

Four Rivers Partnership Volunteer Water Quality Monitoring 2014

Background:

The Four Rivers Partnership is an affiliation of nonprofit organizations, state and local government entities, and schools focused on Winooski River watershed projects including water quality monitoring. The partnership is named after the four major rivers in the Barre-Montpelier region of central Vermont: Steven's Branch, the North Branch, the Dog River, and the Winooski River. Water quality monitoring by the Four Rivers Partnership has focused on these rivers and their tributaries and is managed by the Friends of the Winooski River. Volunteer members of the Four Rivers Partnership have been collecting bacterial data since 2008. In 2014, chloride, phosphorus, and turbidity levels were also tested.

2014 *E. coli* and Water Quality Monitoring Results

In the summer of 2014, the Four Rivers Partnership collected samples for chloride, phosphorus, turbidity, and *E. coli* testing at ten sites in the Barre-Montpelier-Riverton area on five biweekly sampling dates beginning on June 24th. A list of these nine sites and their locations is shown in **Table 1**.

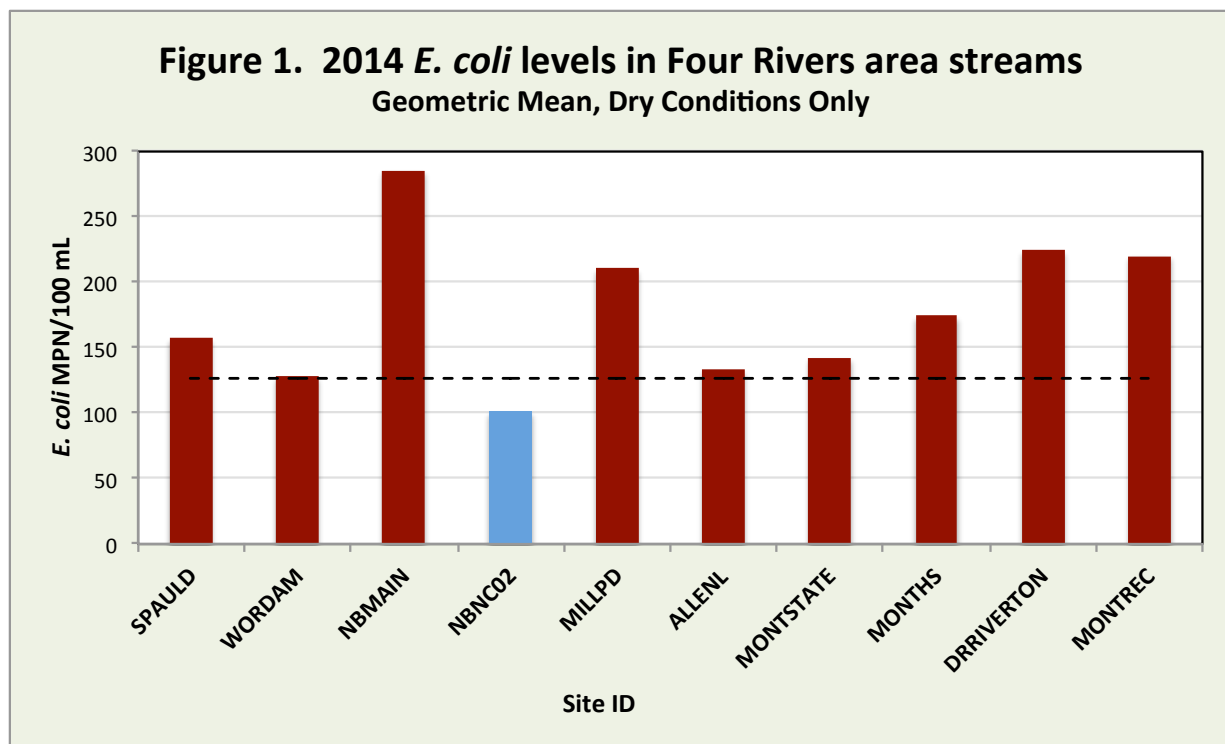
Table 1. Four Rivers Partnership Water Quality Testing Sites, 2014

Location	Waterbody	Site ID	Lat / Long
Mill Road Swimming Hole	North Branch	NBMAIN	44.385342 / -72.550879
Worcester Dam Swimming Hole	North Branch	WORDAM	44.373441 / -72.5453
North Branch Nature Center Bridge	North Branch	NBNC02	44.28355 / -72.57133
Mill Pond Park Canoe Access	North Branch	MILLPOND	44.26766 / -72.56882
Allen Lumber	Winooski River	ALLENL	44.25216 / -72.57114
VSECU parking lot	Winooski River	MONTSTATE	44.260668 / -72.583174
Montpelier High School Access	Winooski River	MONTHS	44.261859 / -72.586412
Montpelier Recreation Fields	Dog River	DRMONTREC	44.25188 / -72.60126
Riverton canoe access	Dog River	DRRIVERTON	44.1994 / -72.6338
Spaulding Falls	Jail Branch	SPAULD	44.111917 / -72.489982

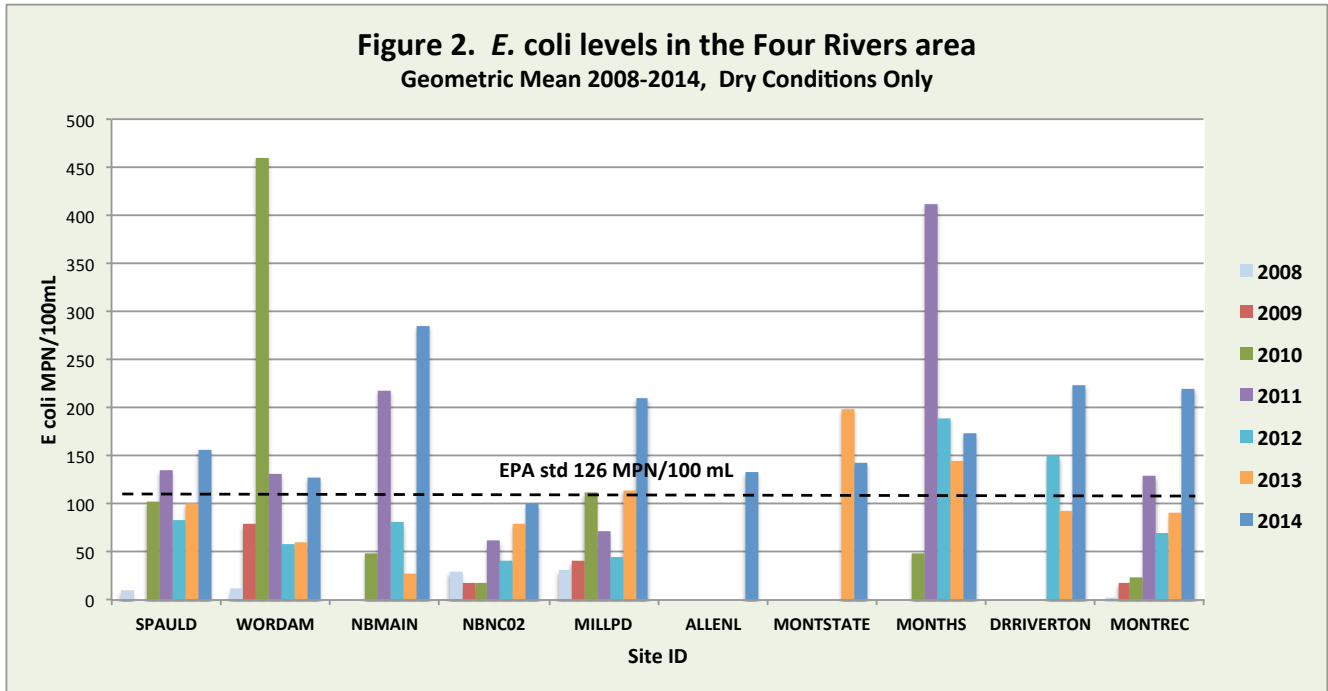
E. coli

Escherichia coli (*E. coli*) is a species of bacteria found in the fecal matter of mammals and is commonly used as an indicator of fecal contamination in rivers, streams, lakes, and oceans. While most strains of *E. coli* do not cause disease, their presence may be associated with other bacteria and viruses that may be pathogenic. *E. coli* amounts are often given as “most probable number” or “colony forming units” - reflections of the laboratory tests used to measure *E. coli* levels. US EPA standards for *E. coli* are based on single sample measurements and/or the geometric mean of samples taken over a period of time. The EPA standard for the geometric mean is 126 mpn or cfu/100mL. This corresponds to a level in which there is a probability that 32-36 individuals/1000 would get sick from water contact.

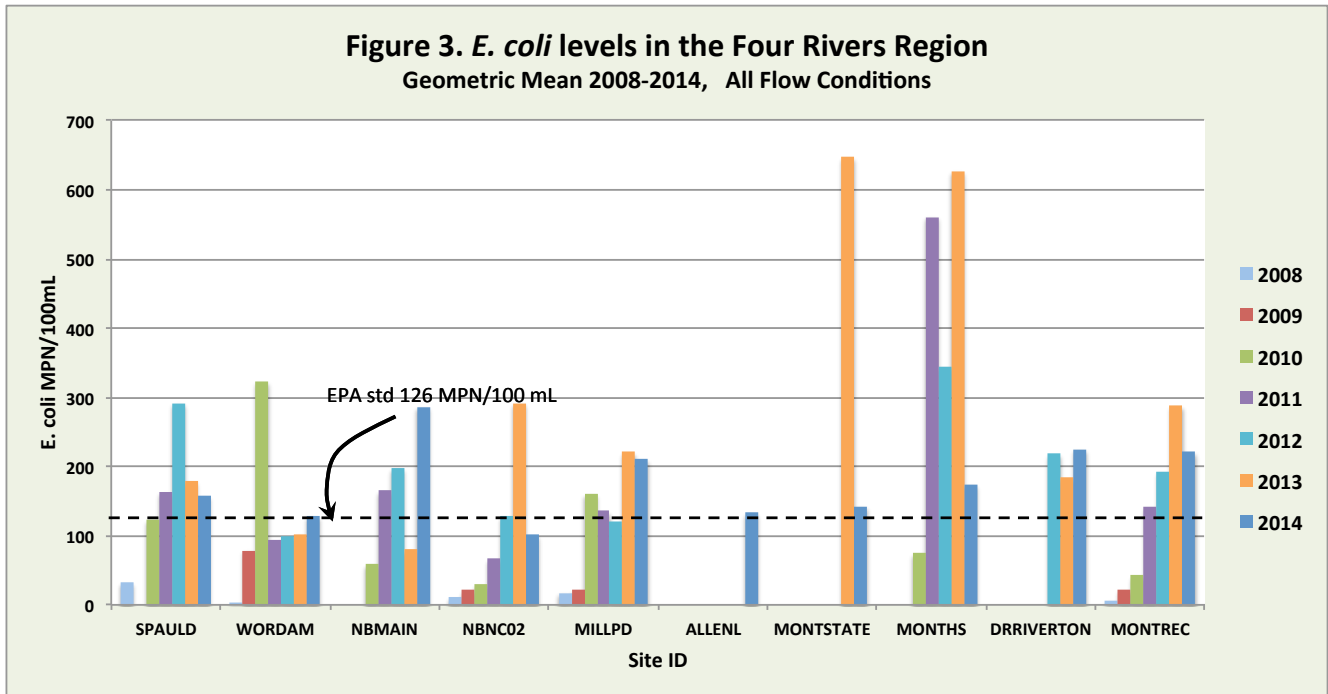
The results of our 2014 *E. coli* monitoring are summarized in **Figure 1**. The geometric mean of all five samples taken at biweekly intervals are shown for each site. All five sampling dates occurred during dry weather (no rain over 0.04 inches in the 48 hours previous) under baseflow conditions with medium to low flow. The EPA geometric mean standard of 126 MPN/100 mL is also shown (dotted black line).



E. coli levels are usually influenced by precipitation amounts, with high levels associated with rainfall and the resulting surface runoff into streams. Despite the dry summer of 2014, the geometric mean *E. coli* count exceeded the EPA and VT standards of 126 MPN/100 mL at all monitoring sites but one (the North Branch Nature Center swimming hole). For comparison, in 2013 the *E. coli* levels at only two of our sampling sites had *E. coli* levels exceeding this standard while all others fell below. A comparison of the geometric mean *E. coli* values under dry conditions for all Four Rivers Partnership monitoring years is shown in **Figure 2**.



Geometric mean *E. coli* levels were higher in 2014 than in other years at most sites. This may be due to an overall increase in the source(s) of *E. coli*, warmer water temperatures (hence longer survival of the bacteria), sampling error, or some other factor. For comparison, mean *E. coli* levels at all sites for all years regardless of precipitation is shown in **Figure 3**.

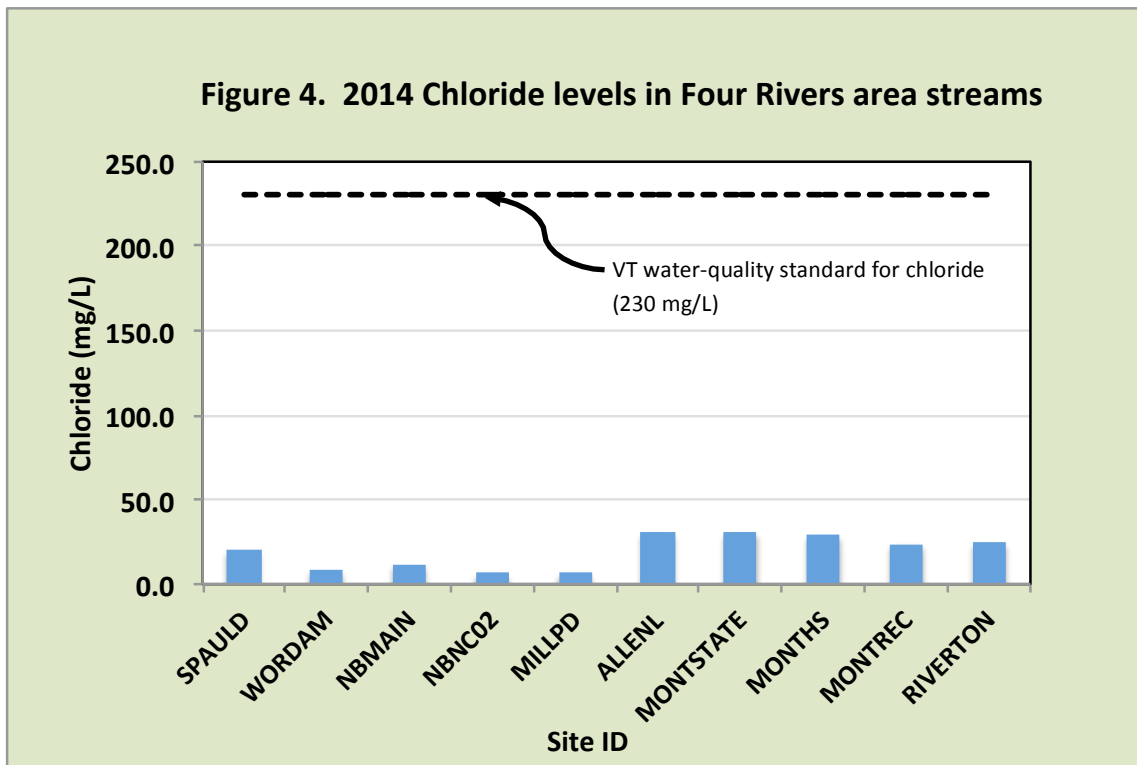


The 2014 mean *E. coli* levels more closely match the previous years' levels calculated when all weather-flow conditions (not just base flow) are included – despite the fact that sampling conditions in 2014 were uniformly dry. Two exceptions are the two sites that had particularly high *E. coli* in past years (MONTSTATE and MONTHS) where the 2014 mean *E. coli* was much lower than in previous years. Both of these sites are on the Winooski River in Montpelier, where there are 6 combined sewer overflows (CSOs) that are thought to contribute raw sewage (and fecal matter and *E. coli*) to the river during heavy rain events.

In 2014, the Friends added a new site, ALLENL, in order to help pinpoint which of the Montpelier CSOs contribute the most *E. coli* to the Winooski River (which is listed as impaired for *E. coli* downstream of the city). The ALLENL site is upstream from all of the known Montpelier CSOs, and MONTSTATE is upstream of two of them, and MONTHS is below all of them. Not surprisingly, all three sites had similar *E. coli* levels in 2014 – probably due to a lack of precipitation events,. The Friends hope to continue to monitor all three sites in future years in order to help pinpoint reaches of high *E. coli* and place remediation efforts strategically.

Chloride

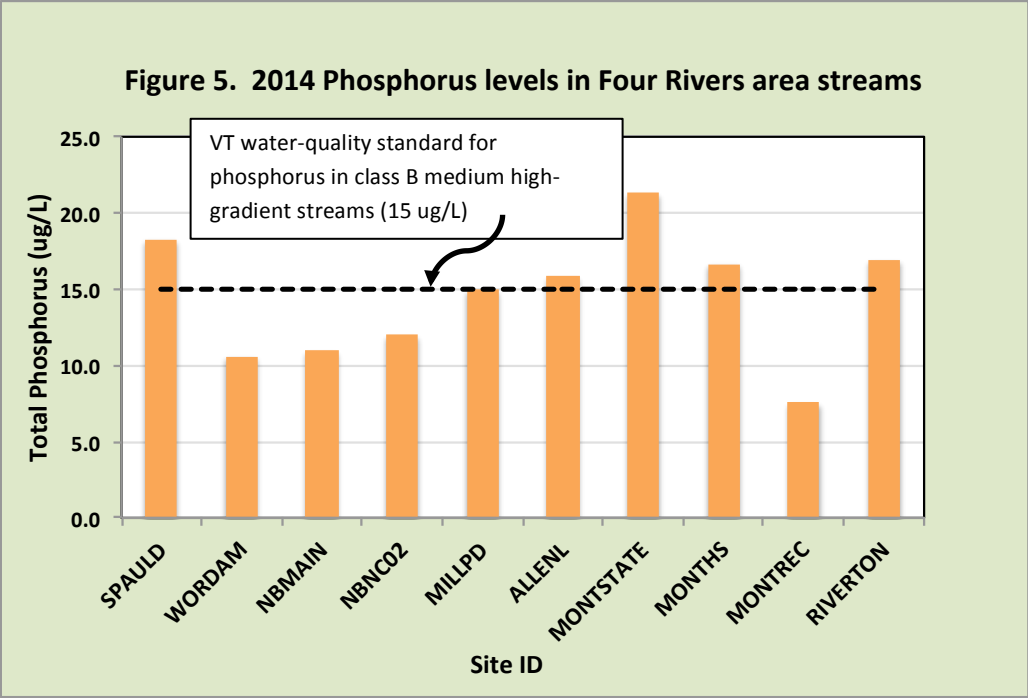
In addition to our usual annual *E. coli* monitoring, the Four Rivers Partnership tested for chlorine, total phosphorus, and turbidity in 2014. The mean chloride levels for each site are shown in **Figure 4**. Mean chloride concentrations were well below the Vermont “chronic” standard for average chloride of 230 mg/L. All of the individual samples taken at these sites had chloride levels below the VT “acute” maximum allowable concentration standard for chloride of 580 mg/L.



Phosphorus

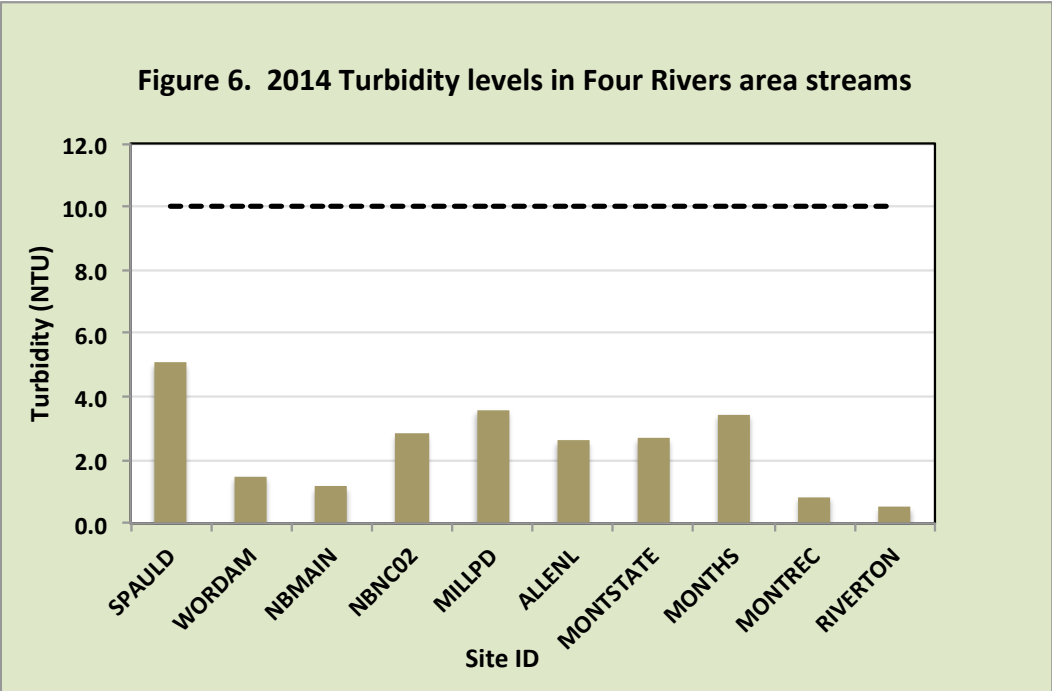
The mean phosphorus level for each site is shown in **Figure 5**. The phosphorus level at several sites were at or greater than the VT standard for medium gradient, cold water streams (15 ug/L).

All three sites on the Winooski River (ALLENL, MONTSTATE, and MONTHS), for example, exceeded this standard, as did one site on the Dog River (RIVERTON) and the Jail Branch site (SPAULD).



Turbidity

The results of turbidity sampling are shown in Figure 6. As with chloride, the turbidity levels at all sites were well below the Vermont standard of an annual average of 10 nepholometric units (NTU) for Class B, cold water habitat under dry, baseflow conditions.



Rain Event Sampling: In 2012, 2013, and 2014, the Four Rivers Partnership sampled small Winooski River and Stevens Brook tributaries during rainstorm events to get an idea of how stormwater runoff is affecting the Winooski. These streams drain watersheds of varying land use composition in the Barre-Montpelier area. The locations of the monitoring sites used are given in **Table 2**.

Table 2. Four Rivers Partnership Rain Event Samplin Sites 2012-14

<u>Site ID</u>	<u>Tributary</u>	<u>Description</u>	<u>Watershed land use</u>	<u>Lat /Long</u>
Macs 10	Unnamed	Trib behind MacDos on 302	Commercial development	44.227861/ -72.550924
Gunner 10	Gunners Brook	@ Blackwell St & 302	Rural and urban residential	44.121391/-72.303450
Bailey 10	Unnamed	Bailey & State, Montpelier	Suburban residential	44.154318/-72.351288
VTRANS 10	Pond Brook	Below footbridge at VTRANS bldg.	Wetlands; some commercial development	44.135739/-72.331140
Sabin 10	Blanchard Brook	@ mouth	Suburban residential	44.150259/-72.334766
MONTSTATE	Winooski River	VSECU parking lot	Varied	44.260668/-72.583174
MONTHS	Winooski River	Montpelier HS access	Varied	44.261859 /-72.586412

Samples were collected at five sites in 2012 and seven sites in 2013 & 2014. Five separate tributaries and the Winooski River were sampled for chloride, phosphorous, and turbidity on a baseline dry day (8/21/12 or 8/19/14), during rain events on 9/5/12, 9/10/13, and 9/11/14. An effort was made to sample during “first flush” –between 30 minutes and 2 hours after the rain began falling. This was not always achieved, however, since 1 to 2 volunteers were often trying to sample several sites during an event. Note, also, that the rain event of 2014 turned out to be a light rain with only 0.03 inches recorded at the Barre-Montpelier Knapp State Airport in Berlin. A summary of the 2012-2014 results is shown in **Table 3**. The 9/11/14 results more closely match the dry baseline data of 8/21/12 – probably because the rainfall this day was so slight and because the summer of 2014 as a whole was quite dry.

Table 3. Chloride, phosphorous, and turbidity in five Winooski River tributaries and the Winooski main stem during rainstorm events on 9/5/2012 and 9/10/13 using 8/21/2012 or 8/19/14 as a dry baseline.

Location	Date	Chloride (mg/L)	TP (ug P/L)	Turbidity (NTU)
Winooski River Main Stem				
MONTHS	dry 8/19/2014	26.2	13.1	2.07
	9/10/13	21.7	26.7	4.06
	9/11/14	39.8	18.4	1.46
MONTSTATE	dry 8/19/2014	25.4	33.9	2.33
	9/10/13	20.3	26.4	4.1
	9/11/14	41.2	18.4	2
Winooski River Tributaries				
BAILEY-10	dry 8/21/2012	85.2	10.6	0.78
	9/5/12	64.4	60.6	7.63
	9/10/13	56.5	35.2	
	9/11/14	145	29.2	19.1
SABIN-10	dry 8/21/2012	120	6.05	1.7
	9/5/12	70.7	108	37.4
	9/10/13	78.9	66.3	28
	9/11/14	119	13.1	0.56
Steven's Branch Tributaries				
VTRANS 10	dry 8/21/2012	64.8	9.75	0.58
	9/5/12	198	28	3.2
	9/10/13	72.6	14.4	1.46
	9/11/14	103	41.6	15.1
MACS-10	dry 8/21/2012	555	6.3	0.94
	9/5/12	231	62.3	43.5
	9/10/13	186	110	91.6
	9/11/14	535	13.6	0.6
GUNNER-10	dry 8/21/2012	56.6	6.34	1.42
	9/5/12	25.7	75.2	41.3
	9/10/13	42.7	40.5	9.79
	9/11/14	56	10.4	1.96

Chloride: According to the Vermont Surface Water Management Strategy, chloride levels above 230 mg/L can lead to poor health and reduced reproduction in aquatic species and may increase stratification in ponds and lakes, thereby inhibiting natural mixing and limiting oxygen availability. Chloride sources include road deicing salts, wastewater, and leachate from landfills. Predictably, chloride levels tend to spike in the spring when road salts are washed into streams during spring rains and snowmelt.

Chloride levels during our rain event monitoring were generally higher during dry (baseline) conditions than during rain events, perhaps due to evaporation from streams concentrating the chloride or high chloride in ground water (rainwater having a diluting effect in both cases). All samples had chloride levels below the Vermont acute standard of 860 mg/L, and most sites had average chloride levels that fell below the mean (chronic) standard of 230 mg/L. The average chloride at the Macs-10

site (377 mg/L), however, was well above the chronic standard. It appears that the chloride concentration in this stream may be generally elevated, especially in dry conditions or the absence of much rainfall. The VTRANS-10 site on Pond Brook had somewhat elevated chloride relative to the other streams sampled.

Phosphorous: The VT Water Quality Standards sets no specific standard for phosphorous levels in Class B waters during rain events (only for base-flow conditions). One way of considering the phosphorous levels detected during the storm events (without discharge data), however, could be to ask whether the phosphorous levels in a stream are contributing to or diluting the phosphorous that eventually gets transported to Lake Champlain. The target phosphorous standard for the Main Lake of Lake Champlain is 10 ug/L. Therefore, since the total phosphorous levels in the samples taken during rain events were all well above 10 ug/L, these tributaries can be considered to have contributed to the phosphorous load during these storms.

Turbidity: Turbidity levels, as expected, were higher during the two heavier rain events we monitored, and were mostly low during dry periods (and during the light rain event monitored in 2014). Two sites, Sabin-10 and Macs-10 appear to be more susceptible to an increase in turbidity during storm events, although more data is needed to confirm a trend.

Quality assurance data and project completeness for the 2014 sampling effort is presented in **Appendices A and B**. This report will be posted on the Friends of the Winooski website, presented to the Montpelier Conservation Commission, given to the 2014 sampling volunteers, and will be used to educate the public about the water quality conditions of area streams.

Appendix A. Quality assurance measures for chloride, *E. coli*, total phosphorus, and turbidity sampling in 2014

Test	Site	Date	A	D	B	Relative % Difference
Chloride	NBMAIN	7/8/14	11.6	11.3	<2	2.6
	NBNC02	7/22/14	7.94	7.76	<2	2.3
	MONTHS	8/5/14	29.4	29	<2	1.4
	DRRIVERTON	8/19/14	28.4	28.5	<2	0.4
Chloride Mean Relative % Difference						1.7
Chloride Mean Blank Concentration						<2
<i>E. coli</i>	NBMAIN	7/8/14	1120	921	<1	19.5
	NBNC02	7/22/14	179	133	<1	29.5
	MONTHS	8/5/14	161	152	<1	5.8
	DRRIVERTON	8/19/14	88	96	<1	8.7
<i>E. coli</i> Mean RPD						15.9
<i>E. coli</i> Mean Blank Concentration						<1
Total P	NBMAIN	7/8/14	21.4	9.51	<5	76.9
	NBNC02	7/22/14	10.3	10.2	<5	1.0
	MONTHS	8/5/14	20.3	21.2	<5	4.3
	DRRIVERTON	8/19/14	7.96	7.55	<5	5.3
	MONTSTATE	9/11/14	18.4	16.9	<5	8.5
Total Phosphorus Mean RPD						21.9
Total Phosphorus Mean Blank Concentration						<5
Turbidity	NBMAIN	7/8/14	2.45	2.19	<0.2	11.2
	NBNC02	7/22/14	1.75	1.89	<0.2	7.7
	MONTHS	8/5/14	6.19	5.99	<0.2	3.3
	DRRIVERTON	8/19/14	0.51	0.54	<0.2	5.7
Turbidity Mean RPD						7.0
Turbidity Mean Blank Concentration						<0.2

Appendix B. Project Completeness

Parameter	Number of Samples Anticipated	Number of Valid Samples Collected & Analyzed	Percent Complete *#
Chloride	88	60	68%
Total Phosphorus	88	60	68%
<i>E. coli</i>	60	51	85%
Turbidity	88	59	67%

* Percent Complete = # of Valid Samples Collected and Analyzed / # of Samples Anticipated

Due to the dryness of the summer of 2014, we were unable to complete our planned rain event sampling - hence the low percent complete numbers.