Chittenden County STREAM TEAM

2013 Volunteer Water Quality Monitoring Report

The Chittenden County Stream Team (CCST) is a program to engage citizens across an eight-town area to implement projects to reduce non-point source pollution and stormwater volume at the local level. The participating towns are Burlington, Essex, Essex Junction, Milton, Shelburne, South Burlington, Williston, and Winooski. The project is managed by the Chittenden County Regional Planning Commission, and run by the Winooski Natural Resource Conservation District with assistance from the Friends of the Winooski River. This report describes the results from the second year of the volunteer water quality monitoring effort by the CCST. The Friends and the District will work with the Steering Committee of the CCST to share the results and publicize the findings.

The Chittenden County Stream Team collected biweekly water quality samples at fourteen sites on Centennial, Englesby, Indian, Mallets, Morehouse, Munroe, Muddy and Potash Brooks during the summer of 2013. These mostly urban or suburban streams suffer from sedimentation, excessive nutrient loads, high temperatures, bacteria, and other pollutants. Samples were collected on a total of six sampling dates during the season and were analyzed for turbidity, total phosphorous, total nitrogen, and chloride. The CCST also sampled for these parameters at five of these sites during two rain events on 9/10 and 10/6. The specific sampling sites and their locations are listed in Table 1 and a map of the sites is shown in Figure 1.

Table 1. Chittenden County Stream Team 2013 Water Quality Sampling Sites

Location	Waterbody	Site ID	Lat / Long
Grove Street in Burlington	Centennial Brook	Cent 10	44.48453 / -73.18423
Champlain School Comm. Gardens	Englesby Brook	Englesby 10	44.45627 / -73.21394
Essex High School	Indian Brook	Indian 10	44.49668 / -73.11093
Lang Farm in Essex	Indian Brook	Indian 20	44.50442 / -73.09190
McMullen Road	Malletts Creek	Milton 10	44.60779/ -73.20103
Route 7 and Bay Road	Munroe Brook	Munroe 10	44.38987/ -73.21730
Spear & Webster Intersection	Munroe Brook	Munroe 20	44.38984 / -73.20103
Landry Park Winooski	Morehouse Brook	Morehouse 10	44.50037 / -73.19370
River Cove Road in Williston	Muddy Brook	Muddy 10	44.47293 / -73.13505
Marshall Avenue in South Burlington	Muddy Brook	Muddy 20	44.45340 / -73.13833
Van Sicklen Road in Williston	Muddy Brook	Muddy 30	44.42823 / -73.14622
Kindness Court in South Burlington	Potash Brook	Potash 10	44.44572 / -73.21348
Farrell Street in South Burlington	Potash Brook	Potash 20	44.44660 / -73.20415
Dorset Street in South Burlington	Potash Brook	Potash 30	44.45150 / -73.17849

Report prepared by:

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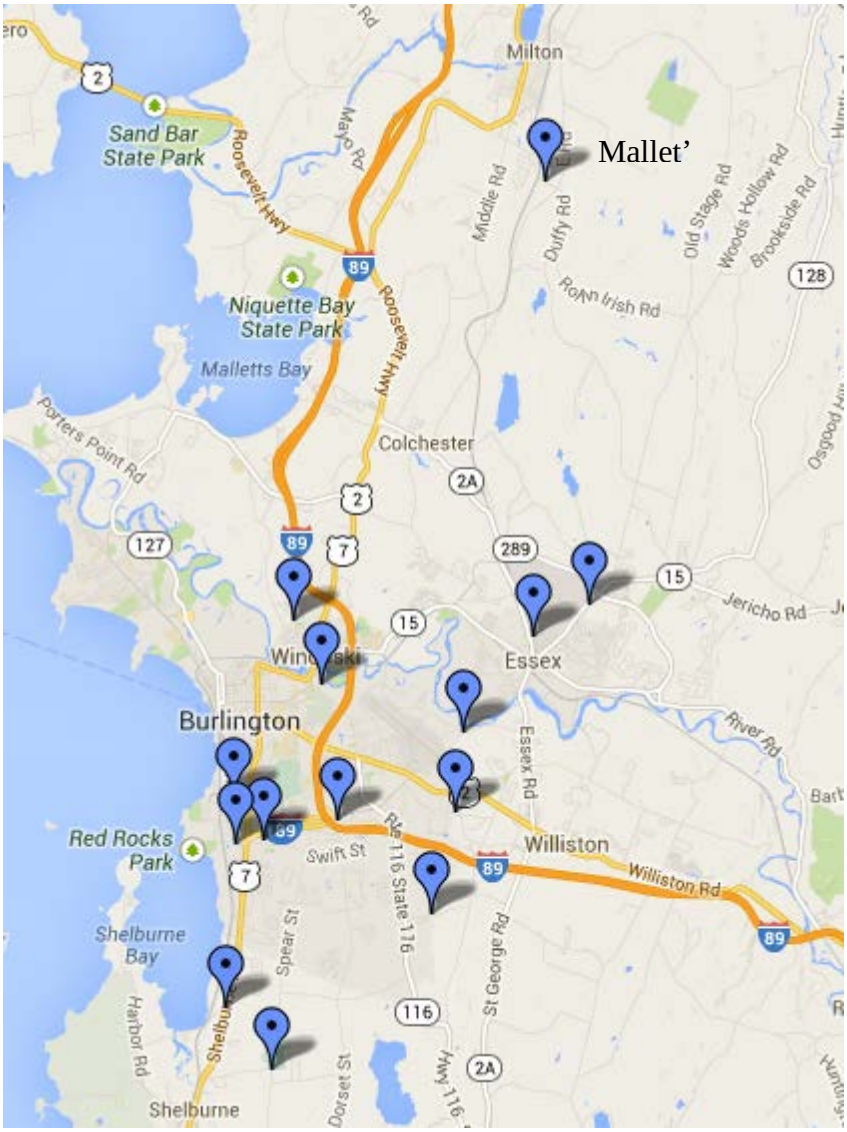
FRIENDS OF THE Winooski

Friends of the Winooski River
PO Box 777
Montpelier VT 05601

info@winooskiriver.org • 802-882-8276

Figure 1. Chittenden County Stream Team 2013 water quality monitoring sites.



Results summary

The Chittenden County Stream Team water quality monitoring results for 2013 are summarized in Table 2. The CCST results indicate that phosphorus levels exceeded the proposed Vermont state standard of 27ug/L in all samples at all sites regardless of flow conditions. Chloride levels were high in some streams, particularly in Centennial and Potash Brooks. Turbidity levels spiked after rain events, but averaged below the state standard of 10 NTU for Class B, cold-water streams. Nitrogen levels were low in all samples and never exceeded the state standard of 5 mg/L. The results for each parameter are discussed in more detail in separate sections below.

Mean levels of the four parameters measured are given for both dry conditions (defined as dates when there had been less than 0.25 inches of rain in the previous 48 hours, and when the volunteer sampler observed the stream flow to be low). It should be noted, however, that since the summer of 2013 was quite rainy, only two of the five sampling dates corresponded to dry, low flow conditions. The mean value for dry conditions, therefore, is based on just two samples.

Results from rain event sampling suggest that Centennial and Morehouse Brooks may be particularly susceptible to phosphorus and turbidity spikes during rainstorms while nitrogen and chloride levels for all streams remained relatively constant.

Quality assurance data is presented in Appendix A. Project completeness percentages are given in Appendix B.

Table 2. 2013 Chittenden County Stream Team Results Summary: Mean values for chloride, total nitrogen, total phosphorous, and turbidity in eight Burlington area streams under all weather conditions and dry conditions. Mean chloride levels above 230mg/L, mean phosphorous levels above 27 ug/L, and mean turbidity levels above 10 NTU are highlighted. Dry conditions were defined as sample dates when there had been less than a total of 0.25 inches of rain during the preceding 2 days based on Burlington airport rainfall data obtained from the National Climate Data Center Climate Data Online website.

Site ID	Chloride (mg/L)		Nitrogen, Total (mg N/L)		Phosphorus, Total (ug P/L)		Turbidity (NTU)	
	All	Dry	All	Dry	All	Dry	All	Dry
Centennial 10	**336**	**313**	0.97	0.72	**126**	**60**	**18.4**	7.4
Engelsby 10	165	140	0.92	1.04	**71**	**67**	7.7	5.2
Indian 10	119	109	1.15	1.09	**49**	**39**	7.5	7.2
Indian 20	48	35	0.38	0.38	**42**	**37**	5.8	6.7
Milton 10	26	27	0.68	0.68	**43**	**45**	7.2	8.5
Munroe10	47	77	0.55	0.6	**61**	**51**	**10.1**	**12.3**
Munroe20	31	30	0.52	0.47	**78**	**59**	**14.9**	6.3
Morehouse 10	47	51	1.18	1.11	**106**	**35**	**42.8**	4.6
Muddy 10	63	67	1.06	1.16	**97**	**89**	**10.1**	7.0
Muddy 20	68	37	0.99	1.17	**110**	**119**	9.5	7.6
Muddy 30	22	26	1.44	1.35	**158**	**137**	7.2	**10.1**
Potash 10	**230**	180	0.81	0.88	**50**	**63**	4.9	6.5
Potash 20	**233**	170	0.73	0.8	**46**	**58**	3.6	5.1
Potash 30	202	179	0.69	0.71	**53**	**55**	4.2	4.8

Chloride

The relative levels of chloride at each of the sampling sites under all weather conditions and dry conditions only are shown in Figure 2. Mean chloride levels exceeded the EPA chronic criterion of 230 mg/L at sites on Centennial and Potash Brooks. 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. Chlorides of potassium, magnesium and calcium have more of an adverse effect on the health of aquatic organisms than sodium chloride, upon which the standard is based.

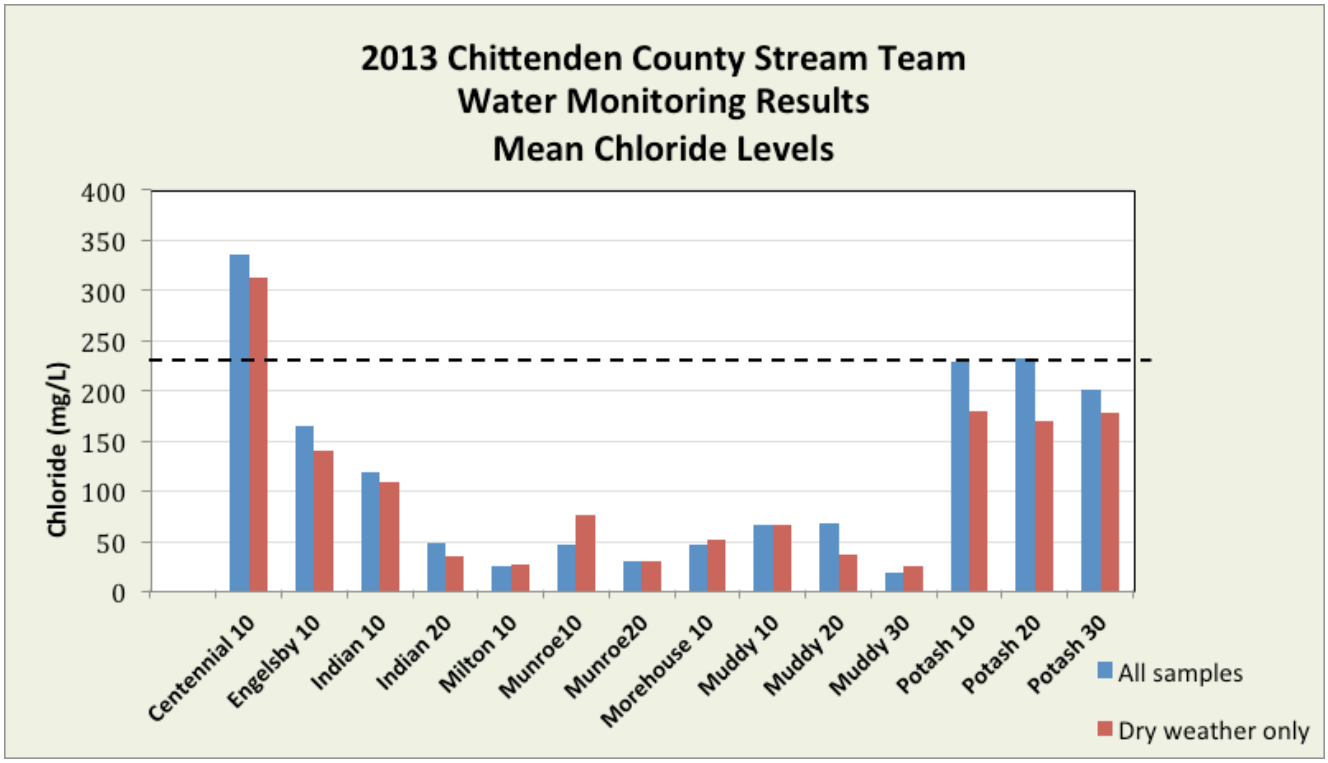


Figure 2. Mean chloride values in eight streams sampled by the Chittenden County Stream Team in 2013. The mean under dry conditions is shown in red; the mean under all weather conditions is shown in blue. Dry conditions were defined as times when the rainfall in the previous 48 hours was less than 0.25 inches. The EPA standard (and proposed Vermont standard) of 230 mg/L is indicated by the dotted line. This is the concentration of chloride above which chronic health effects have been observed in of aquatic species.

The levels of chloride in individual samples varied from 9.51mg/L at the Indian 20 site to 468 mg/L for Centennial Brook. None of the individual samples for any of the CCST monitoring sites had chloride levels that exceeded the EPA's acute standard, which is 860 mg chloride/L. EPA's chronic standard of 230 mg/L was exceeded by the annual mean chloride values in both Centennial and Potash Brooks.

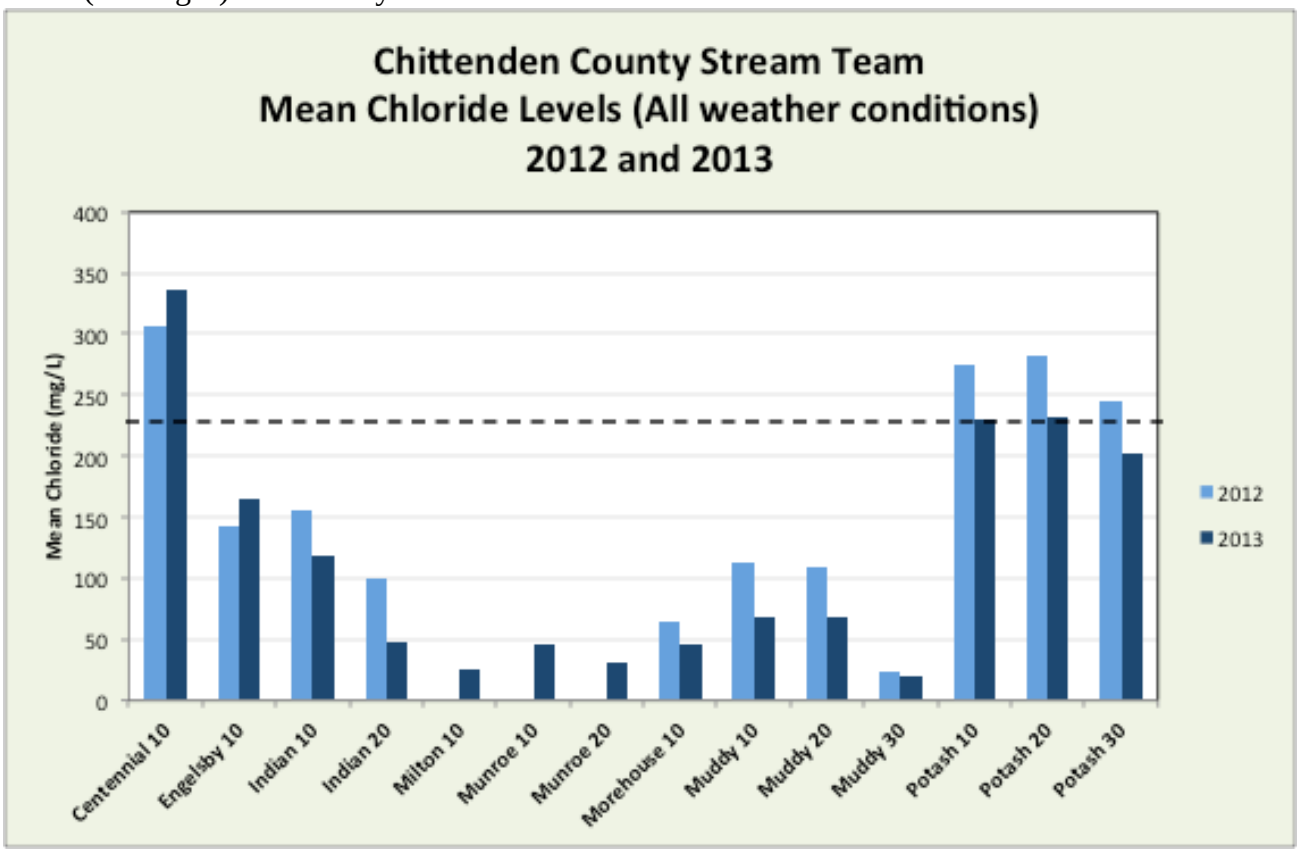
High levels of chloride at Centennial and Potash Brooks are probably due to land use in the watersheds of these streams. Centennial Brook originates south of the Centennial Woods Natural Area between the Sheraton Conference Center and the University of Vermont Library Storage buildings and is known as the stream with the highest chloride concentrations in the state of Vermont. The brook originates on the UVM campus, drains the natural area and a large section of South Burlington near the airport, and empties into the Winooski River. The Potash Brook parallels both I-89 and I-189 and drains a large area of South Burlington. Both watersheds are heavily urbanized, include a large amount of road and parking lot surfaces, and are likely subjected to a good deal of road salt use.

Comparion of chloride levels in 2012 and 2013

The mean chloride levels at the CCST sites in 2013 were similar to the ones measured in 2012 (Figure 3). In both years mean chloride levels in Centennial and Potash Brooks were the highest among the sites tested and were above or near the standard for mean chloride (230 mg/L). The chloride level in Centennial Brook was higher in 2013 than in 2012, while levels in Potash Brook appear to have fallen somewhat. The remaining sites had mean chloride levels well below the standard in both years, and in general, chloride levels were lower in 2013 than in 2012 at most sites. This may be due to the fact that

the summer of 2013 had more rainfall than 2012, and chloride levels tend to be higher in drier conditions.

Figure 3. Comparison of the mean chloride levels measured in the 2012 and 2013 CCST monitoring efforts. The chloride levels in samples collected in all weather conditions (wet and dry) were used to calculate the mean. The EPA standard (and proposed Vermont standard) for mean chloride levels (230 mg/L) is shown by the dotted line



Nitrogen

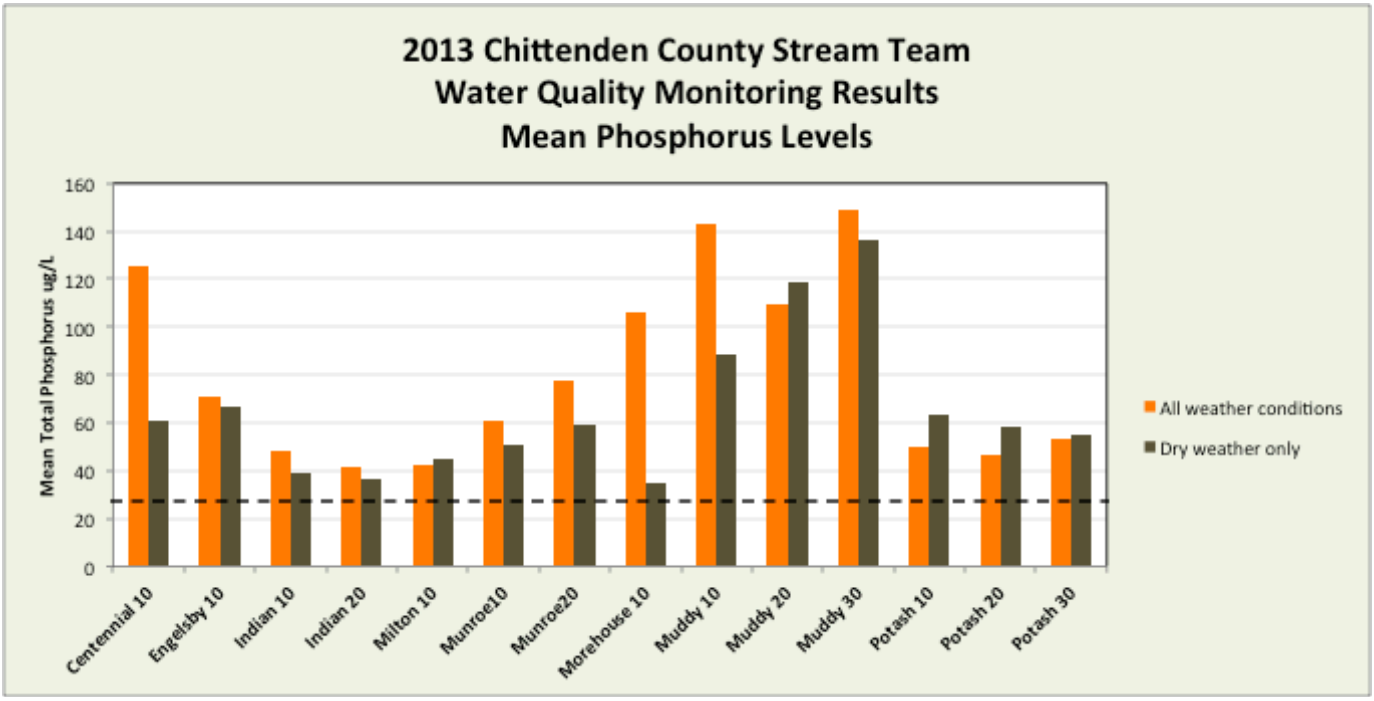
Nitrogen enters streams via runoff carrying fertilizers, manure, or sewage. Water treatment plants that do not specifically remove nitogen may also be a source. The Vermont Water Quality Standards standard for nitrogen levels in Class B waters is 5 mg NO3-N/L at flows above base flow. None of the samples collected in 2012 or 2013 had nitrogen levels that exceeded this standard. The highest nitrogen level in a single sample was 2.34 mg/L, taken at the Centennial Brook site under wet conditions. The levels of nitrogen measured in 2013 were similar to those of 2012 (data not shown.)

Phosphorous

Phosphorous sources include fertilizers, animal manure, septic systems, pet waste, erosion, and plant residues. The mean phosphorous levels under base flow (dry) conditions in all the streams were high, ranging from 35 to 136 ug/L and are shown in Figure 4. While the VT WQS currently sets no specific standard for phosphorous levels in Class B waters below 2500 feet in elevation, the state of Vermont is considering adoption of a base-flow phosphorous standard of 27 ug/L for class B, "warm water medium-gradient streams" and 15 ug/L for "medium high-gradient streams" (we are assuming these streams would fall under the first category, although the streams monitored are not listed as warm-

water streams in the 2011 Vermont Water Quality Standards). This concentration is indicated by a dotted line in Figure 4.

Figure 4. Mean total phosphorous levels at the sites sampled by the CCST in the summer of 2013. The standard proposed by the State of Vermont for mean total phosphorus at base-flow in medium gradient, warm water streams (27 ug/L) is indicated by the dotted black line. Mean levels of total phosphorus under both dry and all-weather conditions are shown. Dry weather conditions were defined as times when the 48-hour rainfall was less than 0.25 inches.



The mean phosphorous levels in both dry and all-weather conditions at all the sites in all the streams sampled were above the target 10ug/L concentration for Lake Champlain and the proposed standard of 27 ug/L for medium-gradient, warm-water streams. Muddy Brook, which forms the border between South Burlington and Williston, had particularly high levels of phosphorous, especially at the most upstream site (Muddy 30). This site is in a fairly rural area of both farms fields and estate-type homes with large expanses of lawn. The other Muddy Brook sites are in areas that are partially developed with a combination of open farm fields and highly developed but widely spaced parcels such as the airport, a rock quarry, and an industrial park.

Phosphorus levels spiked at most sites after rainfall, as shown in the difference between mean phosphorus values in all weather conditions mean phosphorus in dry conditions only. Spikes in phosphorus levels can be due to phosphorus in the runoff (carrying eroding soils, fertilizers, manure, or pet waste, for example) and/or phosphorus associated with sediment particles churned up from the bottom of a stream by the higher water velocities or picked up by the stream from eroding streambanks.

Comparison of Phosphorus levels in 2012 and 2013.

As in 2012, the mean total phosphorus levels in dry conditions 2013 were above 27 ug/L and were highest at the Muddy Brook sites (Figure 5). All sites on Potash Brook had higher total phosphorus levels in 2013 than in 2012, as did the Centennial Brook site and two of the three Muddy Brook sites (Muddy 10 and 20 – the more downstream sites). The remaining sites that were sampled in both years had a decrease in phosphorus levels, particularly the Englesby Brook site, which had one of the highest phosphorus readings in 2012.

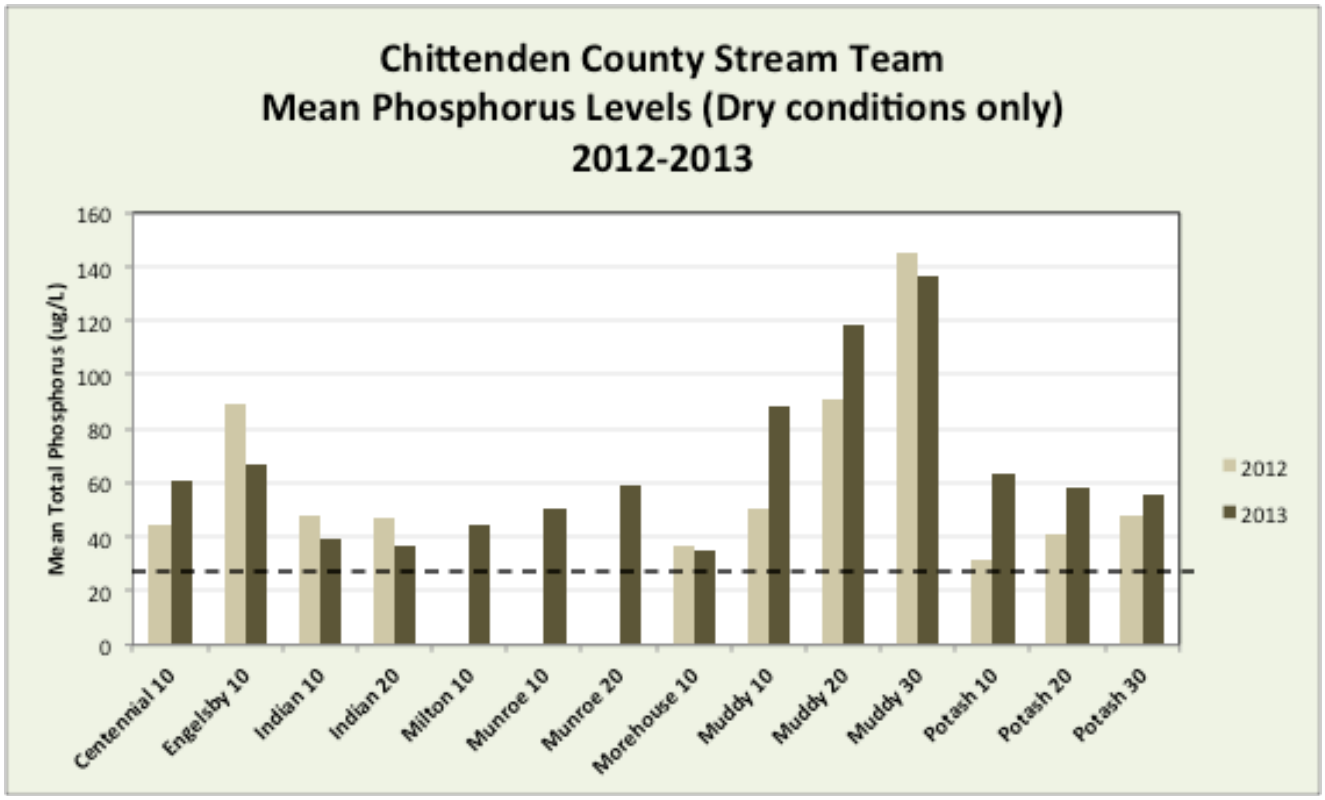


Figure 5. Comparison of mean total phosphorus levels measured in the 2012 and 2013 Chittenden County Stream Team monitoring efforts. The standard proposed by the State of Vermont for mean total phosphorus at base-flow in medium gradient, warm water streams (27 ug/L) is indicated by the dotted black line.

Turbidity

The turbidity of a water sample is a measure of its light-scattering properties, is related to the amount of sediment, algae, microbes, etc suspended in the water, and is an indicator of erosion and/or high nutrient levels. These suspended substances absorb heat from the sun, thereby influencing water temperatures and dissolved oxygen levels. High turbidity can also limit photosynthesis in aquatic plants and algae and affect the health and reproduction of fish and aquatic invertebrates. The VT Water Quality standard for turbidity is 25 nepholometric units (NTU) for warm-water fish habitat and 10 NTU for cold-water fish habitat measured as an average annual turbidity under base flow conditions. While some sites exhibited turbidity levels in single samples well above 10 NTU after rainstorms, none of the mean turbidity values from any of the sampled streams exceeded the VT WQS level.

Rain event sampling

Since the summer of 2013 was quite wet, especially during June, many of the samples collected on the biweekly monitoring dates were taken during high flow conditions. In addition to these samples, a subset of sites was sampled specifically during rainstorms in order to get information regarding the effect of stormwater runoff on stream water quality. A Chittenden County Stream Team volunteer sampled five sites twice during the fall of 2013, once on 9/10, and once on 10/6, as soon as possible after the onset of a rainstorm in an attempt to sample the “first flush” of stormwater flow. The results of this sampling are shown in Table 3.

Table 3. Chittenden County Stream Team 2013 Rain Event Sampling. Chloride levels above 230 mg/L, total phosphorous levels above 27ug/L, and turbidity levels above 10 NTU are highlighted. Means for dry conditions were determined from the biweekly sampling described above.

Site ID	Date	Chloride (mg/L)	Nitrogen, Total - Persulfate (mg N/L)	Phosphorus, Total (ug P/L)	Turbidity (NTU)
Centennial 10 2013 mean, dry conditions		**312.95**	0.72	**60.48**	7.43
Centennial 10 rain event 1	9/10/13	210	0.94	**411**	**44.7**
Centennial 10 rain event 2	10/6/13	**355**	0.77	**141**	**40.9**
Indian 10 2013 mean, dry conditions		109.3	1.09	**39.37**	7.24
Indian 10 rain event 1	9/10/13	85	1.07	**71.7**	7.86
Indian 10 rain event 2	10/6/13	161	1.33	**54.6**	5.52
Morehouse 10 2013 mean, dry conditions		51.22	1.11	**35.2**	4.61
Morehouse 10 rain event 1	9/10/13	15	0.88	**197**	**74.8**
Morehouse 10 rain event 2	10/6/13	51.5	1.29	**298**	**182**
Muddy 20 2013 mean, dry conditions		37.32	1.17	**118.91**	7.57
Muddy 20 rain event 1	9/10/13	71	0.74	**104**	15.2
Muddy 20 rain event 2	10/6/13	79.2	0.81	**84.9**	14.1
Potash 20 2013 mean, dry conditions		170.11	0.8	**58**	5.05
Potash 20 rain event 1	9/10/13	210	0.66	**51.5**	3.76
Potash 20 rain event 2	10/6/13	**270**	0.57	**31.9**	3.18

While this comparison is based on only two rain events, and the mean value under dry conditions for each site is based on the only two samples collected (see Results summary above), it does appear to suggest a few patterns. Total nitrogen levels during the rain event remained relatively stable and did not exceed the VT state standard for nitrogen at any time, whereas phosphorus and turbidity were more variable. At two of the five sites, both turbidity and phosphorus increased during the rain event. Both Centennial and Morehouse Brook sites experienced particularly severe spikes in turbidity and total phosphorus levels. The turbidity level in Centennial Brook increased by approximately 5-fold during the rain events, while the phosphorus level increased by 580% and 133% during rain event 1 and 2, respectively. Morehouse Brook turbidity levels were quite low during dry conditions, but increased by 16- and 38-fold during the two rain events while phosphorus levels increased by 460% and 747%. The phosphorus level at the Indian 20 site and the turbidity level at the Muddy Brook 20 site increased somewhat during the rain events, but all remaining phosphorus and turbidity levels were relatively constant before and after the stormwater input. It appears, therefore, that Centennial and Morehouse Brooks may be particularly susceptible to the effects of stormwater runoff and/or erosion. This is also reflected in the graph in Figure 4, where phosphorus levels during dry versus all conditions are compared.

Appendix A. Quality Assurance Measures for Phosphorous, Chloride, and Turbidity Sampling in 2012

Site ID	Date	Sample Type	Relative Percent Difference Between Duplicate Pairs (RPD)
Centennial 10	6/25/13	Chloride	1.00 %
		Phosphorus	9.6 %
		Nitrogen	0 %
		Turbidity	1.90 %
Indian 10	7/9/13	Chloride	0.90 %
		Phosphorus	0.50 %
		Nitrogen	2.50 %
		Turbidity	16.4 %
Morehouse 10	7/23/13	Chloride	1.00 %
		Phosphorus	18.3 %
		Nitrogen	2.20 %
		Turbidity	5.00 %
Muddy 10	8/13/13	Chloride	0.30 %
		Phosphorus	1.40 %
		Nitrogen	0.90 %
		Turbidity	2.50 %
Potash 10	8/27/13	Chloride	1.50 %
		Phosphorus	0.20 %
		Nitrogen	4.70 %
		Turbidity	11.7 %
Centennial 10	9/10/13	Chloride	1.90 %
		Phosphorus	10.4 %
		Nitrogen	2.20 %
		Turbidity	6.00 %
Indian 10	10/6/13	Chloride	1.90 %
		Phosphorus	0.40 %
		Nitrogen	0.70 %
		Turbidity	17.50 %
Mean Relative Percent Difference (Mean RPD)		**Chloride**	**1.20 %**
		Phosphorus	**5.80 %**
		Nitrogen	**1.90 %**
		Turbidity	**8.70 %**

Appendix B– Project Completeness

Parameter	Number of Samples Anticipated	Number of Valid Samples Collected & Analyzed	Percent Complete
TSS (rain event only)	14	0	0%*
Turbidity (bi-weekly testing only)	80	93	116%*
Total phosphorus	94	93	99%
Total Nitrogen	94	93	99%
Chloride	94	92	98%

* Turbidity was measured instead of TSS during rain events.