 2	Moderate	Baseflow
	August 6	High	Freshet Flow
	September 3	Moderate	Freshet Flow
2015	April 8	High	Freshet Flow/ Snowmelt
	May 6	Moderate	Baseflow
	June 3	High	Freshet Flow
	July 1	High	Freshet Flow
	August 5	Moderate	Freshet Flow
	September 2	Low	Baseflow

Samples were tested for E.coli, total phosphorus, total nitrogen and turbidity; E.coli was tested only on the summer dates. As part of the baseline water quality study, alkalinity was tested at the newly-established tributary sites during the summer months only.

Figure 1. Summary of E.coli Results for Middlebury River sites, 2014-2015.



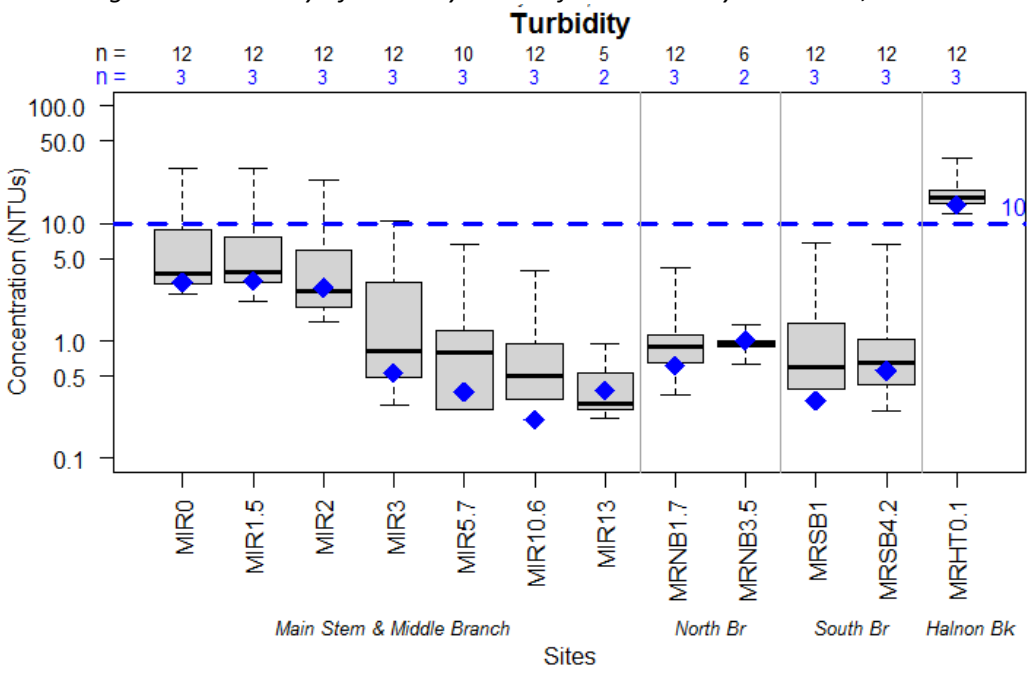
E.coli counts at sites on the Middlebury River main stem and tributaries ranged from 4.1 to >2,420 organisms/ 100 mL during 2014 and 2015. The box-and-whisker chart in Figure 1 summarizes E. coli concentrations detected at all Middlebury River main stem and tributary stations in 2014 and 2015. The whiskers extend to the maximum and minimum values detected in those two years, while the gray-shaded

box represents the interquartile range 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 number of samples (n) represented by each box-and-whisker is displayed across the top of the chart. Since the Wagon Wheel station on the Middle Branch (MIR13) and the Norton Farm Bridge station on the North Branch (MRNB3.5) were sampled in 2015 and not in 2014, there are only 4 sample results reported for each of these stations. A valid box-and-whisker plot should be based on at least 5 samples, so the reader should focus simply on the median value for these two stations represented by the dark horizontal line. The black dashed lines in the figure above represent the health-based standards for E.coli. Vermont Water Quality Criteria (October 2014) 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. One or more samples from all stations except the Middle Branch sites and the Norton Farm Rd bridge site on North Branch exceeded the 235 mpn/100 L on one or more dates. The geometric mean of the Halnon Brook site and the lowest three stations on the main stem exceeded the geometric mean standard of 126 org/100 mL.

Along the main stem, E.coli counts showed an increasing trend with distance downstream from the Middlebury Gorge, consistent with historic results. Agricultural land uses dominate the river corridor in this lower end of the Middlebury River. A majority of the E.coli results for the Halnon Brook site over both years also exceeded the health-based standard. At the popular swimming site, MIR5.7 at the East Middlebury gorge, E.coli values were generally below the health-based standard except during very low flow conditions on September 3 in 2014.

Turbidity levels in the Middlebury River during 2014 and 2015 were relatively low, ranging from <0.2 to 36 NTUs, with an average level of 4.6 NTUs for all samples collected. The box-and-whisker plot below shows the full distribution of Turbidity results for samples collected over the two seasons. The blue diamond marks the mean of that subset of samples collected during baseflow conditions, with the corresponding number of samples (n) indicated in blue along the top of the chart.

Figure 2. Summary of Turbidity Results for Middlebury River sites, 2014-2015.



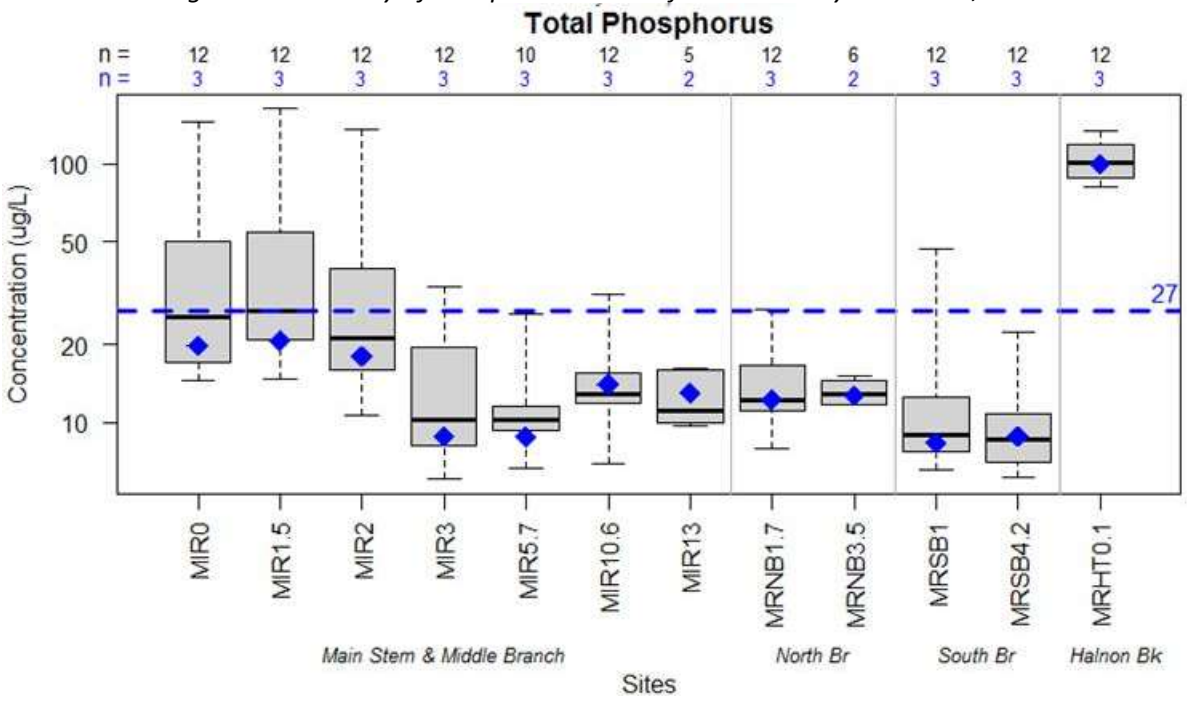
The Vermont state standard of 10 NTUs (for Class B cold-water fisheries) is applicable during baseflow conditions. The mean turbidity value for (up to 3) baseflow sampling events conducted over both seasons did not exceed this turbidity standard, except at the newly-established Halnon Brook station, MRHT0.1. This station is located downstream from a fish hatchery.

Main stem results (left-half of the chart) are largely consistent with historic trends. 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. A slight increasing trend in turbidity with distance downstream is generally observed during all flow conditions. Turbidity can occur as a result of high suspended sediments in the water (during moderate to high flows) and as a result of algae during low flow conditions.

Nitrogen levels were detected at very low concentrations over the two years of spring and summer sampling dates. Concentrations ranged from 0.2 to 0.9 mg/L, with an average of 0.4 mg/L. A past standard for nitrogen as nitrate (5 mg/L) was eliminated during the 2014 update of the Vermont Water Quality Standards.

Phosphorus levels were detected at low to moderate concentrations during 2014 and 2015, ranging from 6.2 to 164 ug/L, with a mean of 29 ug/L. The distribution of Phosphorus results is displayed in the box-and-whisker plot below. The blue diamond marks the mean of that subset of samples collected during baseflow conditions, with the corresponding number of samples (n) indicated in blue along the top of the chart.

Figure 3. Summary of Phosphorus Results for Middlebury River sites, 2014-2015.



For each station except Halnon Brook, the mean concentration of Total Phosphorus for the three available baseflow events (July 2014; May and September 2015) was below the approved instream nutrient standard of 27 ug/L for the warm-water medium gradient (WWMG) wadeable stream ecotype in Class B waters.

Along the main stem (left-half of chart), phosphorus concentrations showed an increasing trend with distance downstream from the Middlebury Gorge (MIR5.7), consistent with historic results. Phosphorus concentrations at the tributary stations were generally lower than concentrations along the main stem on all sample dates, with the exception of the Halnon Brook station. Phosphorus concentrations at this location were elevated during all flow conditions relative to the other Middlebury River stations. This station is located downstream from a fish hatchery.

Alkalinity detected at tributary monitoring sites during the summer sampling dates ranged from 10 to 185 mg CaCO3 per liter. Highest values were consistently detected at the Halnon Brook station, MRHT.01.

2016: Beginning in 2016, Middlebury River watershed will rotate out of focused monitoring, and sampling will be conducted for a reduced number of parameters at sentinel stations only. A third sentinel station in the upper watershed (MIR10.6 at Natural Turnpike crossing of Middle Branch) has now been established to complement long-time sentinel stations at the East Middlebury gorge (MIR5.7) and Shard Villa Road bridge (MIR1.5).

For more information, contact the Middlebury River sampling coordinator:
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or visit our web page at: www.acrpc.org/acrwc

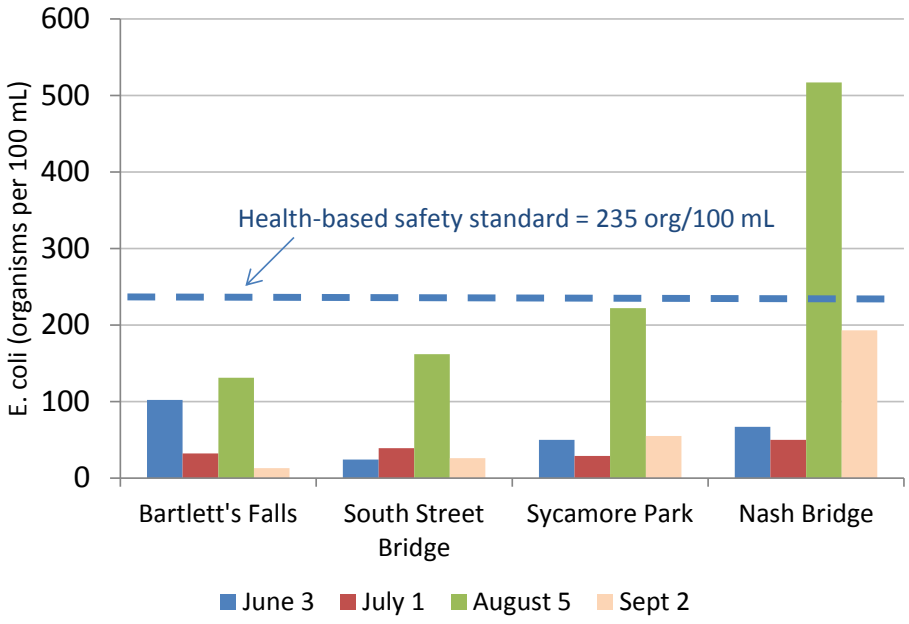
New Haven River - 2015 Water Quality Summary
Addison County River Watch Collaborative

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. In 2015, the number of sampling locations in this watershed has been limited to two sentinel stations, NHR2 and NHR9, and two additional swimming sites monitored only for pathogens (NHR6 and NHR11.5).

During 2015, sampling occurred on two spring dates (April 8 and May 6) and four summer dates (June 3, July 1, August 5, and September 2). The April event occurred during a time of snow melt and represented high flow conditions on the river, based on records from the USGS gage on the New Haven River at Brooksville. High flow conditions were also captured in June and July associated with summer rain fall events falling on saturated ground. May and August events occurred during moderate flow conditions on the river, while the September event captured a low, baseflow condition. On an average annual basis, flows in 2015 were near normal in the Addison County watersheds monitored by the Collaborative.

Samples were tested for E.coli, total phosphorus, and turbidity; E.coli was tested only on the summer dates.



E.coli counts at popular recreational sites were below the recently-modified state standard of 235 organisms/100 mL on all summer dates except September 3. On that date, the station near Nash Bridge in New Haven (NHR2) indicated E.coli counts elevated above the state standard. Low-flow conditions and warm temperatures likely contributed to elevated E. coli counts on September 3. Consistent with historic

results, an increasing trend in E.coli levels is evident with distance downstream from station NHR11.5 (Bartlett's Falls) to NHR2 (Nash Bridge). Developed and agricultural land uses are more prevalent in the lower New Haven River watershed.

Turbidity levels on the New Haven River at the two sentinel stations ranged from 0.2 to 8.7 NTUs, with a mean level of 2.8 NTUs for the six sample dates. Results from 2015 are largely consistent with historic trends. 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 Bristol Flats. A slight increasing trend in turbidity with distance downstream is generally observed during all flow conditions. The Vermont state standard of 10 NTUs (for Class B cold-water fisheries) is applicable during low-flow conditions. This turbidity standard was not exceeded during the one sampling event that captured low-flow conditions(September 2).

Phosphorus was detected at low to moderate concentrations on the New Haven River during the spring and summer sampling dates. Concentrations ranged from 5.7 to 32.9 ug/L, with an average of 14.1 ug/L. Results were consistent with historic trends, which indicate an increase in concentrations with distance downstream. At all stations, moderately high concentrations of Total Phosphorus have been detected in past years at times of high flow and runoff. In 2015, the concentration of Total Phosphorus for the one available low-flow summer sample dates (September 2) at each of the New Haven River sentinel sites was below the approved instream nutrient standard of 27 ug/L for the warm-water medium gradient (WWMG) wadeable stream ecotype in Class B waters.

2016: Beginning in 2016, the New Haven River will become the focus of more detailed evaluation for a two-year period. An increased number of parameters and additional monitoring sites will be evaluated.

For more information, contact the New Haven River sampling coordinator:
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Focus watershed:
2014 and 2015

Otter Creek – 2014 and 2015 Water Quality Summary

Addison County River Watch Collaborative

Site	Location	Town
OTR7.3	Vergennes Falls/below outfall	Vergennes
OTR13	Route 17 Bridge	Weybridge
OTR18	Twin Bridges Picnic Area	Weybridge
OTR23	Frog Hollow	Middlebury
OTR30	Swamp Road Bridge	Salisbury

The Addison County River Watch Collaborative has been monitoring water quality in the lower Otter Creek since 1992. For the 2014 and 2015 seasons, Otter Creek was the subject of a more intensive monitoring focus, where rotational as well as sentinel stations were monitored and additional parameters were tested. Sampled sites include two sentinel sites (OTR18 and OTR7.3) and three rotational sites located on the main stem (see above table).

Table 1 summarizes the flow conditions captured during scheduled sample dates in 2014 and 2015, based on streamflow gaging records from the Otter Creek station at Middlebury. Generally, April events captured high flows coincident with snowmelt each year. Five baseflow events were sampled: two in 2014 on July 2 and August 6, and three in 2015 on May 6, August 5 and September 2. The remaining events ocurred during moderate to high flow conditions resulting from higher-than-normal rainfall in the spring and early summer months and isolated storm events. On an average annual basis, flows in both 2014 and 2015 were near normal in the Addison County watersheds monitored by the Collaborative.

Table 1. Streamflow conditions during sampling events, 2014-2015. (per VTDEC Guidance on Streamflow Observations at time of Water Quality Sampling of Rivers and Streams)

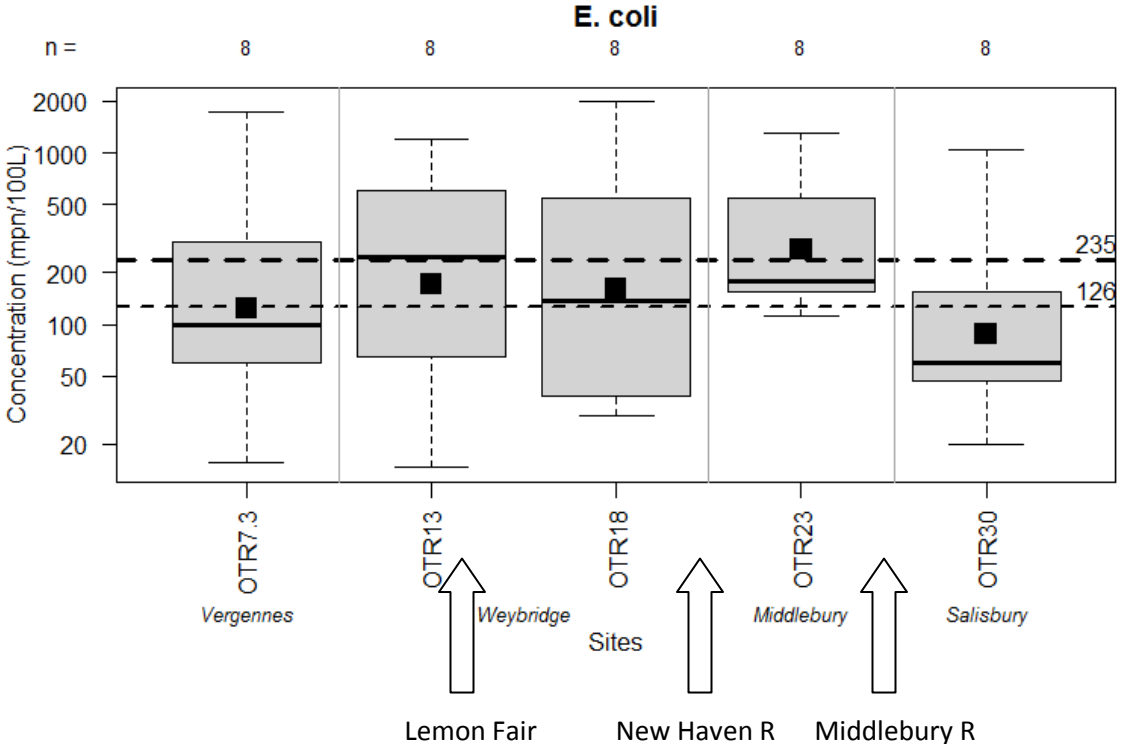
Year	Sample Date	Flow Condition	Flow Category
2014	April 9	High	Freshet Flow/ Snowmelt
	May 7	High	Freshet Flow
	June 4	High	Freshet Flow
	July 2	Moderate	Baseflow
	August 6	Moderate	Baseflow
	September 3	Low	Freshet Flow
2015	April 8	High	Freshet Flow/ Snowmelt
	May 6	Moderate	Baseflow
	June 3	High	Freshet Flow
	July 1	High	Freshet Flow
	August 5	Low	Baseflow
	September 2	Low	Baseflow

Samples were tested for E.coli, phosphorus (total and dissolved), nitrogen and turbidity; E.coli was tested only on the summer dates.

E.coli counts at sites on the lower Otter Creek ranged from 14.6 to 1,986 organisms/100 mL. The box-and-whisker chart in Figure 1 summarizes E. coli concentrations detected at all Otter Creek stations in 2014 and 2015. The whiskers extend to the maximum and minimum values detected in those two years, while the gray-shaded box represents the interquartile range 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 number of samples (n) represented by each box-and-whisker is displayed across the top of the chart. The black dashed lines in Figure 1 represent the health-based standards for E.coli. Vermont Water Quality Criteria (October 2014) 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.

Select samples from each station exceeded the 235 mpn/100 L over the two-year monitoring period. The geometric mean of samples at OTR13, OTR18 and ORT23 exceeded the geometric mean standard of 126 org/100 mL. Between stations OTR30 and OTR13, Otter Creek receives runoff from the Middlebury River, New Haven River and Lemon Fair River. E.coli concentrations in each of these contributing watersheds are elevated at times.

Figure 1. Summary of E.coli Results for Otter Creek sites, 2014-2015.



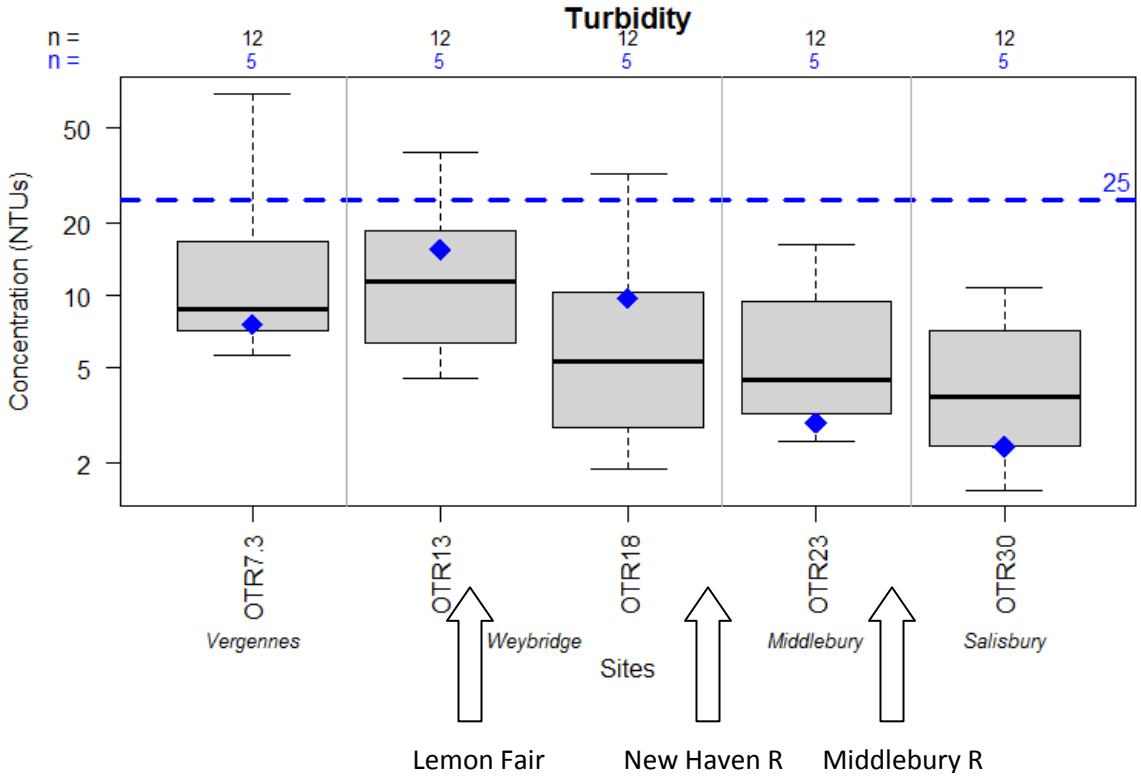
Nitrogen levels were detected at very low concentrations during the six spring and summer sampling dates, Concentrations ranged from 0.3 to 1.0 mg/L, with an average of 0.5 mg/L. These results are largely consistent with historic sampling results for nitrogen. A past standard for nitrogen as nitrate (5 mg/L) was eliminated during the 2014 update of the Vermont Water Quality Standards.

Turbidity levels at the Otter Creek stations ranged from 1.5 to 70 NTUs, with a mean value of 11 NTUs for the two seasons. The box-and-whisker plot in Figure 2 below shows the full distribution of Turbidity results for samples collected over the two seasons. The blue diamond marks the mean of that subset of samples collected during baseflow conditions, with the corresponding number of samples (n) indicated in blue along

the top of the chart. Results from 2014-2015 are largely consistent with historic trends. Based on past years' sampling results, turbidity can become elevated at times of increased flow – during a summer thunderstorm, or during spring runoff conditions. A modest increasing trend in turbidity with distance downstream is typically observed during all flow conditions.

The Vermont state standard of 25 NTUs (for Class B warm-water fisheries) is applicable during baseflow conditions. The mean of the turbidity values for the five baseflow events (blue diamonds in Figure 2) was below the standard at each station during the 2014 to 2015 sampling period. Turbidity was elevated at select downstream stations during moderate- to high-flow conditions. Turbidity values from contributing watersheds of the Middlebury River, New Haven River and Lemon Fair River were somewhat elevated on those high-flow dates.

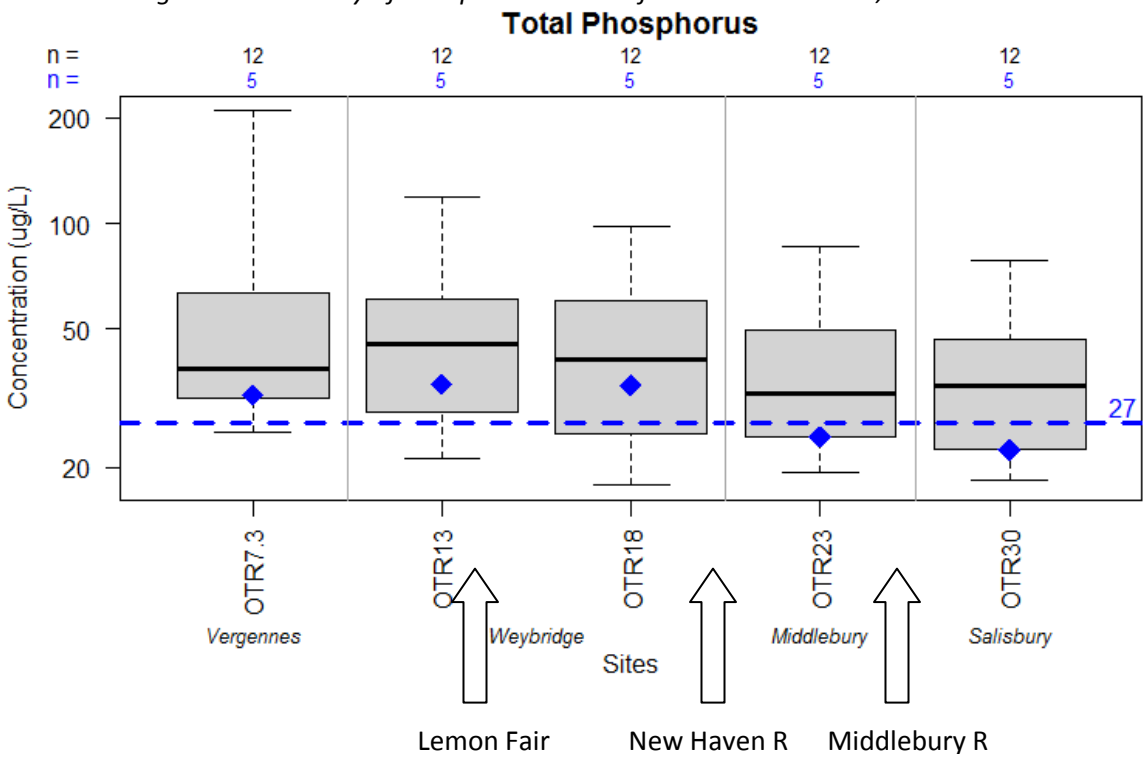
Figure 2. Summary of Turbidity Results for Otter Creek sites, 2014-2015.



Phosphorus levels at Otter Creek stations ranged from 18 to 210 ug/L, with a mean of 47 ug/L for the two seasons. The distribution of Phosphorus results is displayed in the box-and-whisker plot below. The blue diamond marks the mean of that subset of samples collected during baseflow conditions, with the corresponding number of samples (n) indicated in blue along the top of the chart.

For the three downstream stations, OTR18, OTR13 and OTR7.3, the mean Phosphorus concentration for the five available baseflow samples exceeded the approved instream nutrient standard of 27 ug/L for the warm-water medium gradient (WWMG) wadeable stream ecotype in Class B waters. These reaches of the Otter Creek might instead be classified as a Slow Winder stream ecotype, but criteria have not yet been developed for this stream classification.

Figure 3. Summary of Phosphorus Results for Otter Creek sites, 2014-2015.



Results were consistent with historic trends, which generally indicate a modest increase in concentrations with distance downstream. At all stations, moderately high concentrations of Total Phosphorus have been detected in past years at times of high flow and runoff.

The percent of total phosphorus present in the dissolved form varied with flow stage during the 2014 and 2015 sample dates. Generally, dissolved phosphorus represented a higher percentage of the Total Phosphorus concentration during low-flow conditions. This pattern likely reflects the greater relative contribution of sediment-sorbed forms of phosphorus during moderate to high flows.

2016: Beginning in 2016 and continuing through 2019, the Otter Creek watershed will rotate out of focused monitoring, and sampling will be conducted for a reduced number of parameters at sentinel stations only. The number of sampling locations in this watershed will be reduced to two sentinel stations, OTR18 and OTR7.3, as the focus of more intensive sampling rotates to another Collaborative watershed.

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