Water Quality Monitoring in the Upper Winooski River Headwaters

2014

Bacteria, Chloride, Alkalinity, and Nutrients

within the towns of Cabot-Marshfield-Plainfield

Enjoy the river

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The Vermont Department of Environmental Conservation

The Friends of the Winooski River in Cooperation with
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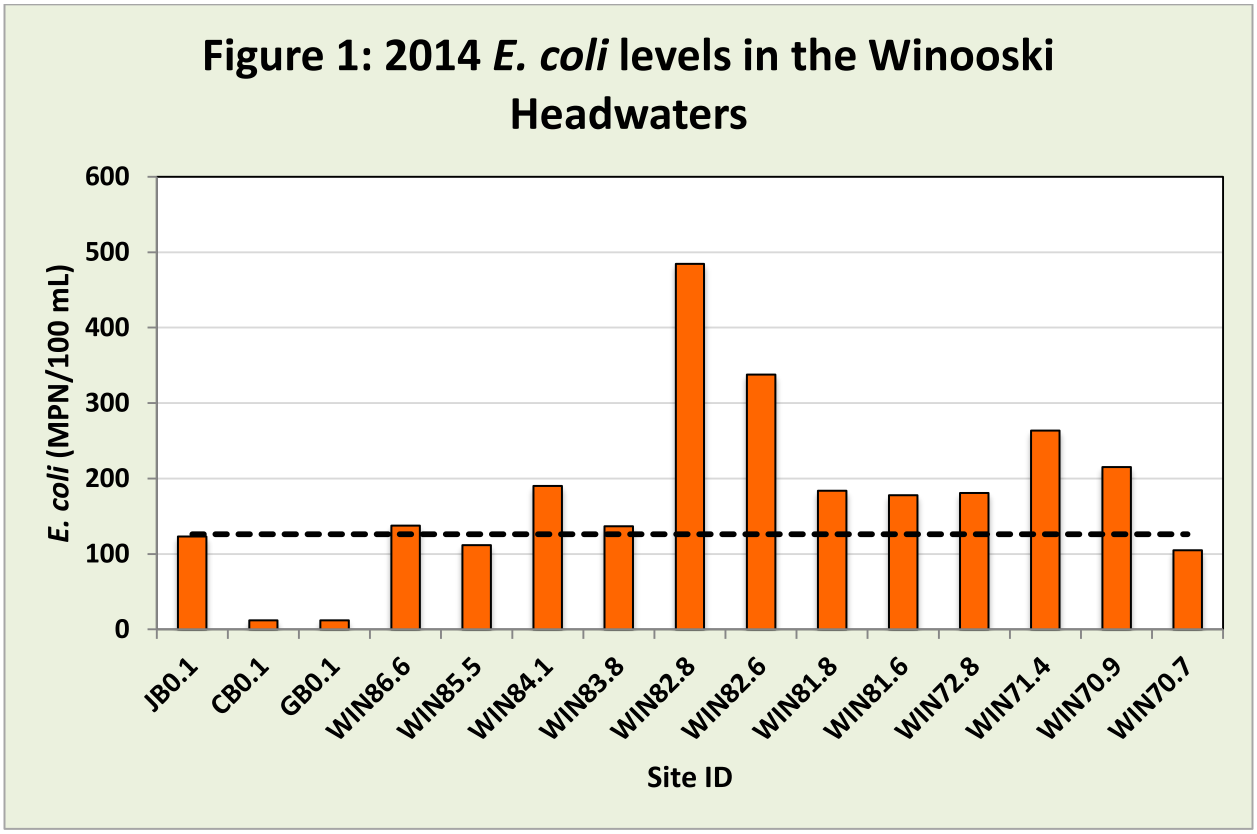
E. coli Bacteria

Background

Fecal coliform bacteria are a particular group of bacteria primarily found in human and animal intestines and wastes. *Escherichia coli* (*E. coli*) is one of the fecal coliform bacteria widely used as an indicator organism to show the presence of such wastes in water and the possible presence of pathogenic (disease-producing)organisms. When *E. coli* is found in waters, its presence is not the problem of concern itself but is rather an indicator of the presence of fecal contamination (most strains of *E.coli* are not pathogenic) from humans or animals. *E. coli* monitoring is commonly conducted to ensure that the water is safe for swimmers and other contact recreational activities; a relationship can often be established between high bacteria concentrations and its sources such as rainfall runoff from urban streets, waterfowl or other wildlife congregations, pastured animals, and untreated waste (septic) water. Vermont has recently updated (October 2014) its E.coli criteria to match the EPA recommended for Class B water quality the standard sets the maximum **Escherichia coli** - 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. This equals a *risk factor of about 36 illnesses/1,000 ingestions*. The EPA also provides an *E. coli* "Beach Action Value" (BAV) of 235 MPN/mL for single water samples. States can adopt this value and use it to close a recreational water site to the public when *E. coli* levels are above this standard.

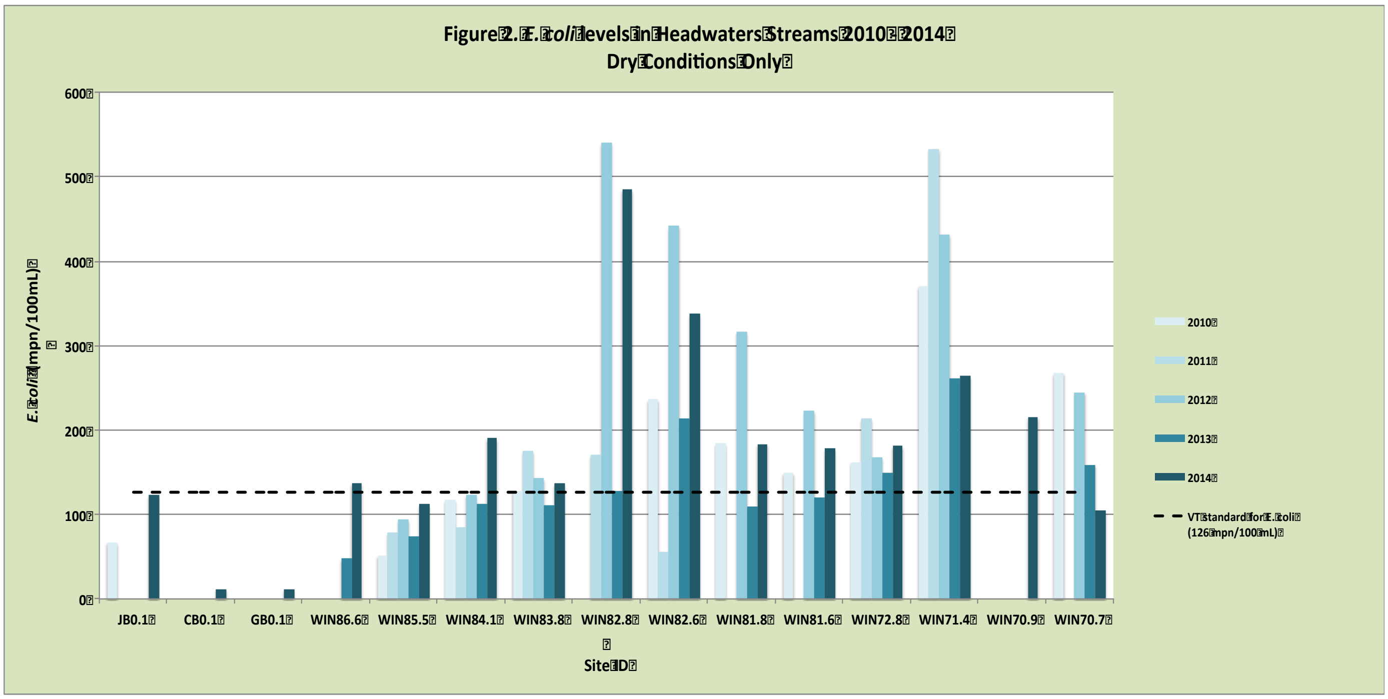
E.coli samples were collected at 12 locations on the Winooski River from June 24 to September 2, 2014 on a biweekly basis. This resulted in 6 samples per location over the course of the summer. All samples were collected under "baseflow" conditions in 2014, so instream *E.coli* levels are representative of when contact recreational activities are likely in the river. The *E.coli* results are also less likely to be due to the immediate runoff of rainwater into the river. The results are presented in **Figure 1** as the geometric mean of all samples collected at a location over the summer period. All results are presented in a table at the end of this report. Site locations are presented as the River Mile (RM) of the river or stream up from its mouth. As such the highest RM, 86.6, is located above Cabot village, and the lowest at RM 70.1 is below the Plainfield WWTF. All site descriptions are found in a table at the end of this report.

Only 1 location, at RM 85.5 immediately below Cabot village, was below the criteria 126 geometric mean (gm) *E.coli*. The uppermost location, RM 86.6, and RM 83.8 at the Durant Cemetery below the Cabot WWTF, were just above the criteria with a 137 gm *E.coli*. The first real jump in gm of E.coli to 190 occurred at RM 84.1, located immediately above the Cabot WWTF. This location is below several small agricultural horse and cattle operations as well as Jug Brook, which are all potential sources of *E.coli*. This location saw its highest levels during the first three sample periods, when it was above the single criteria level of 235. As stated above the levels seem to decrease below the Cabot WWTF at Durant cemetery; then jump to their highest level of 485 gm E.coli at RM 82.8 just above GMP the Hydro generating station, only decreasing slightly to 338 gm *E.coli* at RM 82.6 at the Rt 2 bridge-Marshfield fire station. At both these locations the first 5-6 samples were also above the single point criteria of 235 *E.coli*/100ml. This indicates an E.coli source entering the river along what is known as the "Cabot Flats". This is a light residential area with a single animal, and several greenhouse agricultural operations.



Bacti levels then decrease to below 200 gm E.coli as the river goes thru the village of Marshfield, with samples collected at RM 81.8, and 81.6, above and below the Marshfield WWTF. The bacti gm *E.coli* level remains at this level at the next location sampled at the Martin Bridge. The Bacti gm *E.coli* then increases to above 250 gm *E.coli* below the dam in Plainfield Village at RM 71.4, and remains elevated at RM 70.9 just above the Plainfield WWTF. *E.coli* then decreases to below the contact recreation standard of 126 gm *E.coli* at the swimming holes below the Plainfield WWTF at RM 70.7 below the rip rap bank on river road. The *E.coli* levels were well below criteria in the tribs of creamery brook in Marshfield, and Great Brook and a small tributary ("Trib B") also in Plainfield. Jug Brook in Cabot shows elevated levels of just below the criteria of 126 gm *E.coli*.

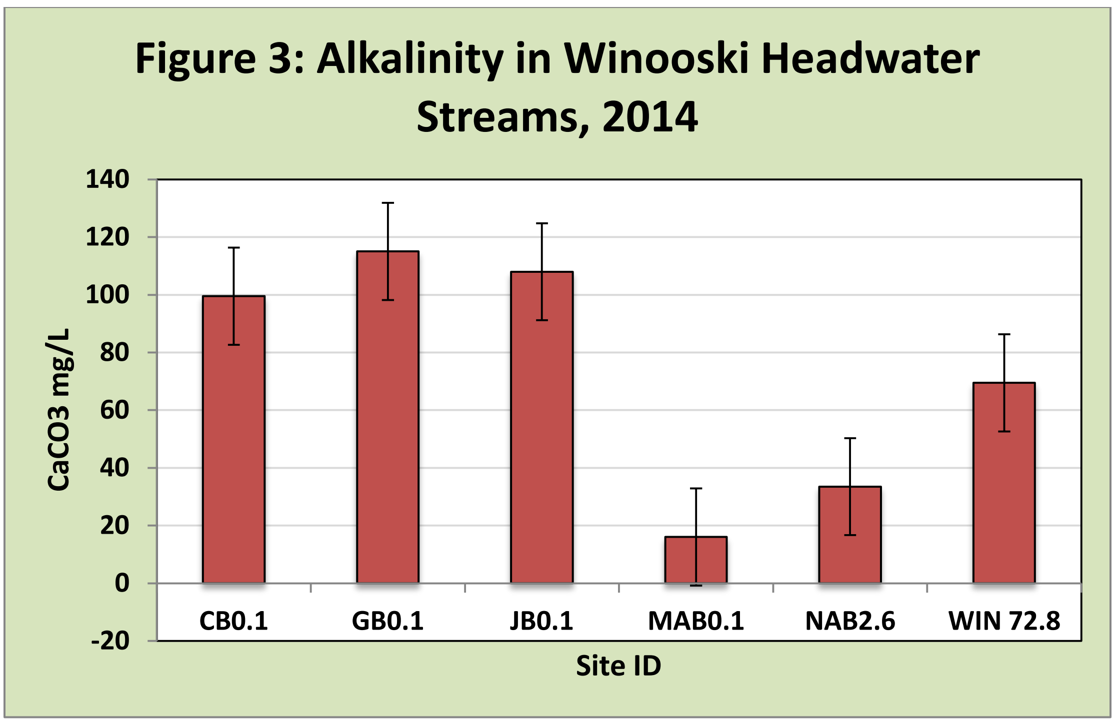
In summary the *E.coli* levels within the main stem of the Winooski River were highest immediately below the "Cabot Flats", and within the Plainfield Village area below the dam and above the WWTF. These areas have over the last several years been consistently above the Bacti *E.coli* standards and should be considered for listing as impaired for contact recreation due to high Bacteria levels **Figure 2.**



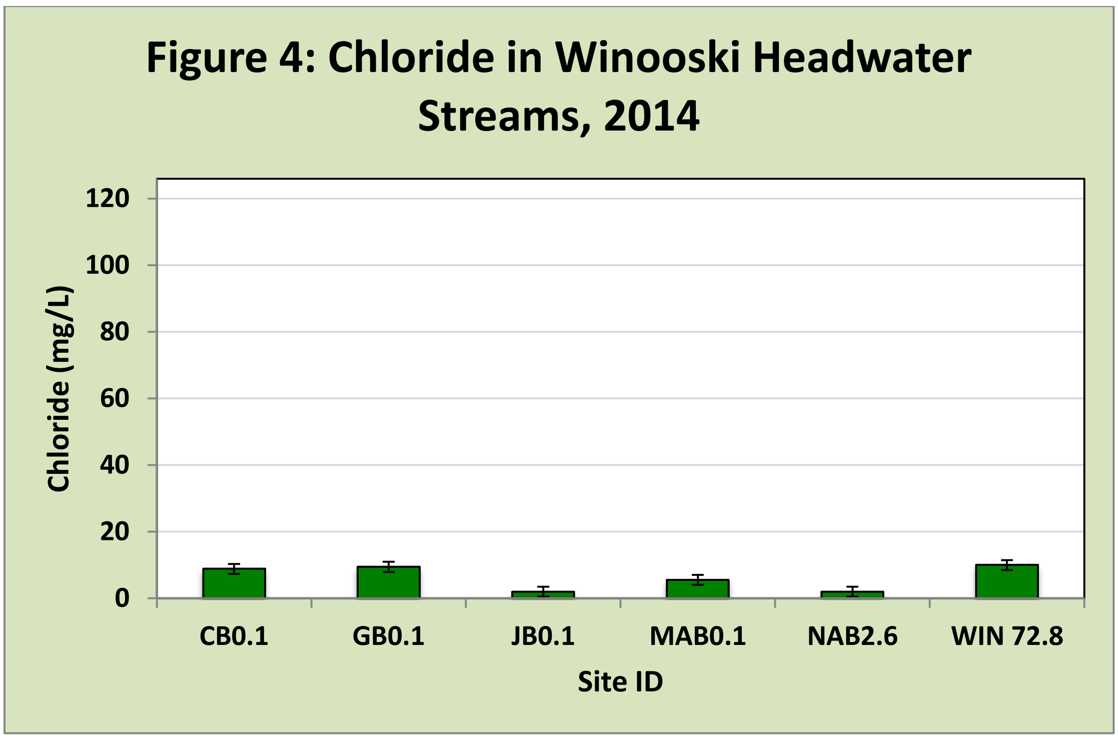
Water Quality testing – Alkalinity, Chloride, and Nutrients.

Water quality was sampled from five tributary locations and the Winooski River at Martin Bridge (see table in appendix). Water quality samples were collected once per month from June thru September for chloride and the nutrients phosphorus, and nitrogen. Alkalinity was tested twice, in August and September. The raw results are also found in table 2 in the Appendix.

Figure 3 shows the alkalinity is highest (>100mg/l) in the tributary streams Jug Brook and Creamery Brook, watersheds draining from the north, and lowest (<40mg/l) in tributaries Marshfield Brook and Naismith Brook, watersheds to the south of the Winooski River. Great Brook in Plainfield was high in alkalinity and the Winooski River at Martin Bridge was moderate. This is a reflection of the bedrock and soils from these watersheds, with the low alkalinity streams draining granitic-based watersheds and high alkalinity streams draining soils higher in calcium.

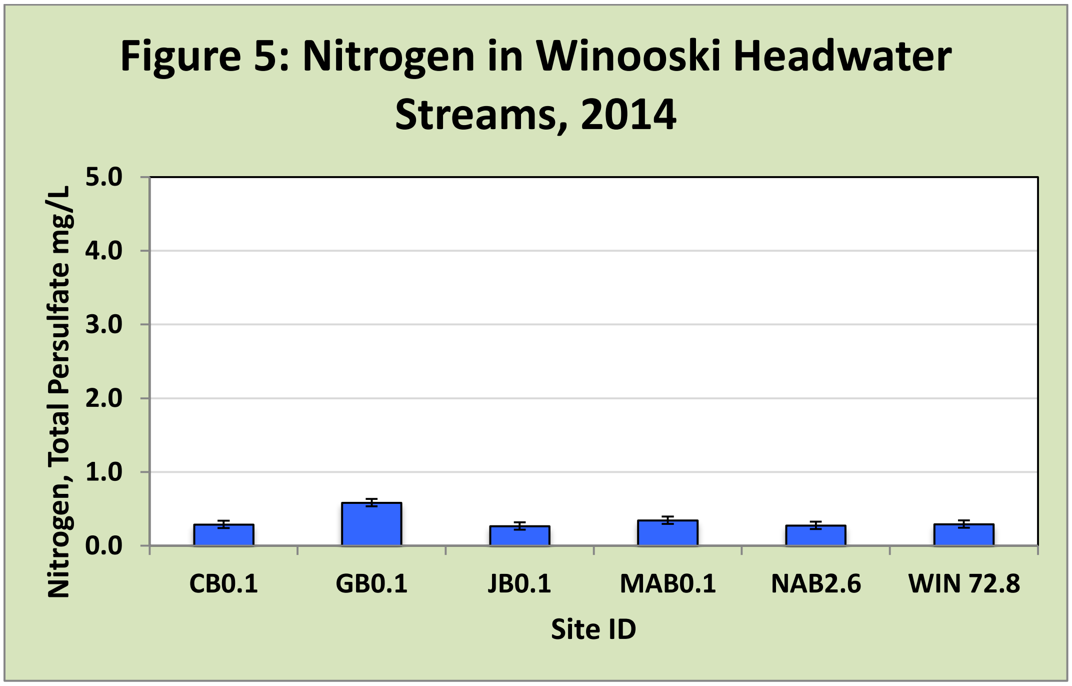


Chloride samples show that all locations are relatively low (<15mg/l) in chloride, **Figure 4** below. Chloride does not become toxic to aquatic life until levels approach 230mg/l. The Vermont Water Quality standards recently (October 2014) adopted the chloride criteria of 230 mg/l chronic (daily mean over four day period), and 860 mg/l acute (one day mean). The low level of chloride in the tributaries of the upper Winooski River indicates that road salts (often the primary source of chloride) are being conservatively applied in these towns. It is important to continue this conservative practice on our roads, driveways and walkways because chloride is relatively inert (does not breakdown in the environment), and can buildup in the groundwater of a watershed over time.



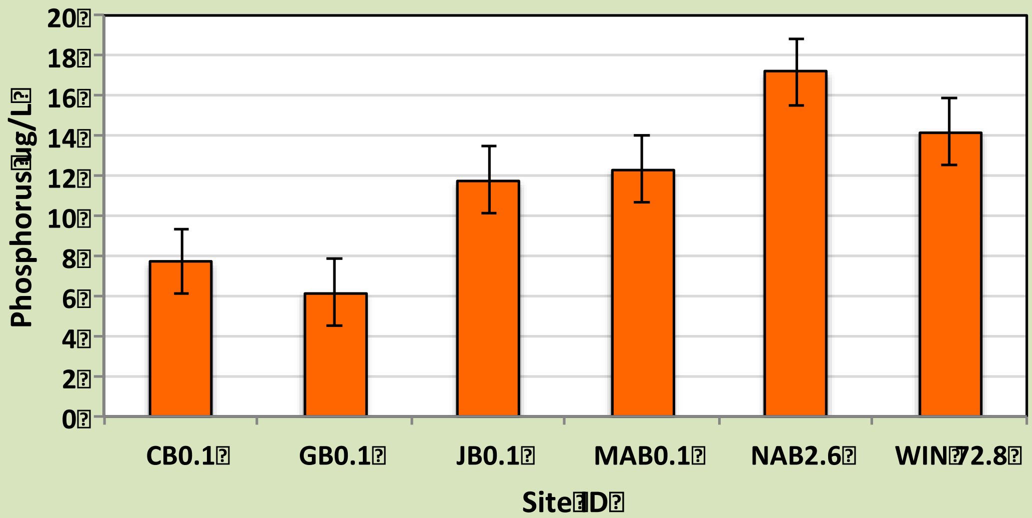
Nutrients

Nitrogen levels as total nitrogen (TN) were relatively low (<0.50 mg/l mean) in all tributary streams and the Winooski River at Martin Bridge **Figure 5**. The highest levels of near 0.50 mg/l were from Great Brook. The lowest (< 0.25 mg/l mean) levels were from the tributaries Jug Brook in Cabot and Naismith Brook in Marshfield.



Phosphorus as total TP levels (**Figure 6**) were found to be relatively low (<8ug/l mean) in 2 tributary streams: Great Brook in Plainfield and Creamery Brook in Marshfield. Jug Brook in Cabot, Marshfield Brook in Marshfield and the Winooski River at Martin Bridge had moderate levels of phosphorus (< 15ug/l mean). Naismith Brook in Marshfield was moderately elevated (17ug/l mean). Naismith Brook is a mostly forested watershed above the sample location at RM 2.6, so it is not known why the TP levels would be elevated in this stream. Vermont water quality standards recently adopted phosphorus TP guidance values by “stream type”. For “Small High Gradient” SHG streams it is 12 ug/l TP. Creamery Brook, Jug Brook, and Marshfield Brook are SHG streams. For “Medium High Gradient” MHG streams the guidance value is 15ug/l. Great Brook, Naismith Brook and Winooski River at Martin Bridge are MHG stream reaches. The phosphorus level at the Marshfield Brook, and Jug Brook sites are therefore at the SHG stream type guidance value, and the Martin Bridge (WIN 72.8) and Naismith Brook sites are at the MHG stream type guidance values for total phosphorus.

Figure 6. Phosphorus Levels in Winooski Headwaters Streams, 2014



Appendices

Table 1: 2014 Sample Site IDs, Locations and Descriptions

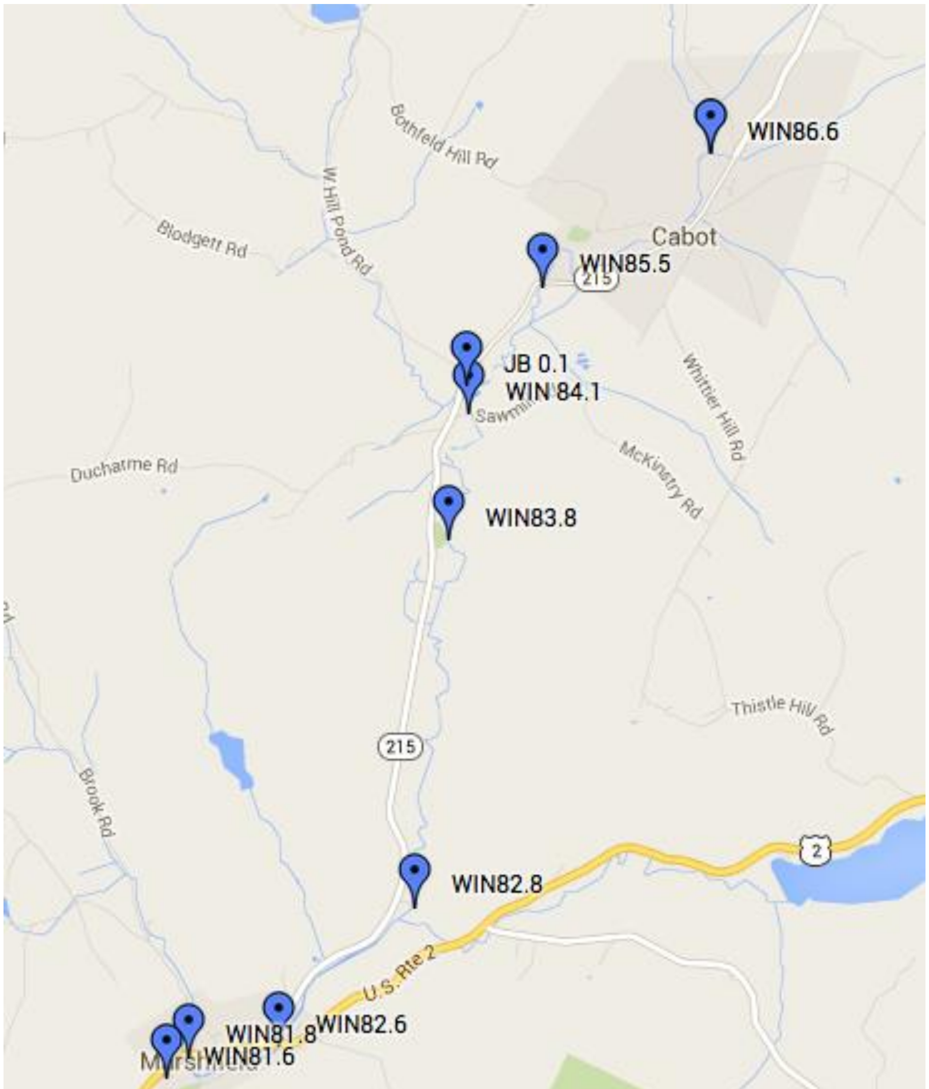
***E. coli* testing sites**

Site ID	Lat/Long	Description
WIN86.6	44.4065/72.31041	Above Cabot Plains Brook, adjacent to Cabot Rec Fields
WIN 85.5	44.3984 / 72.3244	By Larry's ballfield below Cabot village.
JB 0.1	44.3923/ 72.331	Jug Brook at Route 215 in Lower Cabot
WIN 84.1	44.3906 / 72.3307	Above sawmill road bridge at Cabot WWTF
WIN 83.8	44.3829 / 72.3325	Durant cemetery below Cabot WWTF
WIN 83.4	44.3795 / 72.3331	Upper Gould flats, below farm road x-ing 50m
WIN 82.8	44.3604 / 72.3353	Just above GMP generation station.
WIN 82.6	44.3519 / 72.3470	At Rt 2 bridge just above Marshfield Village
CB 0.1		Creamery brook at the mouth
WIN 81.8	44.3511 / 72.3547	Above Marshfield WWTP, below Creamery tributary
WIN 81.6	44.3501 / 72.3566	Below Marshfield WWTF, at flower farm
WIN 72.8	44.2871 / 72.4090	At Martin Bridge
TRB B 0.1	44.2792 / 72.4176	Below RR bed X-ing, below residential area in Plainfield.
WIN 71.4	44.2775 / 72.4258	Below dam Plainfield Village, above Great Brook
GB 0.1	44.2767 / 72.4267	Great Brook just before confluence with the Winooski
WIN 70.9	44.2733 / 72.4322	Above discharge at Plainfield WWTF
WIN 70.7		**Below Discharge at Plain field WWTF**

Water quality monitoring sites

Site ID	Lat/Long	Description
GB 0.1	44.2767 / 72.4267	Great Brook just before confluence with the Winooski
WIN 72.8	44.2871 / 72.4090	Winooski River at Martin Bridge
NAB 2.6	44.27760/ 72.37728	Naismith Brook at Maple Hill Road Bridge
JB 0.1	44.3923/ 72.331	Jug Brook at Route 215 in Lower Cabot
MAB 0.1	44.34762/ 72.358031	Marshfield brook at the mouth
CB 0.1	44.35125/ 72.35567	Creamery brook at the mouth

MAP : Showing *E.coli* sampling locations in Cabot and Marshfield



Map: Showing *E.coli* sampling locations in Marshfield and Plainfield

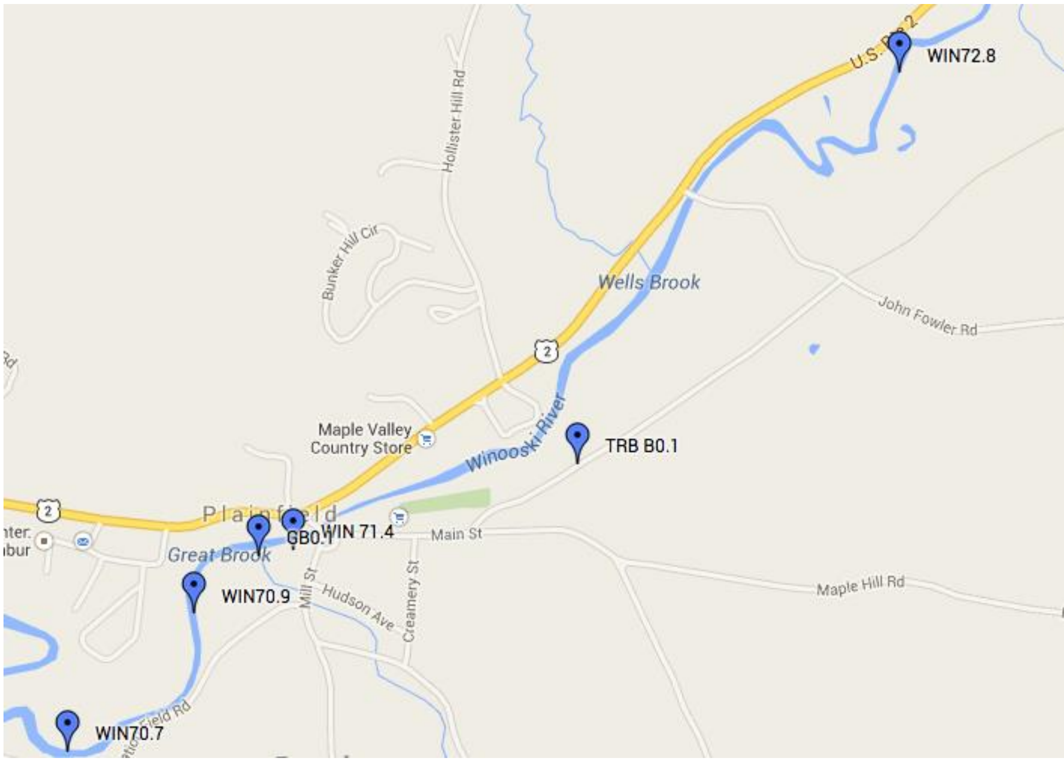


Table 2: 2014 E.coli results from the Upper Winooski Headwaters, and tribs.

Site	Param		Result	Units	Collect Date	Collect Time
CB0.1	Coliform, *E. coli*	<	1.00	mpn/100ml	6/24/2014	6:35:00
CB0.1	Coliform, *E. coli*		51.21	mpn/100ml	7/8/2014	7:25:00
CB0.1	Coliform, *E. coli*		39.86	mpn/100ml	7/22/2014	6:30:00
CB0.1	Coliform, *E. coli*		8.60	mpn/100ml	8/5/2014	6:25:00
CB0.1	Coliform, *E. coli*		86.24	mpn/100ml	8/19/2014	6:27:00
CB0.1	Coliform, *E. coli*		2.02	mpn/100ml	9/2/2014	6:20:00
CB0.1	**Coliform, *E. coli***		**12.05**	**mpn/100ml**	**gm season**	
GB0.1	Coliform, *E. coli*		14.80	mpn/100ml	8/5/2014	6:30:00
GB0.1	Coliform, *E. coli*		9.69	mpn/100ml	8/19/2014	6:48:00
GB0.1	**Coliform, *E. coli***		**12.47**	**mpn/100ml**	**gm season**	
JB0.1	Coliform, *E. coli*		63.82	mpn/100ml	6/24/2014	6:05:00
JB0.1	Coliform, *E. coli*		198.90	mpn/100ml	7/8/2014	6:15:00
JB0.1	Coliform, *E. coli*		191.79	mpn/100ml	7/22/2014	6:27:00
JB0.1	Coliform, *E. coli*		111.23	mpn/100ml	8/5/2014	6:05:00
JB0.1	Coliform, *E. coli*		86.00	mpn/100ml	8/19/2014	6:14:00
JB0.1	Coliform, *E. coli*		151.52	mpn/100ml	9/2/2014	6:37:00
JB0.1	**Coliform, *E. coli***		**123.39**	**mpn/100ml**	**gm season**	
TRB B 0.1	Coliform, *E. coli*		61.55	mpn/100ml	6/24/2014	6:35:00

TRB B 0.1	Coliform, *E. coli*		90.75	mpn/100ml	7/22/2014	6:35:00
TRB B 0.1	Coliform, *E. coli*		42.75	mpn/100ml	8/5/2014	7:15:00
TRB B 0.1	Coliform, *E. coli*		26.53	mpn/100ml	8/19/2014	5:56:00
TRB B 0.1	Coliform, *E. coli*		67.66	mpn/100ml	9/2/2014	6:35:00
TRB B 0.1	**Coliform, *E. coli***		**53.26**	**mpn/100ml**	**gm season**	
WIN 70.1	Coliform, *E. coli*		59.40	mpn/100ml	6/24/2014	6:22:00
WIN 70.1	Coliform, *E. coli*		185.01	mpn/100ml	7/22/2014	6:40:00
WIN 70.1	Coliform, *E. coli*		410.58	mpn/100ml	8/5/2014	6:20:00
WIN 70.1	Coliform, *E. coli*		104.60	mpn/100ml	8/19/2014	7:08:00
WIN 70.1	Coliform, *E. coli*		104.97	mpn/100ml	9/2/2014	6:50:00
WIN 70.1	**Coliform, *E. coli***		**137.72**	**mpn/100ml**	**gm season**	
WIN 70.7	Coliform, *E. coli*		776.56	mpn/100ml	6/24/2014	6:00:00
WIN 70.7	Coliform, *E. coli*		344.80	mpn/100ml	7/22/2014	6:50:00
WIN 70.7	Coliform, *E. coli*		365.40	mpn/100ml	8/5/2014	6:30:00
WIN 70.7	Coliform, *E. coli*		83.92	mpn/100ml	8/19/2014	6:52:00
WIN 70.7	Coliform, *E. coli*		95.90	mpn/100ml	9/2/2014	6:45:00
WIN 70.7	**Coliform, E. coli**		**239.46**	**mpn/100ml**	**gm season**	
WIN 71.4	Coliform, *E. coli*		816.41	mpn/100ml	6/24/2014	6:40:00
WIN 71.4	Coliform, *E. coli*		579.43	mpn/100ml	7/22/2014	6:45:00
WIN 71.4	Coliform, *E. coli*		368.31	mpn/100ml	8/5/2014	7:00:00
WIN 71.4	Coliform, *E. coli*		116.85	mpn/100ml	8/19/2014	6:30:00

WIN 71.4	Coliform, *E. coli*		62.66	mpn/100ml	9/2/2014	6:30:00
WIN 71.4	**Coliform, *E. coli***		**263.72**	**mpn/100ml**	**gm season**	
WIN 72.8	Coliform, *E. coli*		290.93	mpn/100ml	6/24/2014	6:30:00
WIN 72.8	Coliform, *E. coli*		209.82	mpn/100ml	7/22/2014	7:05:00
WIN 72.8	Coliform, *E. coli*		290.93	mpn/100ml	8/5/2014	7:20:00
WIN 72.8	Coliform, *E. coli*		65.65	mpn/100ml	8/19/2014	6:55:00
WIN 72.8	Coliform, *E. coli*		167.05	mpn/100ml	9/2/2014	7:14:00
WIN 72.8	**Coliform, *E. coli***		**181.09**	**mpn/100ml**	**gm season**	
WIN 81.6	Coliform, *E. coli*		114.46	mpn/100ml	6/24/2014	6:40:00
WIN 81.6	Coliform, *E. coli*		547.50	mpn/100ml	7/8/2014	7:15:00
WIN 81.6	Coliform, *E. coli*		260.25	mpn/100ml	7/22/2014	6:30:00
WIN 81.6	Coliform, *E. coli*		228.18	mpn/100ml	8/5/2014	6:30:00
WIN 81.6	Coliform, *E. coli*		141.37	mpn/100ml	8/19/2014	6:35:00
WIN 81.6	Coliform, *E. coli*		60.15	mpn/100ml	9/2/2014	6:28:00
WIN 81.6	**Coliform, *E. coli***		**177.85**	**mpn/100ml**	**gm season**	
WIN 81.8	Coliform, *E. coli*		111.90	mpn/100ml	6/24/2014	6:47:00
WIN 81.8	Coliform, *E. coli*		816.41	mpn/100ml	7/8/2014	6:25:00
WIN 81.8	Coliform, *E. coli*		88.41	mpn/100ml	7/22/2014	6:20:00
WIN 81.8	Coliform, *E. coli*		344.80	mpn/100ml	8/5/2014	6:35:00
WIN 81.8	Coliform, *E. coli*		148.30	mpn/100ml	8/19/2014	6:40:00
WIN 81.8	Coliform, *E. coli*		93.31	mpn/100ml	9/2/2014	6:35:00

WIN 81.8	**Coliform, *E. coli***		**183.79**	**mpn/100ml**	**gm season**	
WIN 82.6	Coliform, *E. coli*		203.54	mpn/100ml	6/24/2014	6:25:00
WIN 82.6	Coliform, *E. coli*		726.99	mpn/100ml	7/8/2014	7:10:00
WIN 82.6	Coliform, *E. coli*		410.58	mpn/100ml	7/22/2014	6:10:00
WIN 82.6	Coliform, *E. coli*		686.67	mpn/100ml	8/5/2014	6:15:00
WIN 82.6	Coliform, *E. coli*		228.18	mpn/100ml	8/19/2014	6:20:00
WIN 82.6	Coliform, *E. coli*		156.48	mpn/100ml	9/2/2014	6:10:00
WIN 82.6	**Coliform, *E. coli***		**337.94**	**mpn/100ml**	**gm season**	
WIN 82.8	Coliform, *E. coli*		344.80	mpn/100ml	6/24/2014	6:20:00
Win 82.8	Coliform, *E. coli*		983.54	mpn/100ml	7/8/2014	7:05:00
WIN 82.8	Coliform, *E. coli*		1413.61	mpn/100ml	7/22/2014	6:00:00
WIN 82.8	Coliform, *E. coli*		517.21	mpn/100ml	8/5/2014	6:10:00
WIN 82.8	Coliform, *E. coli*		344.80	mpn/100ml	8/19/2014	6:10:00
WIN 82.8	Coliform, *E. coli*		151.52	mpn/100ml	9/2/2014	6:02:00
WIN 82.8	**Coliform, *E. coli***		**484.62**	**mpn/100ml**	**gm season**	
WIN 83.8	Coliform, *E. coli*		290.93	mpn/100ml	7/8/2014	6:00:00
WIN 83.8	Coliform, *E. coli*		230.98	mpn/100ml	7/22/2014	6:39:00
WIN 83.8	Coliform, *E. coli*		178.53	mpn/100ml	8/5/2014	6:25:00
WIN 83.8	Coliform, *E. coli*		35.92	mpn/100ml	8/19/2014	6:30:00
WIN 83.8	Coliform, *E. coli*		111.23	mpn/100ml	9/2/2014	6:47:00
WIN 83.8	**Coliform, *E. coli***		**136.81**	**mpn/100ml**	**gm**	

					season	
Win 84.1	Coliform, *E. coli*		307.59	mpn/100ml	7/8/2014	6:00:00
WIN 84.1	Coliform, *E. coli*		365.40	mpn/100ml	7/22/2014	6:32:00
WIN 84.1	Coliform, *E. coli*		275.51	mpn/100ml	8/5/2014	6:15:00
WIN 84.1	Coliform, *E. coli*		124.57	mpn/100ml	8/19/2014	6:23:00
WIN 84.1	Coliform, *E. coli*		64.37	mpn/100ml	9/2/2014	6:42:00
WIN 84.1	**Coliform, *E. coli***		**190.11**	**mpn/100ml**	**gm season**	
WIN 84.3	Coliform, *E. coli*		70.57	mpn/100ml	6/24/2014	6:15:00
WIN 85.5	Coliform, *E. coli*		818.27	mpn/100ml	6/24/2014	5:53:00
WIN 85.5	Coliform, *E. coli*		726.99	mpn/100ml	7/8/2014	6:00:00
WIN 85.5	Coliform, *E. coli*		155.25	mpn/100ml	7/22/2014	6:19:00
WIN 85.5	Coliform, *E. coli*		157.56	mpn/100ml	8/5/2014	5:50:00
WIN 85.5	Coliform, *E. coli*		12.23	mpn/100ml	8/19/2014	6:00:00
WIN 85.5	Coliform, *E. coli*		11.00	mpn/100ml	9/2/2014	6:33:00
WIN 85.5	**Coliform, *E. coli***		**111.85**	**mpn/100ml**	**gm season**	
WIN 86.6	Coliform, *E. coli*		157.99	mpn/100ml	6/24/2014	5:41:00
WIN 86.6	Coliform, *E. coli*		137.35	mpn/100ml	7/8/2014	6:00:00
WIN 86.6	Coliform, *E. coli*		648.82	mpn/100ml	7/22/2014	6:05:00
WIN 86.6	Coliform, *E. coli*		488.44	mpn/100ml	8/5/2014	5:40:00
WIN 86.6	Coliform, *E. coli*		26.24	mpn/100ml	8/19/2014	5:58:00

WIN 86.6	Coliform, *E. coli*		37.44	mpn/100ml	9/2/2014	6:23:00
WIN 86.6	**Coliform, *E. coli***		**137.49**	**mpn/100ml**	**gm season**	

Table 3: 2014 Water Quality results by parameter and site.

SITE ID	Parameter		Result	Units	Date	Time
CB0.1	Alkalinity		91	mg CaCO3/L	8/5/2014	6:25:00
CB0.1	Alkalinity		108	mg CaCO3/L	9/2/2014	6:20:00
GB0.1	Alkalinity		109	mg CaCO3/L	8/5/2014	6:30:00
GB0.1	Alkalinity		121	mg CaCO3/L	9/2/2014	6:20:00
JB0.1	Alkalinity		102	mg CaCO3/L	8/5/2014	6:05:00
JB0.1	Alkalinity		114	mg CaCO3/L	9/2/2014	6:37:00
MAB0.1	Alkalinity		17	mg CaCO3/L	8/5/2014	6:45:00
MAB0.1	Alkalinity		15	mg CaCO3/L	9/2/2014	7:50:00
NAB2.6	Alkalinity		42	mg CaCO3/L	8/5/2014	7:08:00
NAB2.6	Alkalinity		25	mg CaCO3/L	9/2/2014	7:35:00
WIN 72.8	Alkalinity		55	mg CaCO3/L	8/5/2014	7:20:00
WIN 72.8	Alkalinity		84	mg CaCO3/L	9/2/2014	7:14:00
CB0.1	Chloride		8	mg/L	6/24/2014	6:35:00
CB0.1	Chloride		5	mg/L	7/8/2014	7:25:00
CB0.1	Chloride		9	mg/L	8/5/2014	6:25:00
CB0.1	Chloride		14	mg/L	9/2/2014	6:20:00
GB0.1	Chloride		9	mg/L	6/24/2014	6:10:00
GB0.1	Chloride		10	mg/L	9/2/2014	6:20:00
JB0.1	Chloride	<	2	mg/L	6/24/2014	6:05:00
JB0.1	Chloride	<	2	mg/L	7/8/2014	6:15:00
JB0.1	Chloride	<	2	mg/L	8/5/2014	6:05:00
JB0.1	Chloride		2	mg/L	9/2/2014	6:37:00
MAB0.1	Chloride		6	mg/L	6/24/2014	6:40:00
MAB0.1	Chloride		5	mg/L	7/8/2014	6:15:00
MAB0.1	Chloride		5	mg/L	8/5/2014	6:45:00
MAB0.1	Chloride		6	mg/L	9/2/2014	7:50:00
NAB2.6	Chloride	<	2	mg/L	6/24/2014	6:55:00
NAB2.6	Chloride	<	2	mg/L	8/5/2014	7:08:00
NAB2.6	Chloride	<	2	mg/L	9/2/2014	7:35:00
WIN 72.8	Chloride		8	mg/L	6/24/2014	6:30:00
WIN 72.8	Chloride		8	mg/L	8/5/2014	7:20:00
WIN 72.8	Chloride		14	mg/L	9/2/2014	7:14:00
CB0.1	TN		0.36	mg/L	6/24/2014	6:35:00
CB0.1	TN		0.29	mg/L	7/8/2014	7:25:00
CB0.1	TN		0.23	mg/L	8/5/2014	6:25:00
CB0.1	TN		0.28	mg/L	9/2/2014	6:20:00
GB0.1	TN		0.70	mg/L	6/24/2014	6:10:00

GB0.1	TN		0.47	mg/L	8/5/2014	6:30:00
GB0.1	TN		0.68	mg/L	9/2/2014	6:20:00
JB0.1	TN		0.28	mg/L	6/24/2014	6:05:00
JB0.1	TN		0.25	mg/L	7/8/2014	6:15:00
JB0.1	TN		0.25	mg/L	8/5/2014	6:05:00
JB0.1	TN		0.29	mg/L	9/2/2014	6:37:00
MAB0.1	TN		0.37	mg/L	6/24/2014	6:40:00
MAB0.1	TN		0.34	mg/L	7/8/2014	6:15:00
MAB0.1	TN		0.31	mg/L	8/5/2014	6:45:00
MAB0.1	TN		0.36	mg/L	9/2/2014	7:50:00
NAB2.6	TN		0.34	mg/L	6/24/2014	6:55:00
NAB2.6	TN		0.21	mg/L	8/5/2014	7:08:00
NAB2.6	TN		0.28	mg/L	9/2/2014	7:35:00
WIN 72.8	TN		0.35	mg/L	6/24/2014	6:30:00
WIN 72.8	TN		0.27	mg/L	8/5/2014	7:20:00
WIN 72.8	TN		0.26	mg/L	9/2/2014	7:14:00
CB0.1	TP		6.3	ug P/L	6/24/2014	6:35:00
CB0.1	TP		10.4	ug P/L	7/8/2014	7:25:00
CB0.1	TP		8.1	ug P/L	8/5/2014	6:25:00
CB0.1	TP		6.2	ug P/L	9/2/2014	6:20:00
GB0.1	TP		6.9	ug P/L	6/24/2014	6:10:00
GB0.1	TP		5.3	ug P/L	8/5/2014	6:30:00
GB0.1	TP		6.2	ug P/L	9/2/2014	6:20:00
JB0.1	TP		8.8	ug P/L	6/24/2014	6:05:00
JB0.1	TP		8.8	ug P/L	7/8/2014	6:15:00
JB0.1	TP		15.0	ug P/L	8/5/2014	6:05:00
JB0.1	TP		14.4	ug P/L	9/2/2014	6:37:00
MAB0.1	TP		12.2	ug P/L	6/24/2014	6:40:00
MAB0.1	TP		14.1	ug P/L	7/8/2014	6:15:00
MAB0.1	TP		11.5	ug P/L	8/5/2014	6:45:00
MAB0.1	TP		11.7	ug P/L	9/2/2014	7:50:00
NAB2.6	TP		19.2	ug P/L	6/24/2014	6:55:00
NAB2.6	TP		13.2	ug P/L	8/5/2014	7:08:00
NAB2.6	TP		19.1	ug P/L	9/2/2014	7:35:00
WIN 72.8	TP		17.3	ug P/L	6/24/2014	6:30:00
WIN 72.8	TP		11.1	ug P/L	9/2/2014	7:14:00

Table 4: The relative percent difference between duplicate samples collected for 10% of the samples in 2014 from the Winooski Headwaters project.

Site ID	Date	Sample Type	Relative Percent Difference Between Duplicate Pairs (RPD)
JB0.1	6/24/14	Chloride	0%
		Phosphorous	2.6%
		Nitrogen	0%
WIN 85.5	6/24/14	*E. coli*	11.8%
MAB0.1	7/8/14	Chloride	1.3%
		Phosphorous	3.6%
		Nitrogen	3.0%
WIN 82.8	7/8/14	*E. coli*	12.7%
JB0.1	8/5/14	Alkalinity	2.0%
		Chloride	0%
		Phosphorous	12%
		Nitrogen	0%
WIN 71.4	8/5/14	*E. coli*	50.4%
WIN86.6	8/19/14	*E. coli*	12.3%
WIN 72.8	9/2/14	Alkalinity	0.6%
		Chloride	1.5%
		Phosphorous	1.8%
		Nitrogen	3.9%
		E. coli	6.5%
Mean Relative Percent Difference (Mean RPD)		**Alkalinity**	**1.3%**
		Chloride	**0.7%**
		Phosphorous	**5.0%**
		Nitrogen	**1.7%**
		E. coli	**18.7%**

*On one sampling date, 7/22/14, (when only E. coli was sampled) an “A” sample was not taken, only the “B” and “D” samples. Therefore, the RPD could not be calculated for this date.