

Summary Report: 2011 Sampling Results
Addison County Riverwatch Collaborative

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<http://www.lewiscreek.org/addison-county-riverwatch-collaborative/>

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1.0 Introduction

This report provides a brief summary of the 2011 sampling results for the Addison County Riverwatch 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 and Kevin Behm of the Addison County Regional Planning Commission. Analytical services were provided by the LaRosa Analytical Laboratory in Waterbury, 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 2011 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:

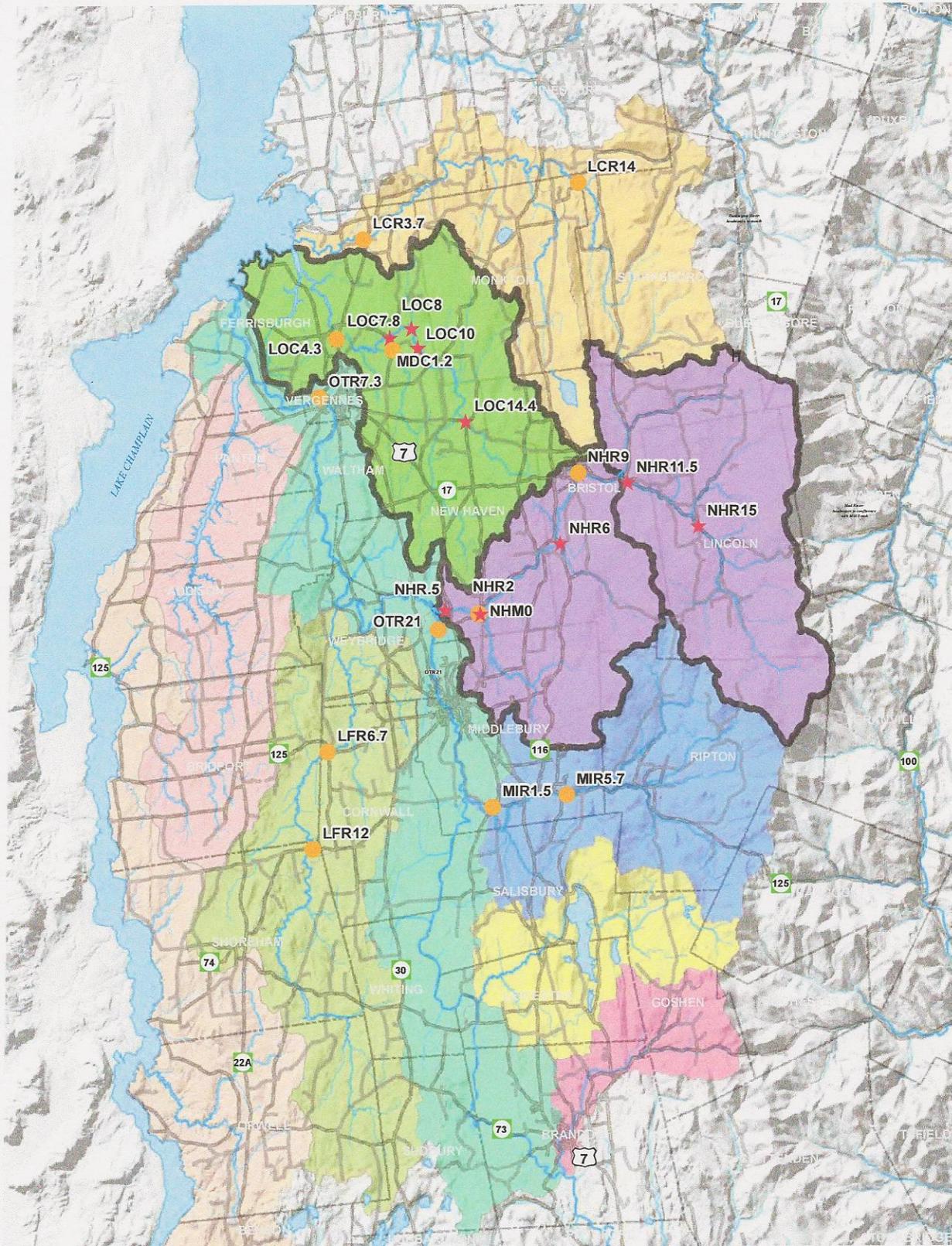
- Lemon Fair River (2003 – present)
- Lewis Creek (1992 – present)
- Little Otter Creek (1997 – present)
- Middlebury River (1993 – present)
- New Haven River (1993 – present)
- Otter Creek (1992 – present)

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 Riverwatch Collaborative

Water Quality Monitoring Sites by Watershed, 2011



- ★ Rotation Basin Site 2011
- Sentinel Site
- Little Otter Creek
- New Haven 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
- Roads**
- Pavement
- Gravel

The Addison County Riverwatch 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.



Table 1. Rotational Schedule for Focused Monitoring

<u>2010-2011</u>	<u>2012 – 2013</u>	<u>2014 - 2015</u>
Little Otter Creek	Lewis Creek	Middlebury River
New Haven River	Lemon Fair	Otter Creek

Beginning with the 2010 sampling season, Little Otter Creek (including Mud Creek) and New Haven 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 2a displays the schedule of sampling sites and parameters for the 2011 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 was added to the list for Summer events.

As a result of 2009 scoping meetings with VTDEC, and consistent with updated goals and objectives for the ACRWC monitoring program, a flow study was undertaken in 2010 in the Little Otter Creek watershed (see separate report: Appendix J of Phase 2 Stream Geomorphic Assessment Report; SMRC, 2011). Limited storm event sampling continued into the Spring of 2011. A 2011 schedule of sampling sites and parameters for the flow study is presented in Table 2b.

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. Samples were delivered to the LaRosa Analytical Laboratory in Waterbury, Vermont, for analysis. A Quality Assurance Summary report for the 2011 sampling data was submitted under separate cover.

During 2011, ACRWC volunteers collected grab samples at 21 sites in these six watersheds during two Spring events (April and May) and three of four scheduled Summer events (June, July, August and September). The September 7 event was cancelled due to damages sustained at the LaRosa Laboratories facility in the wake of Tropical Storm Irene (28-29 August 2011). Sampling dates were pre-determined as the first Wednesday of each month, and were not designed to capture any specific flow condition:

- April 6
- May 4
- June 1
- July 6
- August 3

Table 2a. 2011 Schedule of Sites / Parameters – Spring and Summer

Site Types: R = Rotational; S = Sentinel

ACRWC proposed 2011 sampling dates are: Spring: April 6, May 4; Summer: June 1, July 6, August 3, September 7 (Wednesdays)

No E.coli samples will be collected during Spring events (April, May), only during Summer events (June, July, Aug, Sept)

Project Name: Addison County River Watch Collaborative

Project Number: 137-01

Sample Year: 2011				Spring Schedule (Apr, May)					Summer Schedule (Jun, Jul, Aug, Sep)						
				PARAMETERS					PARAMETERS						
Type	River Name	Site ID	Site Location	E.coli	TP	DP	TN	Turbidity	TSS	E.coli	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	
S	Lemon Fair River	LFR12	Downstream of Route 74 bridge		X		X	X		X	X		X	X	
R	Little Otter Creek	LOC14.4	Plank Rd.		X	X	X	X	X	X	X	X	X	X	X
R	Little Otter Creek	LOC10	Monkton Road		X	X	X	X	X	X	X	X	X	X	X
R	Little Otter Creek	LOC8	Wing Road bridge		X	X	X	X	X	X	X	X	X	X	X
R	Little Otter Creek	LOC7.8	Middlebrook Rd (North)		X	X	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	X	X
S	Mud Creek	MDC1.2	Wing Rd./Middlebrook Rd. (South)		X	X	X	X	X	X	X	X	X	X	X
S	Middlebury River	MIR1.5	Shard Villa Rd. Bridge		X			X		X	X			X	
S	Middlebury River	MIR5.7	Midd. Gorge @ Rte 125 Bridge		X			X		X	X			X	
R	New Haven River	NHR.5	Dog Team Tavern		X			X		X	X			X	
S	New Haven River	NHR2	Muddy Branch confluence		X			X		X	X			X	
R	Muddy Branch	NHM0	Confluence with NHR (~100 ft upstream)		X			X		X	X			X	
R	New Haven River	NHR11.5	Bartlett's Falls Pool		X			X			X			X	
R	New Haven River	NHR15	S. Lincoln Bridge (Gap Rd.)		X			X			X			X	
R	New Haven River	NHR6	Route 116 Bridge, Sycamore Park		X			X		X	X			X	
S	New Haven River	NHR9	South St. Bridge		X			X		X	X			X	
S	Otter Creek	OTR21	Belden Falls		X		X	X		X	X		X	X	
S	Otter Creek	OTR7.3	Vergennes Falls/below outfall		X		X	X		X	X		X	X	

Table 2b. 2011 Schedule of Sites / Parameters – Flow Study

Site Types: R = Rotational; S = Sentinel

Project Name: Addison County River Watch Collaborative

Project Number: 137-01

				Flow Study (pending storm events)					
Sample Year: 2011				PARAMETERS					
Type	River Name	Site ID	Site Location	E.coli	TP	DP	TN	Turbidity	TSS
S	Lewis Creek	LCR3.7	Old Route 7 Bridge						
S	Lewis Creek	LCR14	Tyler Bridge						
S	Lemon Fair River	LFR6.7	Route 125 bridge.						
S	Lemon Fair River	LFR12	Downstream of Route 74 bridge						
R	Little Otter Creek	LOC14.4	Plank Rd.		X	X		X	X
R	Little Otter Creek	LOC10	Monkton Road		X	X		X	X
R	Little Otter Creek	LOC8	Wing Road bridge						
R	Little Otter Creek	LOC7.8	Middlebrook Rd (North)		X	X		X	X
S	Little Otter Creek	LOC4.3	Route 7 Bridge		X	X		X	X
S	Mud Creek	MDC1.2	Wing Rd./Middlebrook Rd. (South)						
S	Middlebury River	MIR1.5	Shard Villa Rd. Bridge						
S	Middlebury River	MIR5.7	Midd. Gorge @ Rte 125 Bridge						
R	New Haven River	NHR.5	Dog Team Tavern						
S	New Haven River	NHR2	Muddy Branch confluence						
R	Muddy Branch	NHM0	Confluence with NHR (~100 ft upstream)						
R	New Haven River	NHR11.5	Bartlett's Falls Pool						
R	New Haven River	NHR15	S. Lincoln Bridge (Gap Rd.)						
R	New Haven River	NHR6	Route 116 Bridge, Sycamore Park						
S	New Haven River	NHR9	South St. Bridge						
S	Otter Creek	OTR21	Belden Falls						
S	Otter Creek	OTR7.3	Vergennes Falls/below outfall						

In the focus watershed, Little Otter Creek, the flow study was designed to rely on Spring and Summer sampling results from the ACRWC program for select stations, as well as separate samplings of storm events which occurred outside the regular ACRWC monitoring schedule. Four such events were sampled during the Spring of 2011:

- March 5 & 6
- March 15
- April 4 (paired with regularly-scheduled sample date, April 6)
- April 27 & 29

Grab samples were collected at each of four stations during these events (where accessible) to monitor changes in concentrations of Total Phosphorus, Dissolved Phosphorus, Turbidity and Total Suspended Solids through the storm hydrograph. Due to ice cover, LOC4.3 was not sampled on March 5, 6, or 15, and LOC7.8 was not able to be sampled on March 5.

4.0 Precipitation Data

Precipitation data were compiled from existing weather stations and USGS gaging stations in vicinity of the ACRWC watersheds (Appendix B). Calendar year 2011 was a substantially wetter-than-normal year, due in part to greater-than-normal monthly rainfall totals in April and May, August and September, as recorded at regional weather stations in South Burlington (Airport), Rutland, and South Lincoln, Vermont (Table B1). Snowfall in the winter of 2010–2011 was greater than normal as recorded at these three weather stations (NOAA Online Weather Data, accessed Jan 2012). Based on USGS provisional real-time gaging records, ice-out in the lower Lewis Creek, Little Otter Creek watersheds occurred in mid- March (on or about March 19, 2011); whereas, ice-out occurred in the lower New Haven River on approximately March 7.

Several moderate to substantial storm events impacted the Addison County region during water year 2011.

- Sept 30 / Oct 1, 2010: this storm event straddled the end of water year 2010 and beginning of water year 2011 (NCDC, 2012). Further details of this event are provided in the Summary Report: 2010 Sampling Results (ACRWC/SMRC, Feb 2011).
- April 26 – 28, 2011: More than three inches of rain fell in northern Addison County, combined with meltwaters from a greater-than-normal snowpack, to result in localized flooding (NCDC, NOAA). Flash flooding and road washouts were documented in Starksboro in the upper Lewis Creek (NCDC and volunteer observations).
- May 26 – 28, 2011: More than two inches of rain fell in northern Addison County, resulting in localized flooding and road closures in Bristol (Route 116, Route 17) and Vergennes (Route 7) in the New Haven River and the Little Otter Creek & Otter Creek watersheds, respectively (NCDC).

- August 28- 29, 2011: Tropical Storm Irene impacted the state of Vermont. Impacts were particularly devastating in central and southern Vermont. In the ACRWC watersheds, damages were sustained to roads and property in the New Haven River and Middlebury River watersheds, in particular. Table 4 summarizes the rainfall recorded at regional weather stations during TS Irene.

Table 4. Precipitation at Regional Weather Stations during TS Irene, 28-29 August 2011

Precipitation Gage	Elevation (ft amsl)	Distance from center of Little Otter Creek watershed	Total Rainfall (inches)
New Haven River at Brooksville, VT (USGS Gage # 04282525) ¹	235	7.8 mi S	3.58
South Lincoln, VT ²	1,370	13.6 mi SE	6.35
Burlington, VT (Airport) ²	330	20 mi N	3.38
Rutland, VT ²		40 mi SSE	4.53

¹ Provisional precipitation data, http://nwis.waterdata.usgs.gov/vt/nwis/uv?site_no=04282525

² NOAA Online Weather Data: <http://www.weather.gov/climate/xmacis.php?wfo=btv>

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, at 66.5 % of this 944 square mile basin.

Flow records are available for the past 21 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. 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 21 years of record, mean annual flows in these ACRWC watersheds for water year 2011 were well above average and represented the maximum recorded over the time period.

Maximum recorded mean annual flows in water year 2011 resulted from a combination of factors:

- a significant and wide-spread Fall storm event at the beginning of the water year;
- a much higher-than-average snow pack stored in the mountains over the winter months;
- several spring storm events yielding bankfull or higher flows; and
- effects of Tropical Storm Irene in late summer.

Table 5. Mean Annual Flows, 1991 – 2011, ACRWC watersheds.

<i>Watershed</i>	Little Otter Creek		New Haven River		Lewis Creek	
<i>Drainage Area (sq mi)</i>	73		116		81	
<i>Gaged Area (sq mi)</i>	57.1		115		77.2	
Min (1991-2011)	2002	27	1995	129	1995	54
Max (1991-2011)	2011	145	2011	377	2011	214
Mean (1991-2011)	68		221		110	
Water Year 2011	145		377		214	

Note: Estimates for water year 2011 (red text) are calculated from provisional Daily Mean Flows, accessed 11 Jan 2012 online at: <http://waterdata.usgs.gov/vt/nwis/rt>

Storm Events:

- Sept 30 / Oct 1, 2010: For the Lewis Creek and New Haven River watersheds, this storm event resulted in a flood of 10- to 25-year magnitude. In the Little Otter Creek, this storm resulted in a bankfull event. Peak flow in each of the ACRWC watersheds was higher during this event than at any time during the previous water year (ending September 30, 2010).
- April 26 – 28, 2011: In the Lewis Creek, this localized storm event yielded a peak flow of 100-year magnitude (April 27), while bankfull flows were recorded in the Little Otter Creek and New Haven River. As part of the flow study in the Little Otter Creek (reported separately), grab samples were collected at each of four stations twice during this flow event: LOC14.4, LOC10, LOC7.8 and LOC4.3.
- May 26 – 28, 2011: A near bankfull event was recorded in the New Haven River watershed on May 27.
- August 28- 29, 2011, Tropical Storm Irene yielded a peak flow (August 28) on the order of a 100-year storm in the New Haven River watershed (see Figure 2). In contrast, the Lewis Creek experienced a peak flow (on August 29) that ranked between a 2-year and 5-year storm. Water rose gradually in the Little Otter Creek peaking at a sub-bankfull stage on August 30. A similar delayed peak was recorded on the Otter Creek at Middlebury on September 2, representing a 5- to 10-year storm.

Figure 3 presents mean daily flows in the Little Otter Creek, New Haven River and Lewis Creek. Flows have been normalized to gaged drainage area. Generally, New Haven River tends to exhibit more flashy flows, and often has a somewhat higher flow per unit area than the Lewis Creek and Little Otter Creek. In water year 2011, the storms of April 27-28 and May 27 appeared to have a greater impact in the Lewis Creek, possibly due to the localized nature of precipitation falling in northern Addison and southern Chittenden Counties.

Instantaneous Flow (Provisional) - New Haven River at Brooksville, Nr Middlebury, VT (USGS Stn# 04282525)

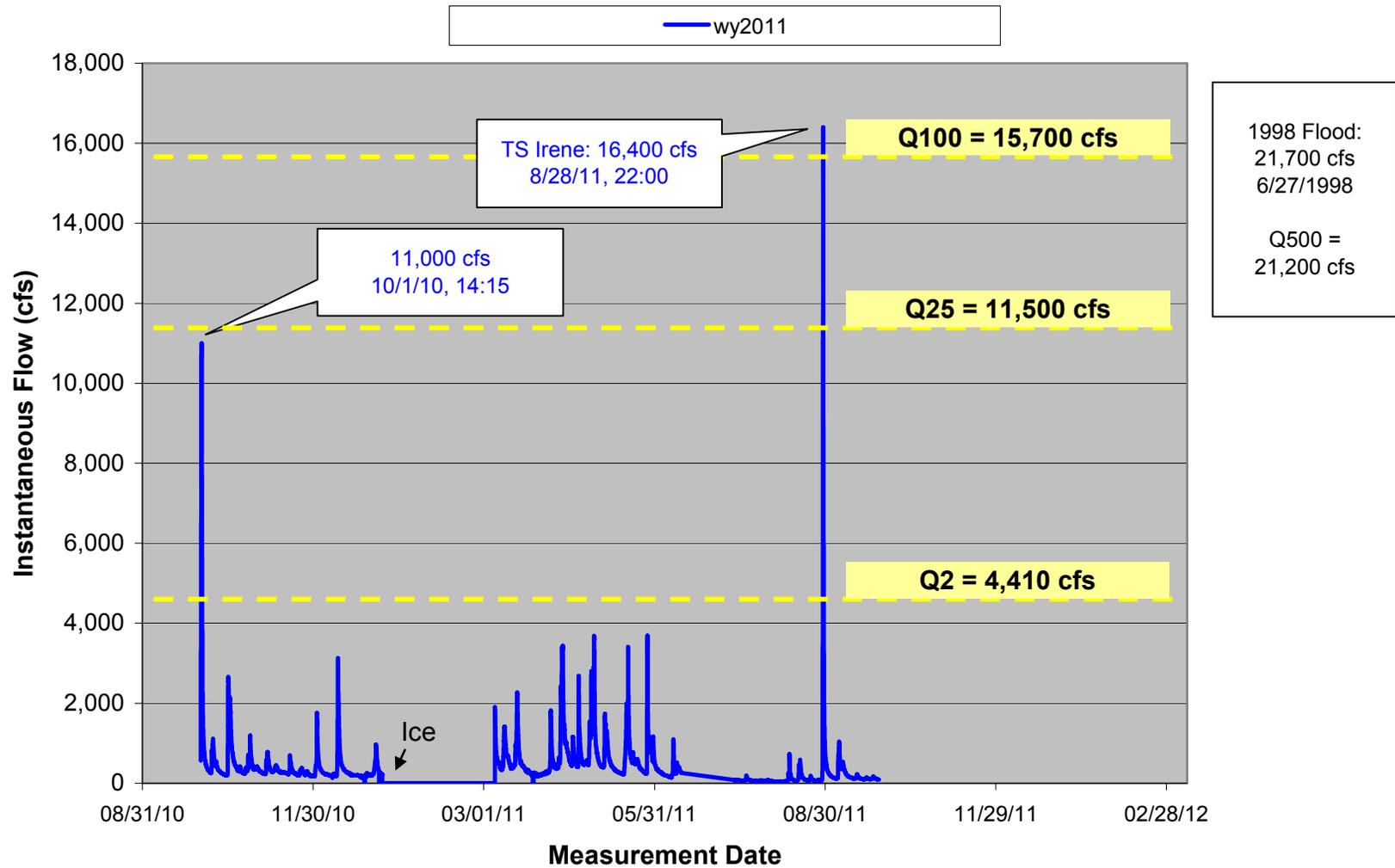


Figure 2. Instantaneous Flows (Provisional) on the New Haven River, Water Year 2011

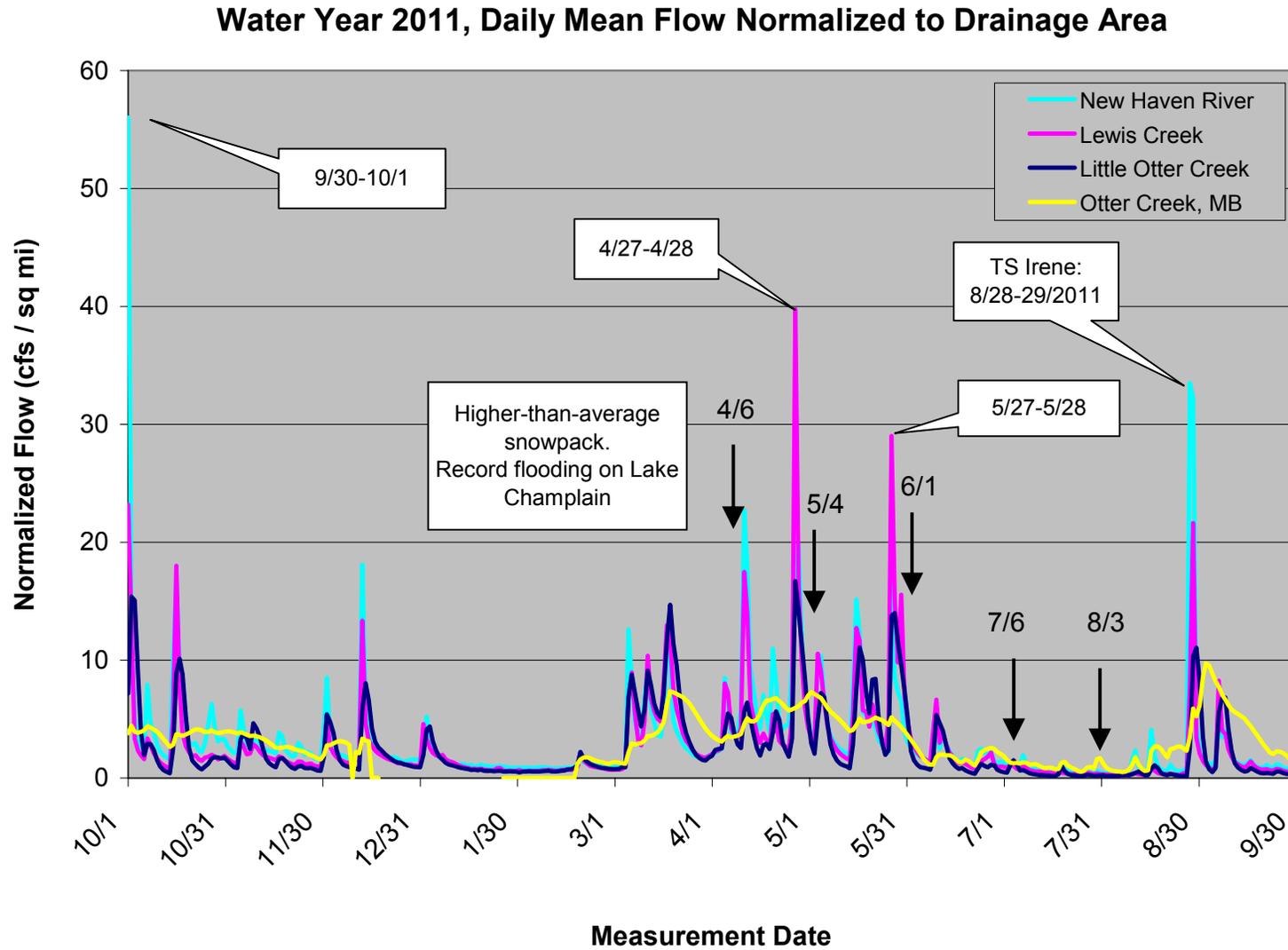


Figure 3. ACRWC Scheduled Spring and Summer Sampling Dates relative to Mean Daily Flows normalized to Gaged Drainage Area.

Spring sampling dates (April 6, May 4 and June 1) coincided with moderate to high stages in area rivers where discharge was either on the rise or the decline associated with spring rains and snow melt (Figure 3; Table B-3 in Appendix B).

Summer sampling dates (July 6 and August 3) generally coincided with low to base flow conditions (Figure 3; Figure 3; Table B-3 in Appendix B). Days immediately preceding the July and August sampling dates were generally dry.

6.0 Sample Results

Appendix C contains quality-assured sample results for the 2011 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 Little Otter Creek and New Haven River were chosen as focus watersheds for 2011 (and previous year 2010). Therefore, sample results are presented for sentinel as well as rotational sites in these watersheds.

In general, water quality results for 2011 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 77 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. *E.coli* concentrations tended to be higher during low-flow events. However, *E.coli* counts were below the state standard at popular swimming sites, such as the Middlebury Gorge on the Middlebury River and Bartlett's Falls, South Street and Sycamore Park on the New Haven River. 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.

Turbidity concentrations in each watershed exceeded the VWQS at one or more stations during the 2011 season. In the mountainous watersheds of Lewis Creek, Middlebury River, and New Haven River (shaded yellow in Table A-1), turbidity tended to exceed the standard of 10 NTUs during high flows in the spring and early summer. 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) was exceeded on a more frequent basis, independent of flow condition. 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 2011, the turbidity standard at the two sentinel stations on Otter Creek was exceeded only once - during the April 6 event.

Phosphorus is monitored in the Addison County watersheds with respect to two main objectives. First, total phosphorus concentrations are compared to proposed instream nutrient criteria (VTDEC WQD, 2009) 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 of at least three low-flow phosphorus concentrations collected on non-consecutive days is compared to the proposed phosphorus criteria. Because 2011 was such a wet year, and due to the cancellation of the September event following TS Irene, only two low-flow measurements of phosphorus were available for 2011. Mean low-flow concentrations of phosphorus in the valley watersheds (Lemon Fair, Little Otter Creek) and in Otter Creek exceeded the proposed instream phosphorus criteria. On the other hand, in the mountainous watersheds, phosphorus concentrations generally did not exceed the proposed instream phosphorus criteria. One exception was the station located on Muddy Branch in the lower New Haven River watershed. This subwatershed has characteristics similar to the valley watersheds, with higher percentages of silt/clay-rich soils, and an increased density of phosphorus sources related to agriculture. The Pond Brook subwatershed of the Lewis Creek also has characteristics similar to the valley watersheds. Based on past years' sample results, relatively high concentrations of phosphorus are detected in this tributary. Pond Brook was not sampled in 2011 or 2010, but will be the subject of a more comprehensive study in 2012-2013, as Lewis Creek rotates to a focus watershed for the next two years.

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 – generally occurring in the spring or fall months. In 2010 and 2011, the Collaborative carried out a flow / loading study in the Little Otter Creek; results are reported separately. A similar study will be carried out in the Pond Brook (Lewis Creek) in 2012.

Nitrogen was monitored in two of the Addison County watersheds in 2011: Lemon Fair River and Little Otter Creek. None of the detected concentrations exceeded the VWQS of 5 mg/L for nitrogen as nitrate. However, the mean concentration of total nitrogen for the two available low-flow summer sample dates exceeded the proposed instream nitrogen criteria for each of the sample stations in these two watersheds.

7.0 References

- ACRWC and South Mountain Research & Consulting, Feb 2011, *Summary Report: 2010 Sampling Results*.
- Olson, Scott A., 2002, Flow-Frequency Characteristics of Vermont Streams. USGS Water-Resources Investigations Report 02-4238.
- National Climatic Data Center, 2012, Event Narratives for Flood Events in Addison County, Vermont, accessed on 12 January 2012 at: <http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~storms>
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http://www.anr.state.vt.us/dec/waterq/lakes/docs/lp_2009nutrientcriteria.pdf
- Vermont Natural Resources Board, 2008. *Vermont Water Quality Standards*. Effective January 1, 2008. Montpelier, VT. <http://www.nrb.state.vt.us/wrp/rules.htm>

Appendix A

Physical Features of Watersheds Monitored by Addison County Riverwatch 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) NGM CV		Soils (2) (% Lake Sediments)	% Hydric Soils	% Wetlands (VSWI)	Topography Relief (ft) Gradient (ft / mile)		Major Land Cover/ Land Use Forest Agric Urban			Stream Classification (Class B) (3)
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) 330 ft amsl 20 miles N	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	2009	1.76	1.81	1.90	1.86	5.25	5.25	4.62	2.32	3.67	2.98	2.98	3.02	37.42
	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
	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
Rutland, VT 620 ft amsl 40 miles SSE	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	2009	2.29	1.98	2.04	1.96	4.43	3.86	9.30	7.71	2.27	4.76	3.64	3.00	47.24
	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
	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

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

Data Sources: ¹ National Climatic Data Center, 2002, Climatology 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 (Airport)	1971-2000	0	0	0	0.3	7.2	17.1	20.9	15.3	15.4	5.8	0.0	0	81.9
	2009-2010	0	0	0	0.0	0.0	17.7	48.4	24.0	0.9	5.5	0.0	0	96.5
	2010-2011	0	0	0	0.1	0.3	27.9	26.9	43.1	29.3	0.8	--	--	128.4
South Lincoln, VT	1981-2000	0	0	0	2.2	13.9	26.9	29.6	22.8	24.5	10.5	0.7	0	131.1
	2009-2010	0	0	0	0.1	1.1	26.0	22.5	33.0	3.2	10.0	1.0	0	96.9
	2010-2011	0	0	0	2.2	4.0	39.5	42.3	40.2	26.2	1.8	--	--	156.2
Rutland, VT	1971-2000	0	0	0	0.3	5.6	13.5	16.7	13.9	12.4	3.6	0.0	0	66.0
	2009-2010	0	0	0	0.0	0.0	18.2	15.9	19.9	0.1	2.1	0.0	0	56.2
	2010-2011	0	0	0	0.0	0.9	21.3	26.8	37.2	14.6	0.9	--	--	101.7

Total snowfall in inches. Values for 1971-2000 period reflect averages for the time period. Values for 2009-2011 seasons are totals.

Source: <http://www.weather.gov/climate/xmacis.php?wfo=btv>

data available as of Jan 2012

Table B-3. Flows recorded in Addison County rivers, 2011

	<i>River</i> USGS Gage # Drainage Area (sq mi)	Little Otter Ck #04282650 57.1	Lewis Creek #04282780 77.4	New Haven River #04282525 115	Otter Ck MB #04282500 630
Sample Dates	3/5/2011	52			
(Daily Mean Flows)	3/6/2011	390			
(cfs)	3/15/2011	315			
	4/4/2011	144			
	4/6/2011	313	560	759	2,240
	4/27/2011	953			
	4/29/2011	647			
	5/4/2011	287	814	1,120	4,370
	6/1/2011	288	362	348	2,280
	7/6/2011	37	58	112	773
	8/3/2011	11	21	46	442
Water Year 2011	10/1/2011		3,100	11,000	
Storm Events	10/2/2011	1,000			
(Peak Flows)	4/27/2011	1,120	4,690	2,800	
(cfs)	4/28/2011			3,680	
	5/27/2011	N/A	N/A	3,690	
	8/28/2011			16,400	
	8/29/2011		2,480		
	8/30/2011	658			
	9/2/2011				6,180
Peak Flows	Q2	1,120	2,280	4,410	4,270
(Olson, 2002; Table 2)	Q5	1,640	2,990	6,980	5,840
	Q10	1,990	3,420	8,870	6,970
	Q25	2,440	3,920	11,500	8,480
	Q50	2,790	4,270	13,500	9,680
	Q100	3,130	4,590	15,700	10,900
	Q500	3,950	5,290	21,200	14,200

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 (insufficient sample volume)
NM = Not Measured

J = estimated value; constituent was present in an associated field blank and the concentration of constituent in the primary sample was more than 5 times the value detected in the field blank, and/or the calculated relative percent difference for an associated field duplicate pair exceeded target value.

R = rejected value; constituent was present in an associated field blank and the concentration of constituent in the primary sample was within 5 times the value detected in the field blank.

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

Lemon Fair River

Location	Date	E. Coli. (mpn/100ml)	TN (mg/L)	TP (ug/L)	Turbidity (NTU)
LFR12	4/6/2011		0.61	132	89
LFR6.7	4/6/2011		0.49	93.3	62.8
LFR12	5/4/2011		0.72	144	64
LFR6.7	5/4/2011		0.76	149	46.2
LFR12	6/1/2011	127	0.97	230 J	56.6
LFR6.7	6/1/2011	42	1.06	307 J	11.3
LFR12	7/6/2011	249	1.01	240	91.2 J
LFR6.7	7/6/2011	248	1.36	270	91.3 J
LFR12	8/3/2011	613	1.29	266	84.1
LFR6.7	8/3/2011	43	1.29	296	15.1

Lewis Creek

Location	Date	E. Coli. (mpn/100ml)	TP (ug/L)	Turbidity (NTU)
LCR14	4/6/2011		184	20.5
LCR3.7	4/6/2011		368	61.5
LCR14	5/4/2011		220	63
LCR3.7	5/4/2011		308	136
LCR14	6/1/2011	91	41	9.41
LCR3.7	6/1/2011	167	91.6	28.2
LCR14	7/6/2011	411	19.9	2.36
LCR3.7	7/6/2011	132	36.5	8.03
LCR14	8/3/2011	770	19.7	4.33
LCR3.7	8/3/2011	48	24.6	9.48

Little Otter Creek

Location	Date	E. Coli. (mpn/100ml)	TN (mg/L)	TP (ug/L)	DP (ug/L)	TSS (mg/L)	Turbidity (NTU)	DP % of Total P
LOC14.4	3/5/2011			36.3	24.8	-- R		68.3%
LOC10	3/5/2011			48.2	32.3	-- R		67.0%
LOC14.4	3/6/2011			170	63.8	83.2 J		37.5%
LOC10	3/6/2011			121	56.4	42.6 J		46.6%
LOC7.8	3/6/2011			135	62.8	47.2 J		46.5%
LOC14.4	3/15/2011			103	63.5	35.2	19.5	61.7%
LOC10	3/15/2011			62.2	38.5	13.3	13.7	61.9%
LOC7.8	3/15/2011			98.1	54.2	28	30.2	55.2%
LOC14.4	4/4/2011			32.1	22.2	4.57	5.81	69.2%
LOC10	4/4/2011			43.9	30.3	5.58	8.5	69.0%
LOC7.8	4/4/2011			51.8	27.6	16.4	25.2	53.3%
LOC4.3	4/4/2011			54.8	31.3	13.5	25.6	57.1%
LOC14.4	4/6/2011		1.25	105	58.5	23.6	34.8	55.7%
LOC10	4/6/2011		0.78	90.1	51.9	15.9	38.3	57.6%
LOC8	4/6/2011		0.89	100	51.7	18.3	43.4	51.7%
LOC7.8	4/6/2011		0.81	110	45.8	37.4	65.8	41.6%
LOC4.3	4/6/2011		0.83	137	52.7	37.4	92.2	38.5%
MDC1.2	4/6/2011		0.49	82.5	55.3	10.6	29.3	67.0%
LOC14.4	4/27/2011			195	60.2	69	121	30.9%
LOC10	4/27/2011			333	40.6	171	396	12.2%
LOC7.8	4/27/2011			318	42.7	209	410	13.4%
LOC4.3	4/27/2011			335	54.3	206	428	16.2%
LOC14.4	4/29/2011			138	72.3	19.7	54.8	52.4%
LOC10	4/29/2011			114	53.5	15.9	59.4	46.9%
LOC7.8	4/29/2011			131	46.2	34	84.5	35.3%
LOC4.3	4/29/2011			171	58.7	32.4	130	34.3%
LOC14.4	5/4/2011		1.26	144	43.4	78.6	97.5	30.1%
LOC10	5/4/2011		1.2	166	61.4	59.6	106	37.0%
LOC8	5/4/2011		1.85	244	64.8	118	205	26.6%
LOC7.8	5/4/2011		1.26	232	55.5	131	180	23.9%
LOC4.3	5/4/2011		1.59	202	71.4	82	116	35.3%
MDC1.2	5/4/2011		3.17	374	155	104	174	41.4%
LOC14.4	6/1/2011	91	0.79	81.2	69.9 J	5.6	6.89	86.1%
LOC10	6/1/2011	142	0.59	139	114 J	11.2	10.6	82.0%
LOC8	6/1/2011	140	0.63	139	109 J	14.5	15.4	78.4%
LOC7.8	6/1/2011	345	0.59	168	104 J	48	52.4	61.9%
LOC4.3	6/1/2011	236	0.74	320	204 J	31.4	35.5	63.8%
MDC1.2	6/1/2011	127	0.85	382	295 J	11.2	8.33	77.2%
LOC14.4	7/6/2011	115	1.84	101	52	16.3	21.6	51.5%
LOC10	7/6/2011	517	1.05	185	104	37.7	40.3	56.2%
LOC8	7/6/2011	326	0.93	162	96.1	29.2	29.6	59.3%
LOC7.8	7/6/2011	248	0.91	168	90.7	34.7	42.6	54.0%
LOC4.3	7/6/2011	148	0.84	189	120	19.7	29.2	63.5%
MDC1.2	7/6/2011	225	0.85	298	196	16.3	17.5	65.8%
LOC14.4	8/3/2011	272	2.9	46.3	29.1	6.67	5.8	62.9%
LOC10	8/3/2011	56	1.91	84.1	NA	24.9	27	NM
LOC8	8/3/2011	NS	NS	NS	NS	NS	NS	NM
LOC7.8	8/3/2011	179	1.2	66.7	28.4	36.3	46.4	42.6%
LOC4.3	8/3/2011	31	0.9	37.4	28.9	2.95	6.69	77.3%
MDC1.2	8/3/2011	2420	1.33	206	96.4	17.7	25.8	46.8%

Middlebury River

Location	Date	E. Coli. (mpn/100ml)	TP (ug/L)	Turbidity (NTU)
MIR5.7	4/6/2011		13.8	2.48
MIR1.5	4/6/2011		83.8	22
MIR5.7	5/4/2011		29.4	5.35
MIR1.5	5/4/2011		75.8	16.6
MIR5.7	6/1/2011	7	9.06	0.42
MIR1.5	6/1/2011	59	41.6	5.73
MIR5.7	7/6/2011	6	10.4	-- R
MIR1.5	7/6/2011	517	33.7	5.07
MIR5.7	8/3/2011	11	8.23	0.36
MIR1.5	8/3/2011	206	26.5	5.03

New Haven River

Location	Date	E. Coli. (mpn/100ml)	TP (ug/L)	Turbidity (NTU)
NHR15	4/6/2011		9.9	1.81
NHR11.5	4/6/2011		14.8	2
NHR9	4/6/2011		13.5	2.4
NHR6	4/6/2011		23.1	3.14
NHR2	4/6/2011		55.3	22.8
NHR.5	4/6/2011		60	23.2
NHR15	5/4/2011		42.2	6.78
NHR11.5	5/4/2011		39.8	6.23
NHR9	5/4/2011		42.4	6.1
NHR6	5/4/2011		67.5	11.7
NHR2	5/4/2011		128	34.5
NHR.5	5/4/2011		92.9	22.5
NHM0	5/4/2011		72.2	25.6
NHR15	6/1/2011	47	6.14	0.51
NHR11.5	6/1/2011	19	8.73	1.04
NHR9	6/1/2011	15	10.8	0.99
NHR6	6/1/2011	30	11.9	1.03
NHR2	6/1/2011	61	21.9	4.11
NHR.5	6/1/2011	61	19.3	2.95
NHM0	6/1/2011	111	66.4	15
NHR15	7/6/2011		9.54	-- R
NHR11.5	7/6/2011		8.1	-- R
NHR9	7/6/2011	30	14.2	-- R
NHR6	7/6/2011	39	8.43	-- R
NHR2	7/6/2011	83	26.1	7.03 J
NHR.5	7/6/2011	66	17.7	2.64 J
NHM0	7/6/2011	142	65.1	20.3 J
NHR15	8/3/2011		6.26	< 0.2
NHR11.5	8/3/2011		6.89	0.26
NHR9	8/3/2011	23	6.5	0.34
NHR6	8/3/2011	32	6.72	0.41
NHR2	8/3/2011	204	24.6	8.8
NHR.5	8/3/2011	129	12.1	2.25
NHM0	8/3/2011	461	51.2	16.1

Otter Creek (Lower)

Location	Date	E. Coli. (mpn/100ml)	TN (mg/L)	TP (ug/L)	Turbidity (NTU)
OTR21	4/6/2011		0.53	53.8	19.5
OTR7.3	4/6/2011		0.55	97.4	54.6
OTR21	5/4/2011		0.3	36.6	5.69
OTR7.3	5/4/2011		0.38	46.9	11.2
OTR21	6/1/2011	32	0.47	62.1	5.61
OTR7.3	6/1/2011	37	0.55	82.1	6.98
OTR21	7/6/2011	93	0.52	36.2	3.86
OTR7.3	7/6/2011	69	0.58	58.9	10.2
OTR21	8/3/2011	93	0.82	43.8	3.14
OTR7.3	8/3/2011	60	0.85	99.6	15.4

Attachments

- 1 Lemon Fair River – 2011 Water Quality Summary
- 2 Lewis Creek – 2011 Water Quality Summary
- 3 Little Otter Creek – 2011 Water Quality Summary
- 4 Middlebury River – 2011 Water Quality Summary
- 5 New Haven River – 2011 Water Quality Summary
- 6 Otter Creek (Lower) – 2011 Water Quality Summary

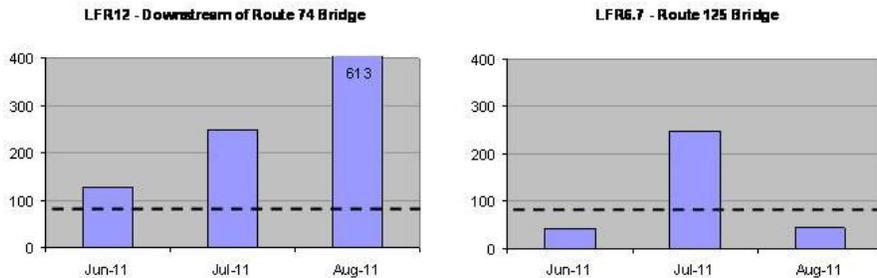
Addison County Riverwatch Collaborative Lemon Fair River - 2011 Water Quality Summary

The Addison County Riverwatch Collaborative has been monitoring water quality in the Lemon Fair River since 2003. In a non-focus year, two sentinel stations are monitored in this watershed, LFR12 and LFR6.7. During 2011, Lemon Fair sites were tested for phosphorus, nitrogen and turbidity on the first Wednesday in April and May (Spring sampling dates) and in June, July, and August (Summer sampling dates). E.coli was tested only on the Summer dates. A scheduled September event was cancelled due to damages sustained at the LaRosa Analytical Laboratory during Tropical Storm Irene. Flow in the river during the July and August sample dates represented low to baseflow conditions (based on area streamflow gages). Flows on the April, May and June dates were moderate to high, due to snow melt and spring rains.

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

E.coli counts in the Lemon Fair River at the Route 74 bridge site (LFR12) were above the state standard of 77 organisms/ 100 mL on all three Summer sampling dates: June 1, July 6, and August 3. E.coli levels at the downstream station at the Route 125 bridge (LFR6.7) also exceeded the standard on July 6. Detected E.coli counts at LFR12 and LFR6.7 were consistent with historic monitoring results.

E.Coli Vermont State Standard = 77 MPN / 100 mL



Turbidity levels in the Lemon Fair at the sampled stations ranged from 11 to 91 NTUs, with an average level of 61 NTUs for the five sample dates, including spring sampling dates, April 6 and May 4. Concentrations exceeded the Vermont state standard of 25 NTUs (for Class B warm-water fisheries) at LFR12 on all sample dates and at LFR6.7 on April 6, May 4 and July 6. Results for stations LFR12 and LFR6.7 were generally consistent with historic data.

Phosphorus was detected at moderate levels during the five Spring and Summer sampling dates. Concentrations ranged from 93 to 307 ug/L, with an average of 213 ug/L. The mean of the Summer, low-flow, sample results at each station (LFR12 = 253 ug/L and LFR6.7 = 283 ug/L) exceeded the recently proposed instream phosphorus criterion of 44 ug/L for warm-water medium gradient (WWMG) wadeable stream ecotype in Class B waters. It should be noted that mean values were developed on the basis of two sample dates only – since low-flow conditions were only encountered on July 6 and August 3. VTDEC guidance (2009) suggests that Summer-time low-flow means should be developed on the basis of at least three samples collected on nonconsecutive days.

Nitrogen concentrations were generally very low (ranging from 0.5 to 1.4 mg/L) and well below the state standard for nitrogen as nitrate (5 mg/L). The mean of the Summer, low-flow, sample results at sites LFR12 and LFR6.7 exceeded the recently proposed instream nitrogen criteria of 0.75 mg/L for WWMG wadeable stream ecotype in Class B waters (the mean at each station was developed from two samples only).

2012: A more intensive monitoring focus rotates back to the Lemon Fair for a two-year period beginning in the year 2012. The Addison County Riverwatch Collaborative will sample for additional parameters (including dissolved phosphorus and total suspended solids) and six rotational monitoring sites will be added to the two sentinel stations to round out the sampling schedule for 2012 and 2013. Two stations will be located on the Beaver Branch tributary in the lower watershed.

For more information, contact the Lemon Fair sampling coordinator:
Kathy Morse, 545-2859, kmorse@middlebury.edu

Addison County Riverwatch Collaborative Lewis Creek - 2011 Water Quality Summary

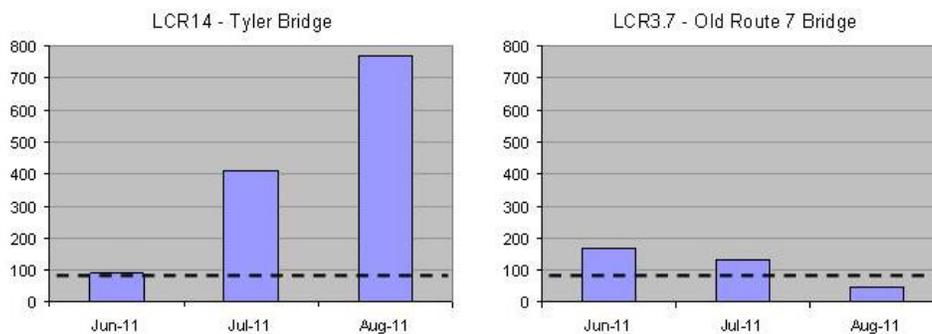
The Addison County Riverwatch Collaborative has been monitoring water quality in the Lewis Creek since 1992. In a non-focus year, two sentinel stations are monitored in this watershed, LCR3.7 and LCR14. During 2011, these sites were tested for phosphorus and turbidity on the first Wednesday in April and May (Spring sampling dates) and in June, July, and August (Summer sampling dates). E.coli was tested only on the Summer dates.

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

A scheduled September event was cancelled due to damages sustained at the LaRosa Analytical Laboratory during Tropical Storm Irene. Flow in the river during the July and August sample dates represented low to baseflow conditions (based on records for the USGS gage which operates just upstream of the Route 7 crossing). Flows on the April, May and June dates were moderate to high, due to snow melt and spring rains.

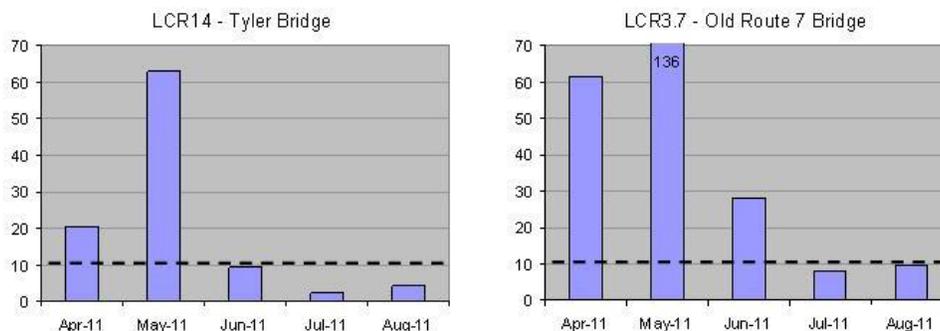
E.coli counts in the Lewis Creek at both sites exceeded the state standard of 77 organisms/100 mL on all three Summer sampling dates: June 1, July 6, and August 3, except for the August sample collected at LCR3.7. E.coli levels at the upstream site, Tyler Bridge (LCR14), were significantly higher than the downstream site, Old Route 7 Bridge (LCR3.7). Detected E.coli counts at these sentinel sites in the 2011 season were largely consistent with historic monitoring results.

E.Coli Vermont State Standard = 77 MPN / 100 mL



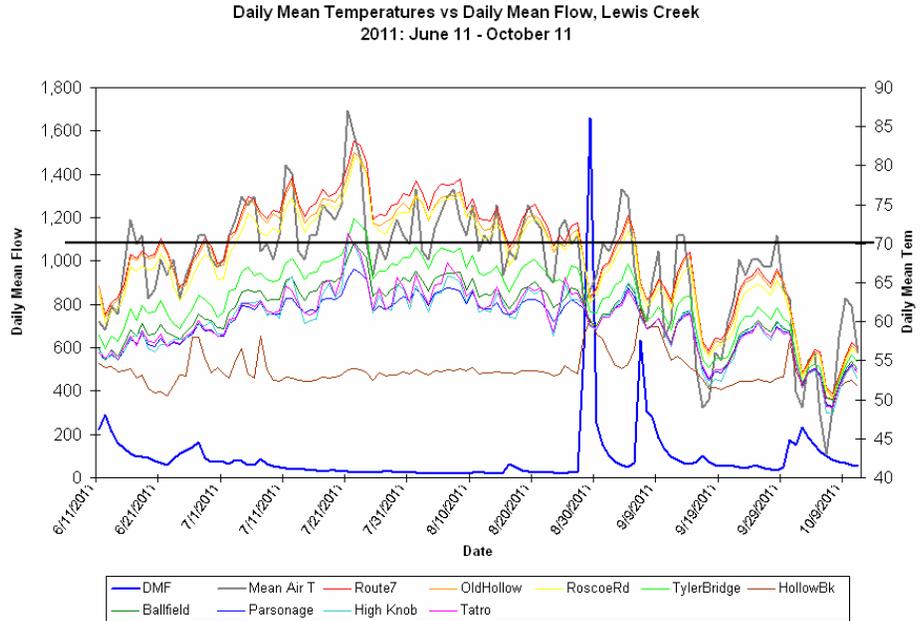
Turbidity levels in the Lewis Creek at the sampled stations ranged from 2.4 to 136 NTUs, with a mean level of 34 NTUs for the five sample dates, including two spring dates, April 6 and May 4. Turbidity levels exceeded the Vermont state standard of 10 NTUs (for Class B cold-water fisheries) at both sites during the spring sample dates; the result for station LCR3.7 also exceeded the standard on June 1. Flows on the Lewis Creek on April 6, May 4 and June 1 were moderate to high as a consequence of spring rains and snow melt (April). The May 4 samples were collected within days after an April 27-28 storm event. More than three inches of rain fell in northern Addison County, combined with meltwaters from a greater-than-normal snowpack. Flash flooding and road washouts were documented in Starksboro in the upper Lewis Creek. Peak flow recorded on April 27 at the gaging station near Route 7 indicated a 100-year flood magnitude.

Turbidity Vermont State Standard = 10 NTUs



Phosphorus was detected at low to moderate concentrations during the five Spring and Summer sampling dates, ranging from 20 to 368 ug/L, with an average of 131 ug/L. The mean concentration of Total Phosphorus for the two available low-flow Summer sample dates (July 6, August 3) at either sentinel site did not exceed the proposed criteria of 44 ug/L for the warm-water medium gradient (WWMG) Wadeable stream ecotype in Class B waters.

Temperature was monitored at nine stations on the Lewis Creek main stem and major tributaries during the summer of 2011 as part of a separate study funded by a Vermont Watershed Grant from the VT Department of Fish & Wildlife. Data loggers were deployed at these sites by Lewis Creek Association, VT Fish & Wildlife, and VT Department of Environmental Conservation. Temperatures in the lower main stem exceeded 70°F for several days during the mid-Summer. Generally, the mean daily water temperature increased with distance downstream, corresponding to a decrease in forest cover of the upstream watershed, and increased clearing of the landscape and riparian buffers for residential, commercial and agricultural land uses.



2012: A more intensive monitoring focus rotates back to the Lewis Creek for a two-year period beginning in the year 2012. The Addison County Riverwatch Collaborative will sample for additional parameters (including dissolved phosphorus and total suspended solids), and six rotational monitoring sites will be added to the two sentinel stations to complete the sampling schedule in 2012 and 2013.

The Pond Brook subwatershed of Lewis Creek will be the focus of a separate project of the Lewis Creek Association funded by an Ecosystem Restoration Program grant from the VT Agency of Natural Resources. Pond Brook has been identified as a major sediment and phosphorus loader to the Lewis Creek watershed based on Spring / Summer water quality monitoring from 2004 to present (Hoadley, 2011; available at: <http://lewis-creek.org/lewis-creek-water-quality>). Total Phosphorus concentrations have consistently been above levels which would suggest nutrient enrichment, and have been above the proposed instream nutrient criteria (44 ug/L) for Class B “warm-water medium-gradient” wadeable streams (VTDEC WQD, 2009).

In 2012, three additional water quality stations will be established in this subwatershed to complement the existing rotational site, which is located at the Silver Street crossing of Pond Brook. A temporary flow gaging station will also be established in Pond Brook to characterize the hydrology of this subwatershed, and to enable coarse calculations of nutrient and sediment yields in four sub-units of this watershed. Stream flow and water quality monitoring data will be used to inform and develop priority implementation projects on a sub-watershed scale. Coarse estimates of phosphorus yields from each sub-watershed will be used to communicate land use impacts on water quality and encourage landowner and municipal participation. In cooperation with local, state and federal partners, projects will be prioritized and developed to achieve reductions in phosphorus and sediment loading from this major tributary. Projects will include wetland restoration & conservation, livestock exclusion, riparian buffer plantings, alternate tillage and crop rotation practices, improved forest management techniques, and improved road maintenance practices.

For more information, contact the Lewis Creek sampling coordinator:
Louis DuPont, 453-5538, ldupont@gmavt.net

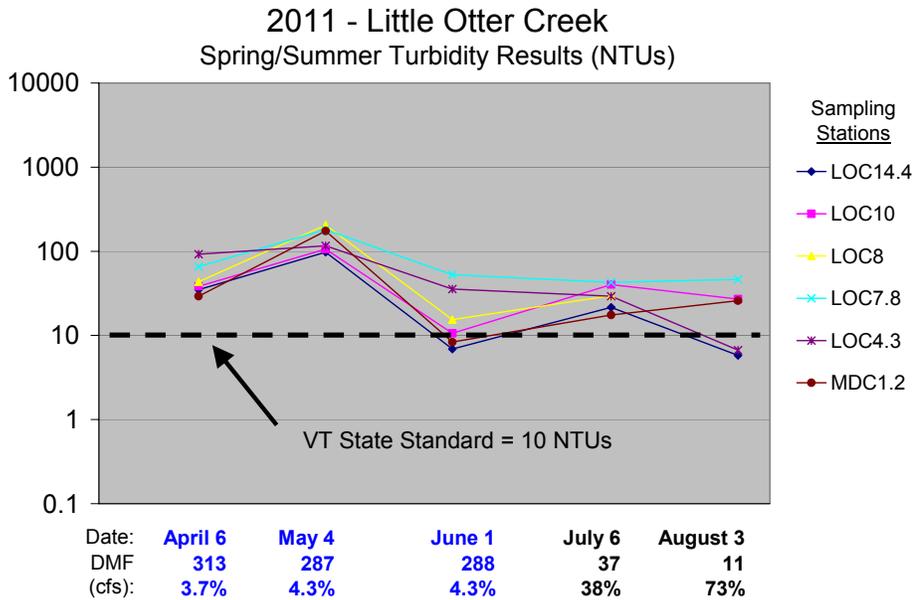
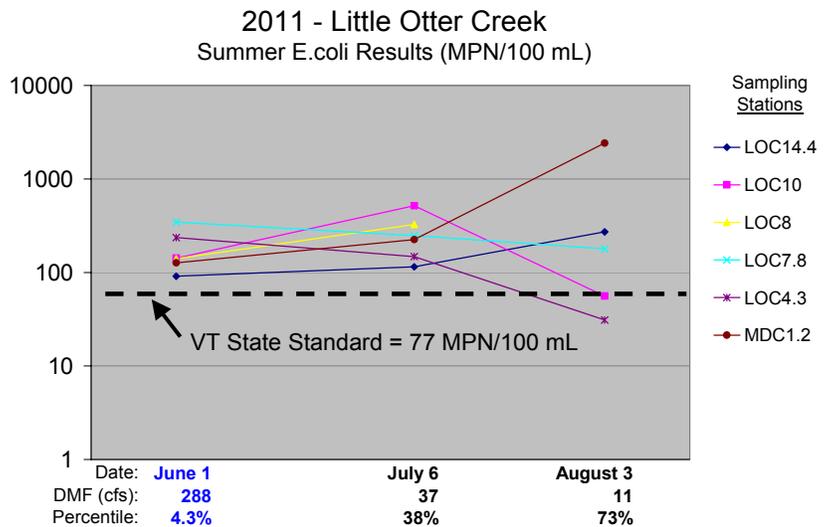
Addison County Riverwatch Collaborative
 Little Otter Creek - 2011 Water Quality Summary

2010 – 2011
 Focus Watershed

The Addison County Riverwatch Collaborative has been monitoring water quality in the Little Otter Creek since 1997. During 2011, six sites were tested for phosphorus, nitrogen and turbidity on the first Wednesday in April and May (Spring sampling dates) and in June, July, and August (Summer sampling dates). E.coli was tested only on the Summer dates. A scheduled September event was cancelled due to damages sustained at the LaRosa Analytical Laboratory during Tropical Storm Irene. Flow in the river during the July and August sample dates represented low to baseflow conditions (based on records for the USGS gage near the Route 7 crossing). Flows on the April, May and June dates were moderate to high, due to snow melt and spring rains.

Site	Location	Town
LOC14.4	Plank Rd.	New Haven
LOC10	Monkton Road	Ferrisburgh
LOC8	Wing Rd bridge	Ferrisburgh
LOC7.8	Middlebrook Rd (North)	Ferrisburgh
LOC4.3	Route 7 Bridge	Ferrisburgh
MDC1.2	Wing Rd./Middlebrook Rd. (South)	Ferrisburgh

E.coli counts in the Little Otter Creek stations were well above the state standard of 77 MPN / 100 mL on all three sample dates: June 1, July 6, & August 3, – except for stations LOC4.3 and LOC10 on August 3. Flows on the July and August sample dates were low, whereas flows were high during the June event following rains on May 27 and 28. E.coli concentrations detected at these stations during 2011 are relatively consistent with historic monitoring results. Mud Creek station (MDC1.2) has traditionally had elevated E.coli as it is located directly downstream of a dairy pasture where livestock have direct access to the stream.



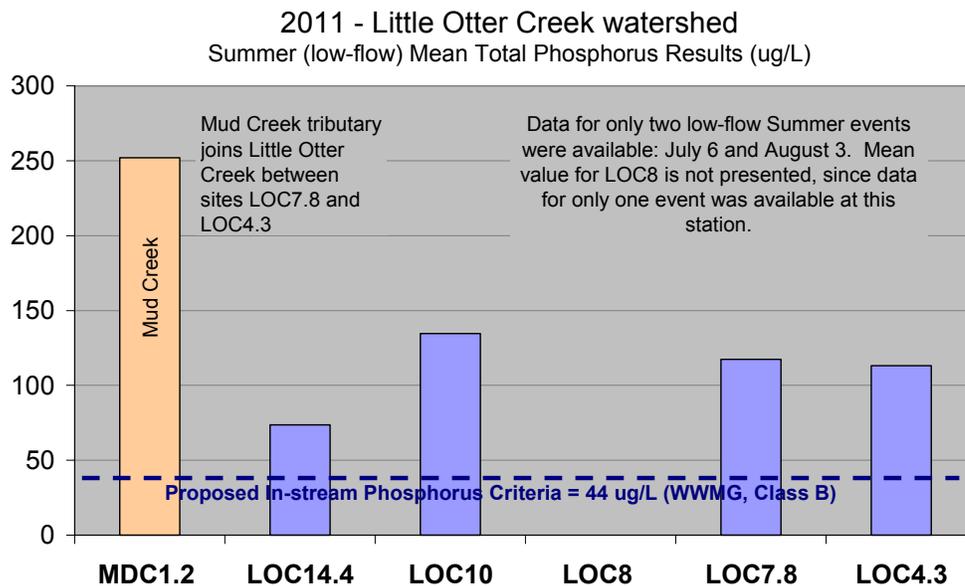
Turbidity levels in the Little Otter Creek at the six stations were moderate to high and often exceeded the Vermont standard of 10 NTUs (for Class B cold-water fisheries). Values ranged from 5.8 to 428 NTUs, with a mean level of 78 NTUs for the five sample dates, including the two spring sampling events on April 6 and May 4.

It is interesting to note that – for essentially the same flow condition (287 to 288 cfs) – turbidity values at all stations were significantly higher on May 4 than they were on June 1. This finding may be related to the greater prevalence of bare, unvegetated soils in the floodplains and along

banks of the river and contributing tributaries and ditches during the earlier May sampling event. The May 4 sampling event occurred during the rising limb of a streamflow hydrograph in response to a relatively minor

rain event that fell on grounds saturated from the April 27-28 storms. The June 1 sampling event took place on the falling limb of a storm hydrograph that peaked near a bankfull stage (on May 28) following heavy rains on May 27.

Phosphorus levels were detected at low to moderate concentrations during the five Spring and Summer sampling dates. Concentrations ranged from 32 to 382 ug/L, with an average of 152 ug/L for the May through August sample dates. Total Phosphorus concentrations detected in 2011 were generally consistent with historic data. Moderate to high concentrations of Total Phosphorus have been recorded in past years at times of high flow and runoff. Vermont recently proposed in-stream phosphorus criteria for aquatic life and aesthetics uses in wadeable streams (VTDEC, 2009). The mean concentration of Total Phosphorus for two, low-flow Summer sample dates exceeded the proposed criteria of 44 ug/L for the warm-water medium gradient (WWMG) wadeable stream ecotype in Class B waters.



Nitrogen concentrations in the Little Otter Creek were very low (ranging from 0.49 to 3.2 mg/L) and below the state standard for nitrogen as nitrate (5 mg/L). Vermont recently proposed in-stream nitrogen criteria for aquatic life and aesthetics uses in wadeable streams (VTDEC, 2009). The mean concentration of Total Nitrogen for the two available low-flow Summer sample dates exceeded the proposed criteria of 0.75 mg/L for the warm-water medium gradient (WWMG) wadeable stream ecotype in Class B waters.

2012: For years 2010 and 2011, the Little Otter Creek watershed was the subject of focused monitoring, including a flow study to evaluate nutrient and sediment loading. Results have been reported separately. Water quality data were used to calculate coarse estimates of phosphorus loading on a subwatershed basis as a means of prioritizing restoration and conservation efforts within the watershed. Regional, state and federal partners (NRCS, Ducks Unlimited, VT Land Trust) are making use of this data with a focus on lands that drain to the creek north of Plank Road and east of Monkton Road. Conservation easements and Wetland Reserve Program projects are being implemented where landowners are willing. UVM Extension and VT Agency of Agriculture are also referencing ACRWC water quality data as they work with farmers in the watershed, including Large Farm and Medium Farm Operations, to implement improved agronomic practices such as livestock exclusion, cover cropping, increased buffers, and incorporation of manure.

In years 2012 through 2015, the Little Otter Creek watershed will rotate back to a reduced frequency of monitoring at two sentinel stations, LOC4.3 and MDC1.2.

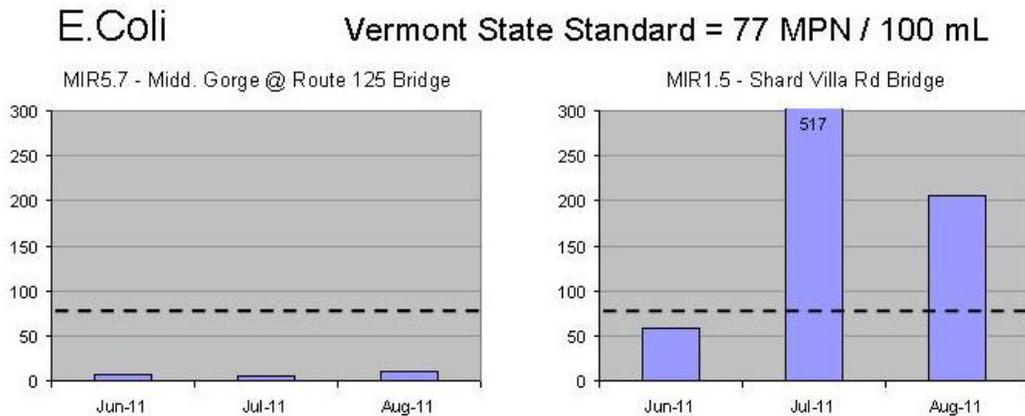
For more information, contact the Little Otter Creek sampling coordinator:
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Addison County Riverwatch Collaborative Middlebury River - 2011 Water Quality Summary

The Addison County Riverwatch Collaborative has been monitoring water quality in the Middlebury River since 1993. For years 2010 through 2013, this watershed has been identified for a reduced frequency of monitoring at two sentinel stations, MIR1.5 and MIR5.7. During 2011, these sites were tested for phosphorus and turbidity on the first Wednesday in April and May (Spring sampling dates) and in June, July, and August (Summer sampling dates). E.coli was tested only on the Summer dates. A scheduled September event was cancelled due to damages sustained at the LaRosa Analytical Laboratory during Tropical Storm Irene. Flow in the river during the July and August sample dates represented low to baseflow conditions (based on streamflow gages in area rivers). Flows on the April, May and June dates were moderate to high, due to snow melt and spring rains.

Site	Location	Town
MIR1.5	Shard Villa Rd. Bridge	Middlebury
MIR5.7	Midd. Gorge @ Rte 125 Bridge	Middlebury

E.coli counts at the Middlebury Gorge near the Route 125 bridge (MIR5.7) were well below the state standard of 77 organisms / 100 mL on three sample dates: June 1, July 6, and August 3. E.coli counts at the downstream station at Shard Villa Road bridge (MIR1.5) were well above the state standard on two of the three summer sampling dates. These results are generally consistent with historic Summer sampling results, which have shown an increase in E.coli levels in the Middlebury River downstream of the Route 7 bridge.



Turbidity levels in the Middlebury River were generally low and below the Vermont state standard of 10 NTUs (for Class B cold-water fisheries). Values ranged from 0.36 to 22 NTUs, with an average level of 7 NTUs for all five sample dates, including moderate- to high-flow dates, April 6, May 4 and June 1. Based on past years' sampling results, Turbidity can increase well above the state standard at times of high flow – during a Summer thunderstorm, or during Spring runoff conditions – particularly in the lower section of the river below the Route 7 bridge. During high-flow conditions on April 6 and May 4 of 2011, Turbidity concentrations exceeded the water quality standard at MIR1.5 (located at the Shard Villa Rd crossing).

Phosphorus levels were detected at relatively low concentrations during the five Spring and Summer sampling dates. Concentrations ranged from 8 to 84 ug/L, with an average of 33 ug/L. Moderately high concentrations of Total Phosphorus have been recorded in past years at times of high flow and runoff in the lower reaches of the Middlebury River. In 2011, the mean concentration of Total Phosphorus for the two available low-flow Summer sample dates (July 6, August 3) at either site did not exceed the proposed criterion of 44 ug/L for the warm-water medium gradient (WWMG) wadeable stream ecotype in Class B waters.

2012: The Addison County Riverwatch Collaborative will continue to monitor for E.coli, phosphorus and turbidity at these two sentinel sites in 2012. 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 2014.

For more information, contact the Middlebury River sampling coordinator:
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Addison County Riverwatch Collaborative
 New Haven River - 2011 Water Quality Summary

2010 – 2011
 Focus Watershed

The Addison County Riverwatch Collaborative has been monitoring water quality in the New Haven River since 1993. During 2011, seven locations within the watershed were tested for phosphorus and turbidity on the first Wednesday in April and May (Spring sampling dates) and in June, July, August and September (Summer season). E.coli was tested only on the Summer dates at all sites except NHR11.5 and NHR15. A scheduled September event was cancelled

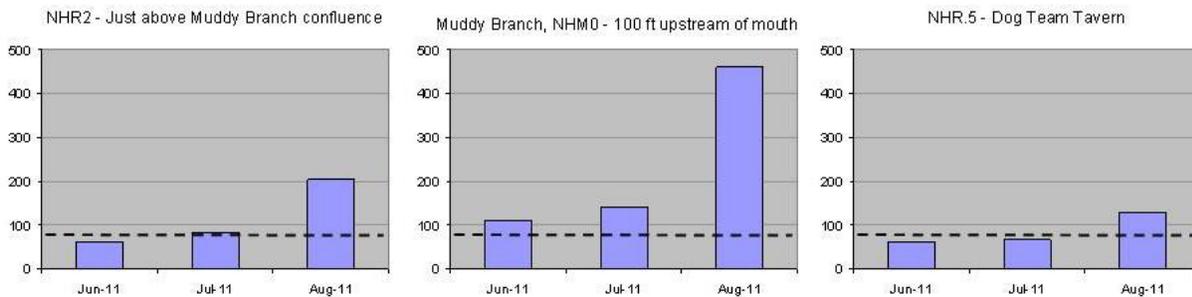
Site	Location	Town
NHR.5	Former Dog Team Tavern	New Haven
NHR2	Muddy Branch confluence	New Haven
NHR6	Route 116 Bridge, Sycamore Park	Bristol
NHR9	South St. Bridge	Bristol
NHR11.5	Bartlett's Falls Pool	Bristol
NHR15	S. Lincoln Bridge (Gap Rd.)	Lincoln
NHM0	Confluence with NHR (~100 ft upstream)	New Haven

due to damages sustained at the LaRosa Analytical Laboratory during Tropical Storm Irene. Flow in the river during the July and August sample dates represented low to baseflow conditions (based on records from the USGS gage on the New Haven River at Brooksville, just upstream from NHR.5). Flows on the April, May and June dates were moderate to high, due to snow melt and spring rains.

E.coli counts at popular recreational sites (South St. Bridge, NHR9; Sycamore Park, NHR6) were below the state standard of 77 organisms/ 100 mL on all three Summer dates, June 1, July 6, and August 3. In the lower watershed, where agricultural activities are more concentrated along the main stem and tributaries, E.coli counts were above the state standard on July 6 and August 3 at NHR2 (located just above the Muddy Branch confluence) and on August 3 at NHR.5 (Dog Team Tavern). Detected E.coli counts were generally consistent with historic results which have indicated an increase in levels downstream of the Munger Street bridge near river mile 5. This is the first year that ACRWC has monitored water quality in the Muddy Branch (NHM0). This tributary drains a 17 square mile area (14.6% of the total watershed), and joins the New Haven River main stem near the Nash bridge (just below NHR2). The Muddy Branch contains 27% agricultural land use, which is somewhat greater than the watershed as a whole (15%). E.coli counts in the Muddy Branch were above the water quality standard on all three Summer sampling dates.

E.Coli

Vermont State Standard = 77 MPN / 100 mL



Turbidity levels on the New Haven River at the six sampled stations ranged from 0.3 to 34 NTUs, with a mean level of 6.1 NTUs for the five sample dates, including two spring dates, April 6 and May 4. Turbidity levels exceeded the Vermont state standard of 10 NTUs (for Class B cold-water fisheries) at sites NHR2 and NHR.5 during the spring sample dates; the result for station NHR6 also exceeded the standard on May 4. At the seventh station, NHM0, on the Muddy Branch tributary, Turbidity levels ranged from 15 to 26 NTUs, exceeding the water quality standard on four sample dates: May 4, June 1, July 6 and August 3. Flows on the New Haven River on April 6 and May 4 were moderate as a consequence of spring rains and snow melt (April). A bankfull flow event (April 28) had preceded the May 4 sample date. 2011 results are largely consistent with historic trends. Based on past years' sampling results, Turbidity can increase well above the standard 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 is apparent with distance downstream during all flow conditions.

Phosphorus was detected at relatively low concentrations on the New Haven main stem during the Spring and Summer sampling dates. Concentrations ranged from 6 to 128 ug/L, with an average of 27 ug/L. Results were consistent with historic trends, which indicate an increase in concentrations between the Munger Street bridge in New Haven (NHR 5) and the confluence of Muddy Branch (NHR 2). At all stations, moderately high

concentrations of Total Phosphorus have been detected in past years at times of high flow and runoff. In 2011, the mean concentration of Total Phosphorus for the two available low-flow Summer sample dates (July 6, August 3) at each of the New Haven River sites did not exceed the proposed criterion of 44 ug/L for the warm-water medium gradient (WWMG) wadeable stream ecotype in Class B waters. In the Muddy Branch (NHM0), Total Phosphorus ranged from 51 to 72 ug/L on four sample dates, May 4, June 1, July 6 and August 3. The mean concentration of Total Phosphorus (58 ug/L) for the two available low-flow Summer sample dates (July 6, August 3) at this station exceeded the proposed nutrient criteria.

2012: The Town of Bristol (Conservation Commission) has received a Clean & Clear Grant to develop channel and floodplain restoration and conservation projects and update geomorphic assessments in the watershed. This study has referenced ACRWC water quality data. Emphasis has been on potential projects along the New Haven River main stem in Bristol and New Haven, as well as the lower reaches of Baldwin Creek. Projects presently being implemented include: two Vermont Land Trust easements on contiguous parcels spanning the Baldwin Brook tributary to the New Haven River along 3,550 feet of river; a CREP easement in a former corn field that involves buffer plantings along the full width of the river corridor for 1,200 feet of frontage along the lower New Haven River; and a river corridor easement (VT River Conservancy) along the same parcel. A pending CREP easement and river corridor easement (VT River Conservancy) are also in the works on an adjoining parcel involving 1,650 feet of river frontage.

In years 2012 through 2015, the New Haven River watershed will rotate back to a reduced frequency of monitoring at three sentinel stations, NHR11.5 (E.coli only), NHR5 and NHR2.

For more information, contact the New Haven River sampling coordinator:
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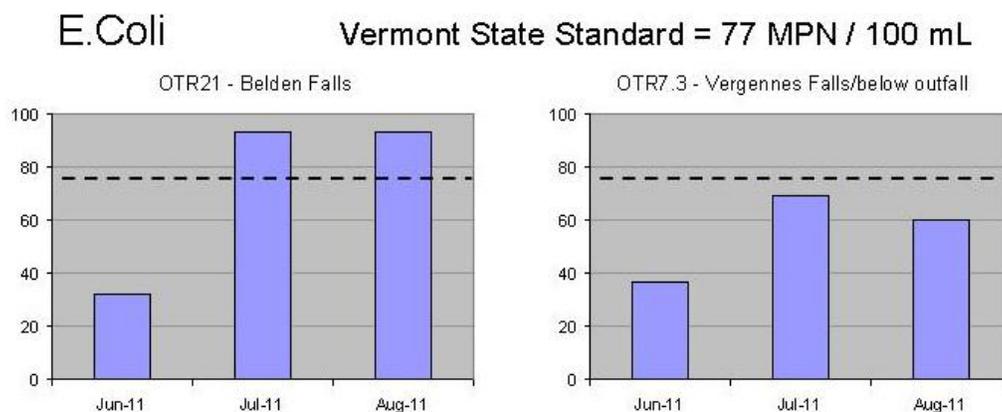
Addison County Riverwatch Collaborative Otter Creek - 2011 Water Quality Summary

The Addison County Riverwatch Collaborative has been monitoring water quality in the lower Otter Creek since 1992. For years 2010 through 2013, the number of sampling locations in this watershed has been reduced to two sentinel stations, OTR21 and OTR7.3. During 2011, these sites were tested for phosphorus and turbidity on the first Wednesday in April and May (Spring sampling dates) and in June, July, and August (Summer sampling dates).

Site	Location	Town
OTR21	Belden Falls	New Haven
OTR7.3	Vergennes Falls/below outfall	Vergennes

E.coli was tested only on the Summer dates. A scheduled September event was cancelled due to damages sustained at the LaRosa Analytical Laboratory during Tropical Storm Irene. Flow in the river during the July and August sample dates represented low to baseflow conditions (based on records for the USGS gage on Otter Creek at Middlebury). Flows on the April, May and June dates were moderate to high, due to snow melt and spring rains.

E.coli concentrations in the Otter Creek at the Belden Falls site (OTR21) were slightly above the state standard of 77 MPN / 100 mL on two of the three sample dates: July 6 and August 3. E.coli counts at the downstream station at Vergennes Falls below the Vergennes wastewater treatment facility outfall (OTR7.3) were below the state standard on the Summer sample dates. E.coli concentrations detected at these sentinel stations during 2011 are relatively consistent with historic monitoring results.



Turbidity levels in the Otter Creek at the two sentinel stations were generally low and below the Vermont state standard of 25 NTUs (for Class B warm-water fisheries), except for the April 6 sample at OTR7.3 where a value of 55 NTUs was reported. If the April sample from OTR7.3 is not included, values ranged from 3.1 to 19.5 NTUs, with a mean value of 9.1 NTUs for the five sample dates. Results are consistent with historic data, which indicate that median turbidity values are generally less than 10 NTUs.

Phosphorus levels were detected at relatively low concentrations during the five Spring and Summer sampling dates. Concentrations ranged from 36 to 100 ug/L, with an average of 60 ug/L. Moderately high concentrations of Total Phosphorus have been recorded in past years at times of high flow and runoff. In 2011, the mean concentration of Total Phosphorus at site OTR7.3 for the two available low-flow Summer sample dates (July 6, August 3) was 70 ug/L. This value is slightly higher than the proposed criterion of 44 ug/L for the warm-water medium gradient (WWMG) wadeable stream ecotype in Class B waters. The Otter Creek might instead be classified as in the Slow Winder ecotype, but criteria have not yet been developed for this ecotype.

2012: The Addison County Riverwatch Collaborative will continue to monitor for E.coli, phosphorus and turbidity at these two sentinel sites in 2012. 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 2014.

For more information, contact the Otter Creek sampling coordinator:
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