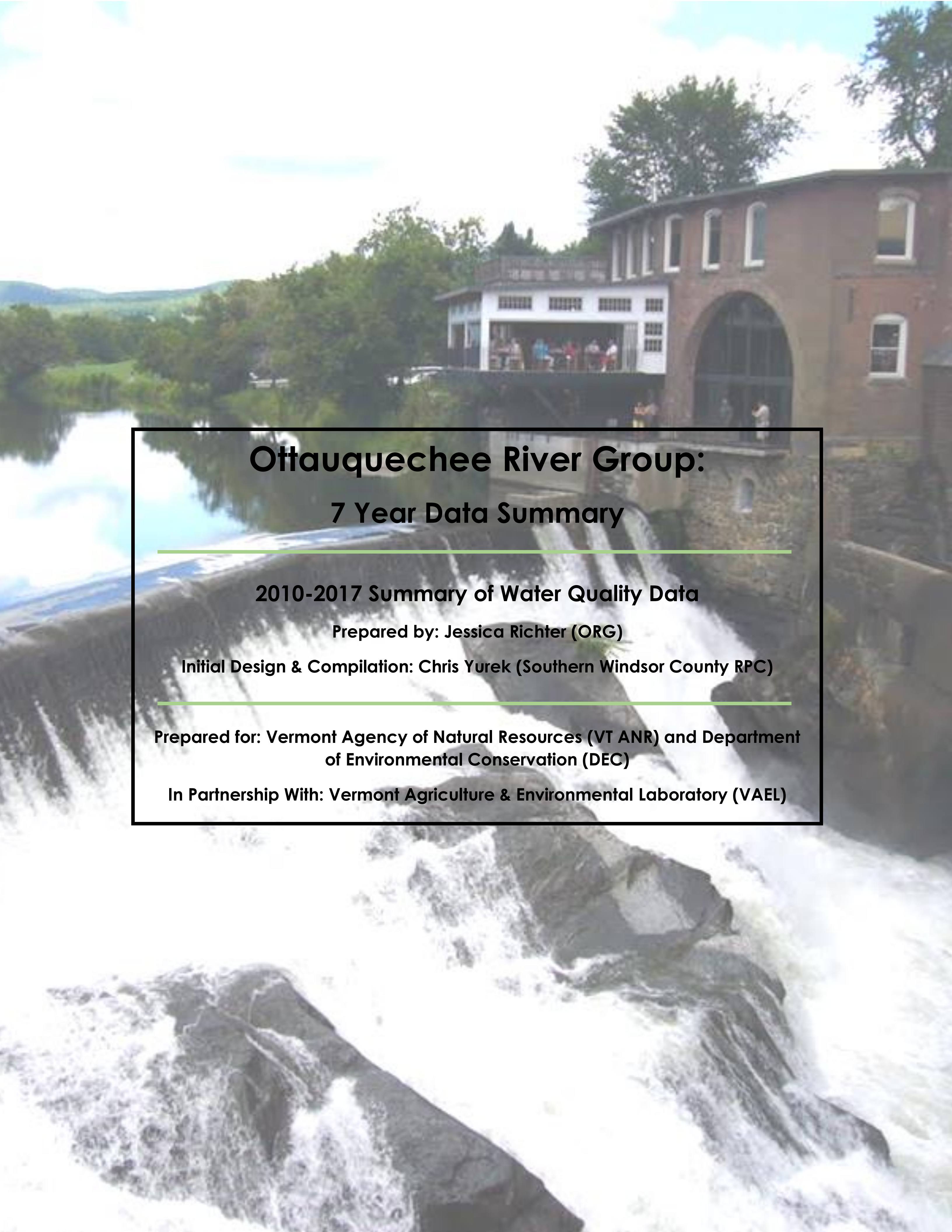

Ottauquechee River Group:

7 Year Data Summary

2010-2017 Summary of Water Quality Data

Prepared by: Jessica Richter (ORG)

Initial Design & Compilation: Chris Yurek (Southern Windsor County RPC)

Prepared for: Vermont Agency of Natural Resources (VT ANR) and Department of Environmental Conservation (DEC)

In Partnership With: Vermont Agriculture & Environmental Laboratory (VAEL)

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ACKNOWLEDGEMENTS:
The Ottauquechee River Group would like to extend a special thank you to Jay Flaster, Tom Hayes, Darlyne Franzen, Shawn Kelley, Nicki Buck, Kristen Brodie, Change the World Kids (CTWK), and all the other volunteers and VT ANR interns who have participated in the program since its inaugural 2010 sampling season. This dedicated team of citizen scientists made sampling in the Ottauquechee Watershed possible over the course of ORG's existence. We would like to extend an additional thank you to VT Watershed Grant for funding, the ONRCD for acting as ORG's fiscal agent, VT DEC Watershed Coordinator Marie Levesque Caduto, and all the staff at the Vermont LaRosa Environmental Laboratory as well as Endyne, Inc.

OVERVIEW:
The Ottauquechee River Group's (ORG) water quality monitoring program (WQMP) has been made possible through partnership with the LaRosa Environmental Laboratory, as well as a dedicated team of citizen volunteers. The program has been run by volunteer coordinator and VT ANR Stream Alteration Engineer Todd Menees, who is typically assisted annually by a VT DEC intern.
There were 10 sites chosen to be sampled in 2010 and 15 sites from 2011 through 2015, each to be sampled once every two weeks for the duration of each summer. An additional 5 sites were added during the 2016 monitoring season totaling 20 sites. No new sites were added in 2017. The annual goal for each site was seven sampling dates (6 in 2016 & 2017); with a minimum of five data points to achieve statistical validity (2011 did not reach that goal due to Tropical Storm Irene). Each site was tested for five parameters including Total Phosphorus (TP), Total Nitrogen (TN), Chloride (Cl-), Turbidity (TURB), and *E. coli* bacteria, with the exception of 2010 when TN was not tested and 2011 when TP was not tested. The sample sites are depicted in a map included later in this report.

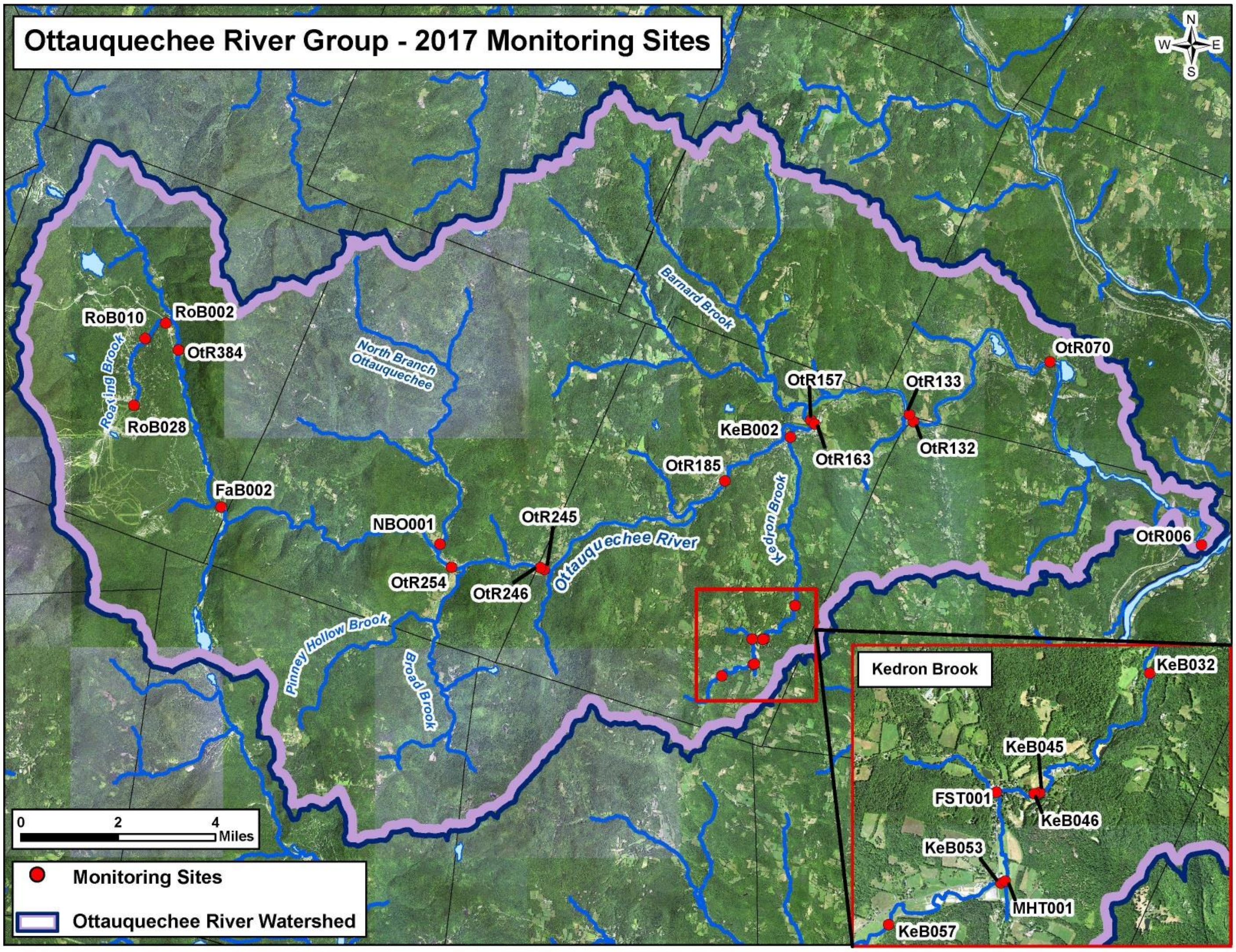
OTTAUQUECHEE WATERSHED:
The Ottauquechee River runs approximately 38 miles in length and encompasses roughly 223 square miles of drainage area. The headwaters of the Ottauquechee start in the Green Mountain Range in the towns of Killington, Bridgewater and Plymouth, Vermont. The river travels from the headwaters through east-central Vermont before it drains into the main stem Connecticut River in North Hartland, Vermont. There are a number of major tributaries to the river, including the North Branch Ottauquechee, Broad Brook, Pinney Hollow Brook, Barnard Brook, and Kedron Brook.
The Ottauquechee River has many important recreational functions including wading, tubing, boating, kayaking, swimming, and fishing for both coldwater and warmwater species (warmwater fishery limited to as far up river as the North Hartland Dam down to the confluence with the Connecticut River). The watershed holds populations of both native and stocked trout (Rainbows, Browns, and Brook Trout).
In addition to its many recreational uses and aquatic organism habitat, the Ottauquechee Watershed is also home to many other important wildlife species, including Osprey, Common Loon, American Bittern, American Black Duck, Pied Billed Grebe, Blue Winged Teal, and American Bald Eagle.

Acronyms

ORG	Ottauquechee River Group
WQMP	Water Quality Monitoring Program
WQM	Water Quality Monitoring
VT DEC	Vermont Department of Environmental Conservation
VT ANR	Vermont Agency of Natural Resources
TP	Total Phosphorus
TN	Total Nitrogen
TURB	Turbidity
Cl-	Chloride
NTU	Nephelometric Turbidity Units
WWTF	Waste Water Treatment Facility
RPD	Relative Percent Difference
GMHA	Green Mountain Horse Association

SECTION 1 – SITE ID's, COORDINATES & MAPS:

Site Name	Site ID	Latitude	Longitude
Hartland covered bridge swim area	OtR006	43.5931 N	-72.3488 W
Below Quechee WWTF	OtR070	43.6477 N	-72.4108 W
Below Taftsville WWTF	OtR132	43.6299 N	-72.4669 W
Above Taftsville Dam	OtR133	43.63203 N	-72.46867 W
Below Woodstock WWTF	OtR157	43.6303 N	-72.5090 W
Above Woodstock WWTF	OtR163	43.6292 N	-72.5075 W
Behind Woodstock Union High School	OtR185	43.61223 N	-72.54421 W
Below Bridgewater WWTF	OtR245	43.5858 N	-72.6184 W
Above Bridgewater WWTF	OtR246	43.58637 N	-72.61995 W
Route 100A bridge	OtR254	43.58648 N	-72.65647 W
Rabeck Road bridge	OtR384	43.65093 N	-72.76862 W
Kent Pond outlet	KtB015	43.67552 N	-72.79902 W
Falls Brook/Ottauquechee confluence	FaB002	43.60423 N	-72.75102 W
Kedron Brook below Horse Stables	KeB032	43.575140 N	-72.515449 W
Kedron Brook below WWTF	KeB045	43.5652 N	-72.5281 W
Kedron Brook above WWTF	KeB046	43.56508 N	-72.52874 W
Kedron Brook above GMHA	KeB057	43.554160 N	-72.545467 W
North Branch/Ottauquechee confluence	NBO001	43.59335 N	-72.66113 W
Roaring Brook above Roaring/Ottauquechee Confluence	RoB002	43.658907 N	-72.773887 W
Roaring Brook/Mountain View Road crossing	RoB010	43.64901 N	-72.78779 W
Roaring Brook above WWTF	RoB028	43.634434 N	-72.786835 W
Kedron Brook at Teagle Park	KeB002	43.62528 N	-72.51731 W
Fletcher Schoolhouse Rd Tributary	FST001	43.56523 N	-72.53310 W
Morgan Hill Rd Tributary	MHT001	43.55780 N	-72.53207 W
Behind So. Woodstock Fire Station	KeB053	43.55761 N	-72.53255 W



Ottauquechee River Group - 2017 Monitoring Sites
N
W
E
S
RoB010
RoB002
OtR384
Roaring Brook
RoB028
FaB002
North Branch Ottauquechee
Barnard Brook
OtR157
OtR133
OtR070
KeB002
OtR163
OtR132
OtR185
Kedron Brook
NBO001
OtR245
Ottauquechee River
OtR006
OtR254
OtR246
Pinney Hollow Brook
Broad Brook
Kedron Brook
KeB032
KeB045
FST001
KeB046
KeB053
MHT001
KeB057
0
2
4
Miles
Monitoring Sites
Ottauquechee River Watershed


Kedron Brook Sampling Sites
September & October 2017
N
W
E
S
KeB002
Ottauquechee River
Kedron Brook
WOODSTOCK
HARTLAND
Kedron Brook
FST001
KeB053
MHT001
Monitoring Sites
0
0.5
1
Miles

SECTION 2: LITERATURE REVIEW

PHOSPHORUS:

Phosphorus is a naturally occurring nutrient, stemming from sources such as animal waste and phosphorus laden bedrock, to human induced sources such as laundry, cleaning and industrial effluent and agricultural/fertilizer runoff. Excess phosphorus in surface waters can lead to accelerated eutrophication (Brian Oram). Eutrophication refers to the natural aging process of a body of water, stemming from increased nutrient concentrations within the water body, leading to plant growth. As plants die at a faster rate than they can decompose, the dead plant matter, in tandem with sediment build-up, fill in the bed of the water body, causing the river, lake or bay to become shallower. This is a process that typically takes thousands of years (Brian Oram).

Cultural eutrophication is the unnatural acceleration of this process due to human activity, leading to increased phosphorus and nitrogen concentrations and increased sedimentation. This leads to the aging of waterways/water bodies at a much faster rate than the geological processes can create new ones (Brian Oram). Cultural eutrophication can often lead to extensive algal blooms, accompanied by a fishy smell and very low dissolved oxygen. If this is the case, water testing for phosphorus will lead to low readings due to the fact that the phosphorus is already in the algae (Brian Oram).

High concentrations of phosphorus can lead to severely detrimental affects upon a waterway. Excess phosphorus can cause accelerated algae and plant growth which can choke out the waterway and use excessive amounts of oxygen in the absence of photosynthesis and as plants die and are consumed by aerobic bacteria. Low levels of dissolved oxygen (DO) can lead to the death of fish and other aquatic organisms (Brian Oram).

CHLORIDE:

Chloride is a salt resulting from the combination of a gas chlorine with a metal. Small amounts of chlorides are essential for normal cell function in aquatic organisms and plants; however fish and aquatic communities cannot survive in high levels of chloride (Kentucky Water Watch). There are many potential contributing sources to excess chlorides in surface waters, including but not limited to agricultural runoff, rocks containing chlorides, industrial wastewater discharge, oil well wastes, waste water treatment facility discharge and, most commonly, road salting to prevent vehicle accidents (Kentucky Water Watch).

High chloride concentrations in aquatic communities can cause disruption of osmoregulation in aquatic organisms leading to impaired survival, growth, and/or reproduction. However, there are several factors which can influence the degree of detriment caused by excess chloride, including dissolved oxygen concentrations, water temperature, exposure time, and the presence/absence of other contaminants (Government of British Columbia - Environmental Protection Division).

CHLORIDE CONCENTRATIONS ABOVE THESE LEVELS CAN BE TOXIC		
SPECIES	SHORT-TERM EXPOSURE	LONG-TERM EXPOSURE
Snail	2,540 mg/L (PPM)	400 mg/L (PPM)
Fathead Minnow	6,570 mg/L (PPM)	430 mg/L (PPM)
Rainbow Trout	6,740 mg/L (PPM)	900 mg/L (PPM)
Channel Catfish	8,000 mg/L (PPM)	800 mg/L (PPM)
Carp	8,390 mg/L (PPM)	850 mg/L (PPM)

NITROGEN:
Much like phosphorus, nitrogen is essential for plant life, however an overabundance can cause a number of serious adverse health and ecological impacts. Although nitrogen is abundant naturally in the environment, it is also introduced to surface waters through sewage discharge and fertilizer runoff. Waste water treatment facilities (WWTF) can also contribute to nitrogen concentrations in surface waters if that facility does not specifically remove nitrogen. Some nitrates enter surface waters directly from the atmosphere, which carries nitrogen-containing compounds from automobiles and other similar sources of fossil fuel combustion (U.S. Geological Survey).

Excessive nitrogen concentrations can lead to over stimulated algae and aquatic plant growth. This excessive growth can clog water intakes, use up excessive dissolved oxygen (DO), and block light to deeper waters. Eutrophication can occur as a result which can lead to aquatic organism death and can even "kill" a lake or pond by depriving it of light and oxygen (U.S. Geological Survey).

TURBIDITY:
Turbidity is a measure a relative clarity of a liquid. It is an optical characteristic of water and is an expression of the amount of light that is scattered by material in the water when a light is shined through the water sample. It is usually expressed in Nephelometric Turbidity Units (NTU). "The higher the intensity of scattered light, the higher the turbidity. Materials which cause water to become turbid include clay, silt, finely divided inorganic and organic matter, algae, soluble colored organic compounds, and plankton and other microscopic organisms" (U.S. Geological Survey).

During low flow (base flow) events, turbidity is usually relatively low. However during or immediately following a rain event, turbidity will be measurably higher due to the fact that particles from the surrounding land are washed into the waterway. Furthermore, during heavy precipitation or high flow events, erosive force within the stream increases, causing sediments from the stream bank to be more easily washed into the stream, in turn increasing turbidity (U.S. Geological Survey).

High turbidity readings can influence light penetration and productivity, recreational values, and aquatic organism habitat. In rivers and streams in can lead to sedimentation which fills in fish habitat and spawning areas. Particles can provide attachment places for other pollutants, notably metals and bacteria. For this reason, turbidity can be used as one of many means to gage surface water quality (U.S. Geological Survey).

E. COLI:
E. coli is a form of coliform bacteria, which is a large assemblage of various species of bacteria linked together because of ease of culturing as a single group. It is comprised of both fecal bacteria found in the intestines of warm-blooded animals, and non-fecal coliform bacteria. *E. coli* is one of the more common forms of coliform bacteria, and its presence in high concentrations may indicate a raw sewage discharge (New Hampshire Department of Environmental Services). The acceptable concentrations of *E. coli* bacteria present in surface waters is calculated by a risk analysis based upon statistics to protect human health. Acceptable volumes are also based upon the intended usage of the water resource (i.e. human consumption, swimming, boating, fishing, etc.). Typical sources of *E. coli* bacteria include waste water treatment facilities, failing septic systems, domestic and wild animal waste, and stormwater runoff (New Hampshire Department of Environmental Services).

SECTION 3: SUMMARY OF 2010 RESULTS

SECTION 3.1: 2010 TOTAL PHOSPHORUS DATA

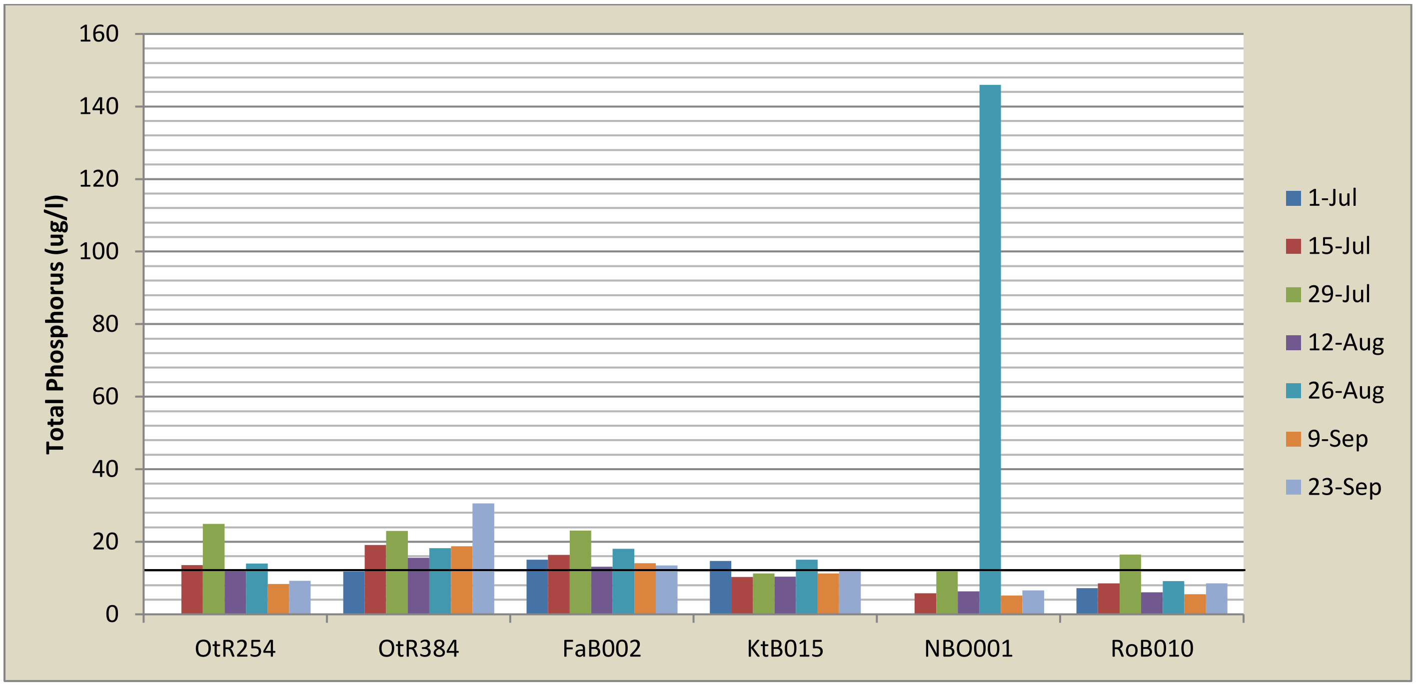


Figure 3a: 2010 Total Phosphorus Data (above Bridgewater WWTF)

As depicted in *Figure 3a & Figure 3b*, a large percentage of data points exceeded Vermont water quality standards (12 ug/L) with regards to phosphorus levels. A total of 77.6% of data points exceeded these standards. Consistently high phosphorus levels are exhibited at site KeB045, with tremendous spikes present at NBO001 and KeB045. Low and consistent trends are indicated at sites KtB015 on Kent Brook and RoB010 on Roaring Brook in Killington, while higher trends are exhibited in Kedron Brook around Woodstock.

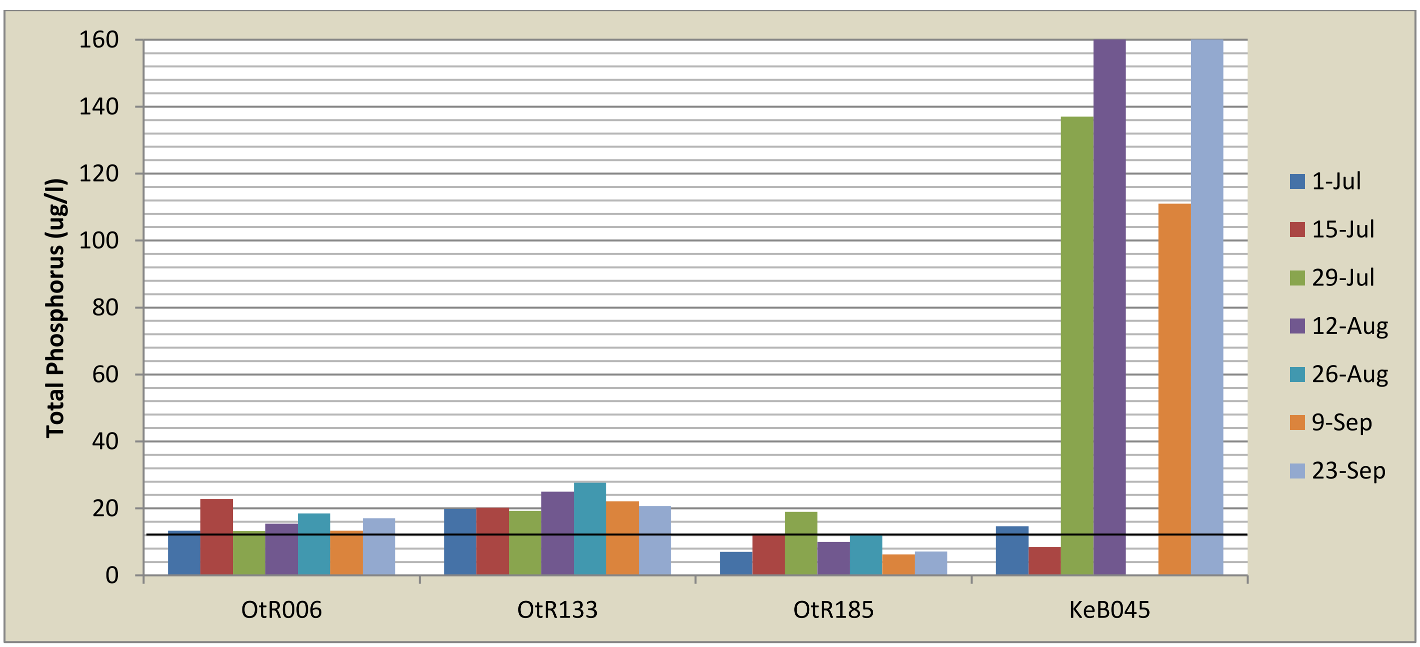


Figure 3b: 2010 Total Phosphorus Data (below Bridgewater WWTF)

SECTION 3.2: 2010 TURBIDITY DATA

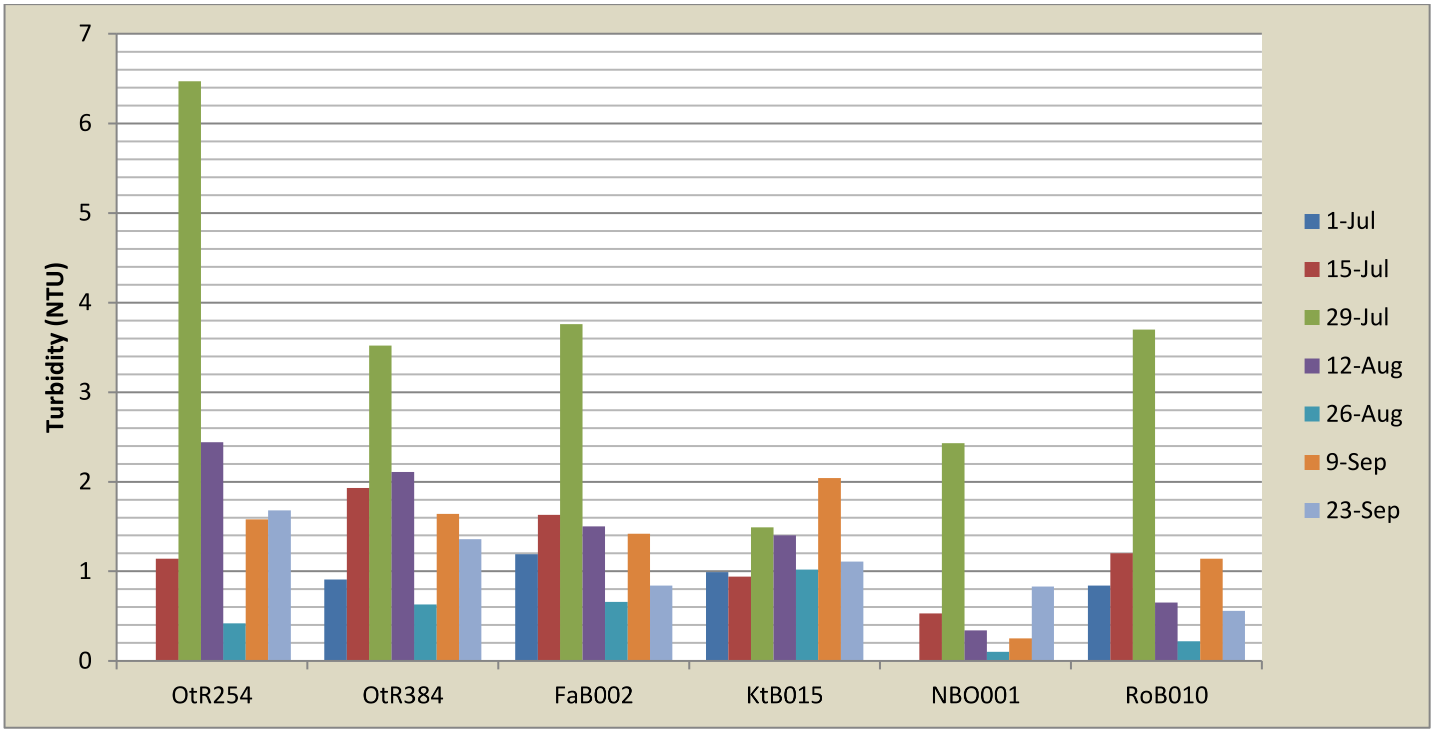


Figure 3c: 2010 Turbidity Data (above Bridgewater WWTF)

As indicated in *Figure 3c & Figure 3d*, turbidity levels in 2010 were well within compliance of the current State of Vermont standards. Current standards state that a river or stream should not exceed 10 NTU; while the highest level exhibited (OtR254 on July 29, 2010) is still well shy of 7 NTU. A significant spike in turbidity is observable at nearly all sites upstream of the Bridgewater WWTF on July 29. No significant increasing or declining trends are observable at any sites throughout the 2010 monitoring season.

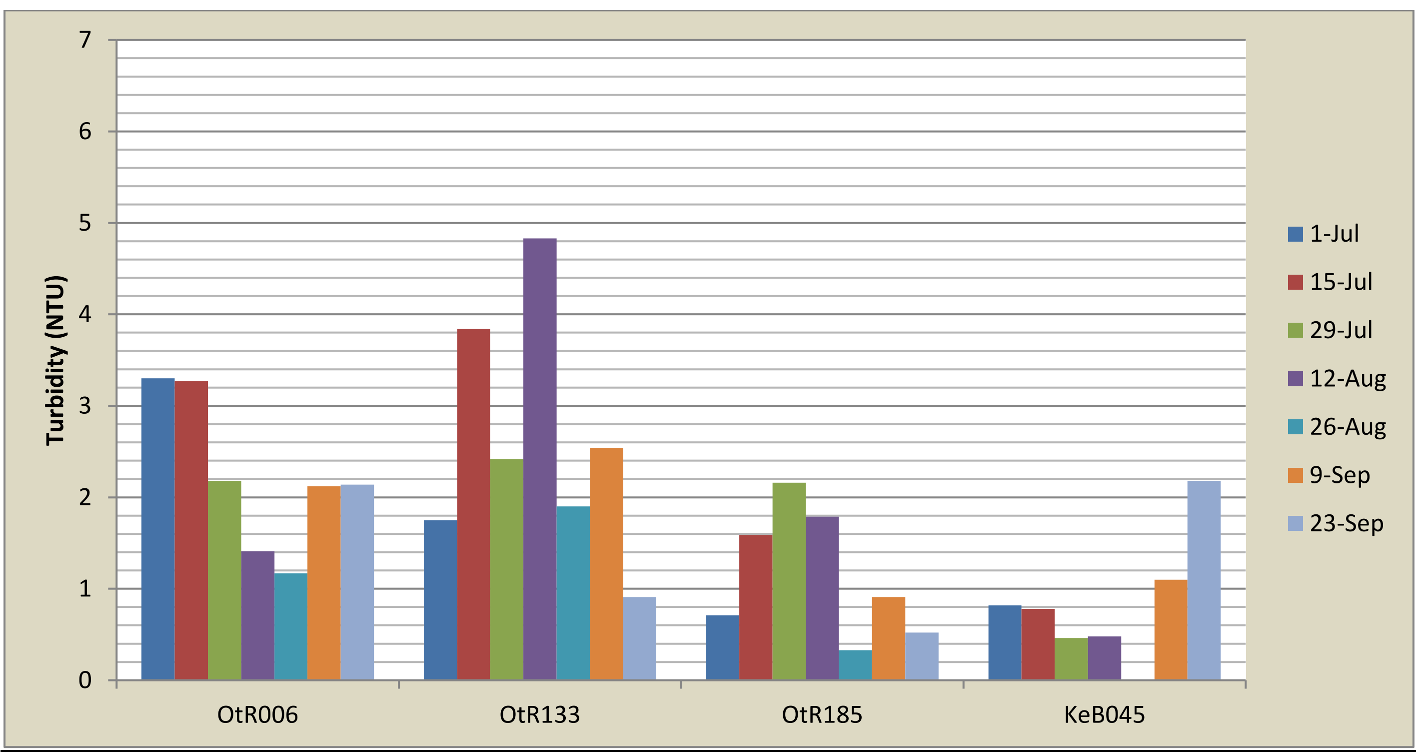


Figure 3d: 2010 Turbidity Data (below Bridgewater WWTF)

SECTION 3.3: 2010 CHLORIDE DATA

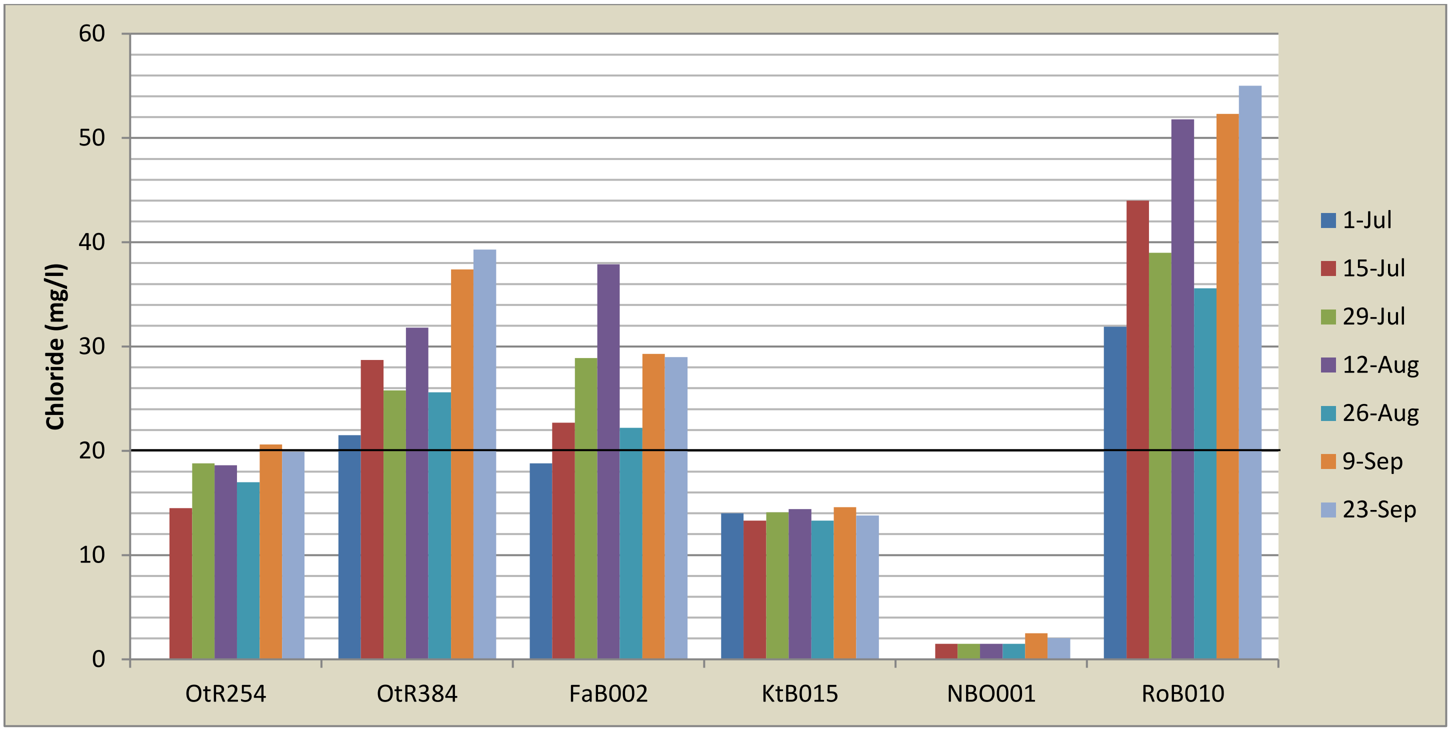


Figure 3e: 2010 Chloride Data (above Bridgewater WWTF)

Chloride concentrations during the 2010 monitoring season were consistently high at site RoB010 on Roaring Brook in Killington and consistently low at site NBO001 on the North Branch of the Ottauquechee River in Bridgewater. The next highest levels of trend variation occurred in Falls Brook (site FaB002) above the confluence with the Ottauquechee River in Killington and in the Ottauquechee River (site OtR384) in Killington. Nearly all sampling sites showed a generally increasing trend in Chloride levels as the summer progressed.

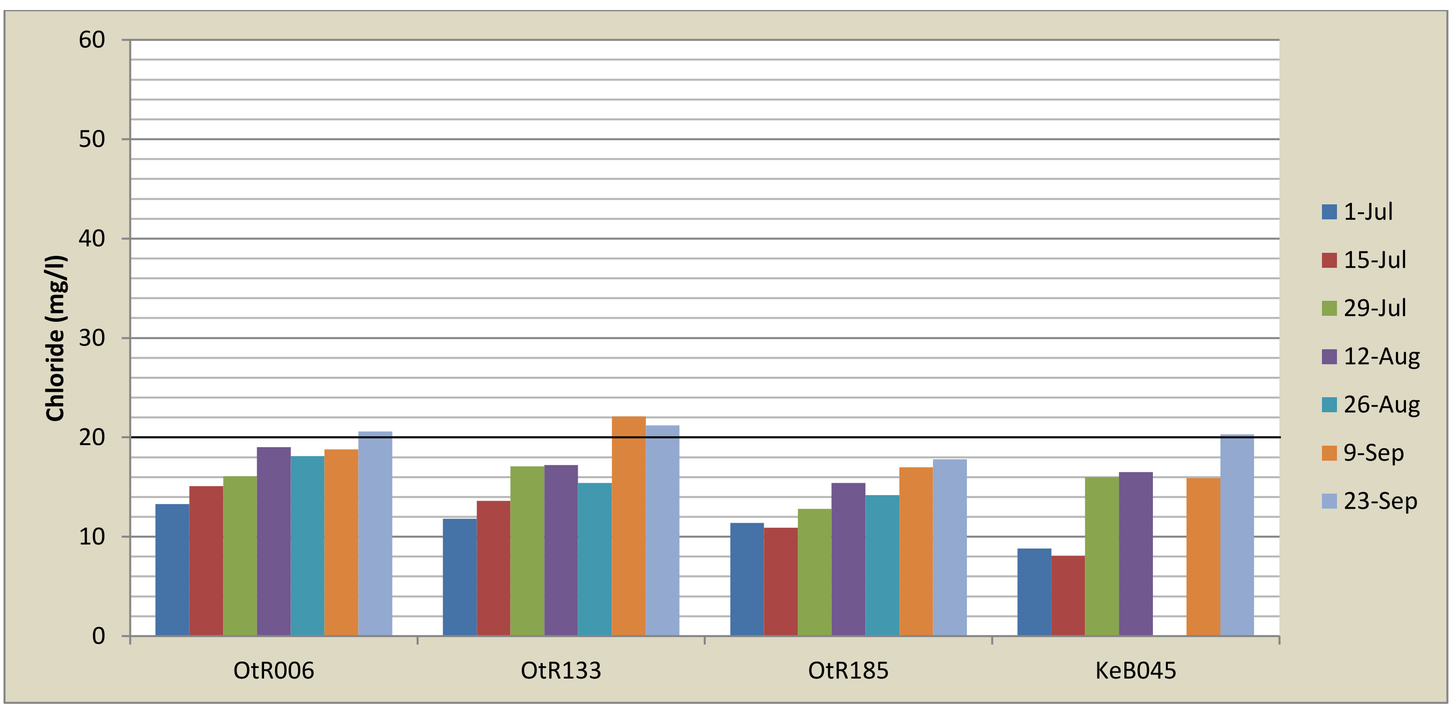


Figure 3f: 2010 Chloride Data (below Bridgewater WWTF)

SECTION 3.4: 2010 *E. COLI* DATA

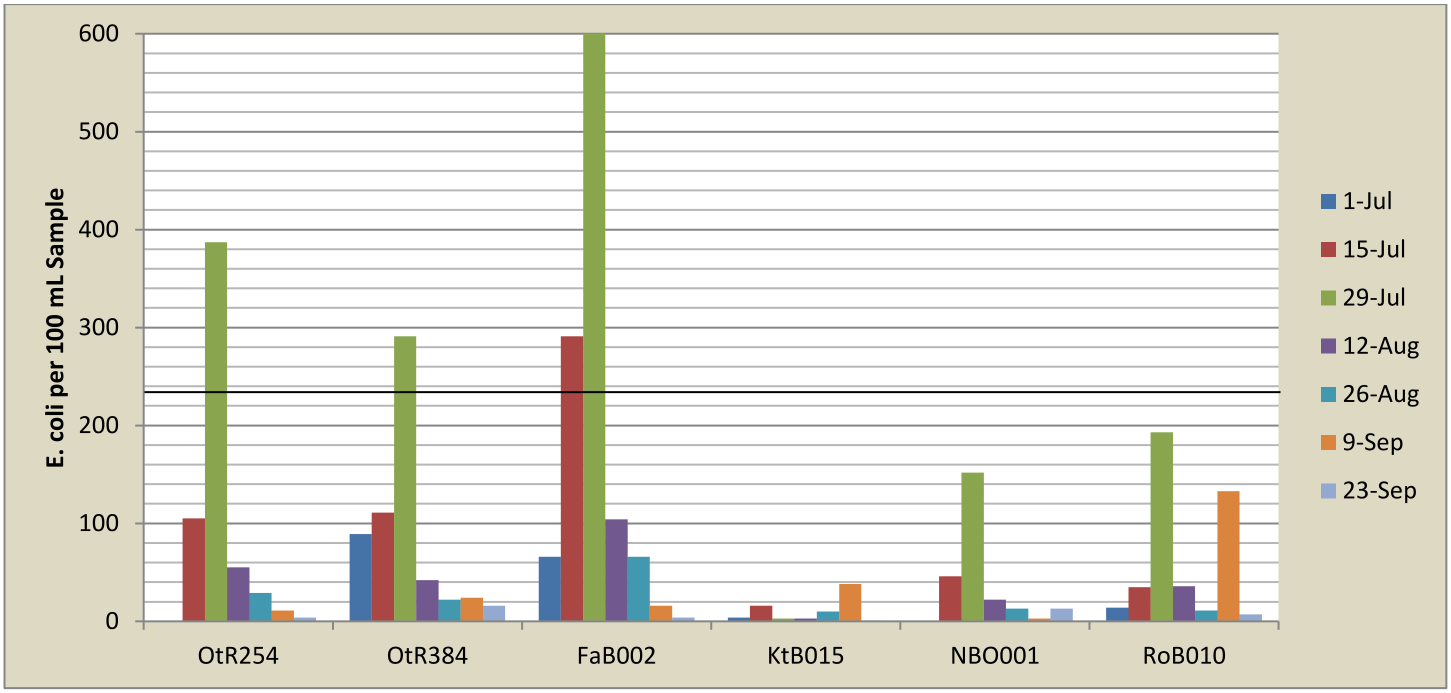


Figure 3g: 2010 E. coli Data (above Bridgewater WWTF)

About 37% of *E. coli* bacteria samples collected during the 2010 season exceeded State & Federal standards for swimming suitability. Results indicate that *E. coli* bacteria levels varied the most in Falls Brook (FaB002) and varied the least in Kent Pond Brook (site KtB015) in Killington. The second highest levels of *E. coli* trend variation occurred Kedron Brook (site KeB045) in Woodstock.

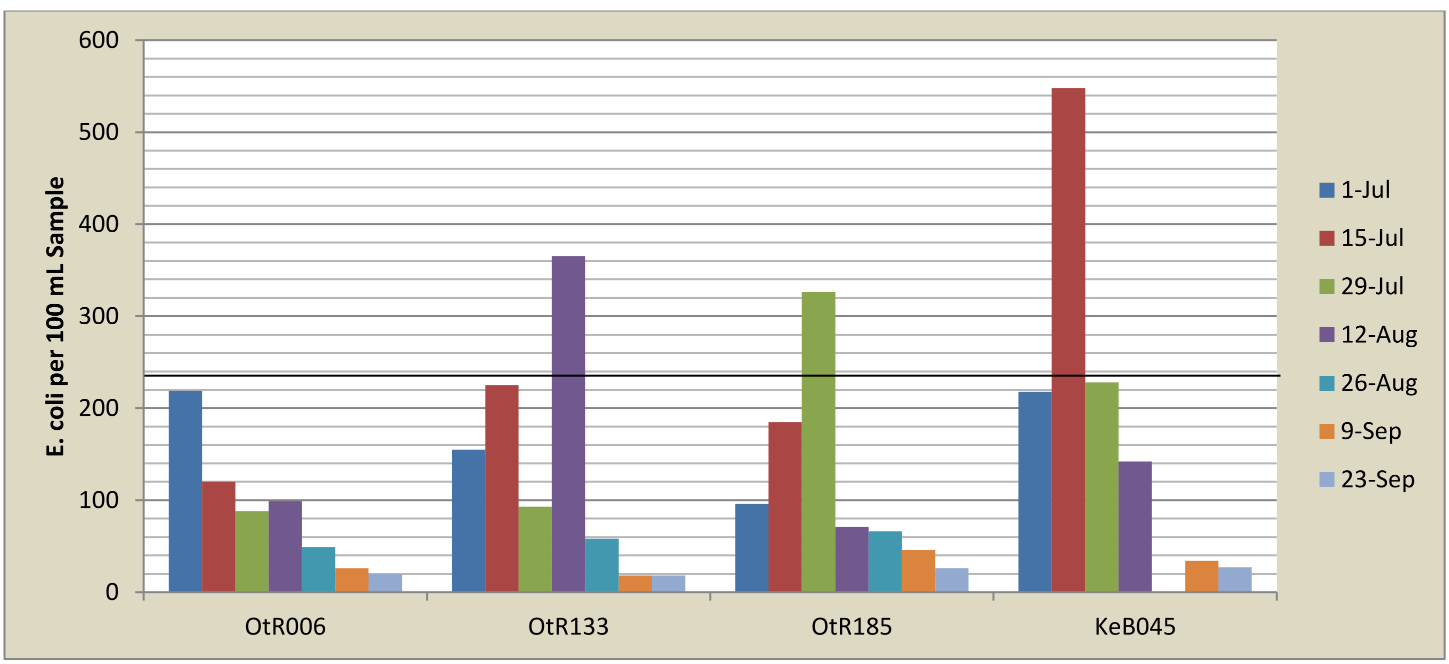


Figure 3h: 2010 E. coli Data (below Bridgewater WWTF)

SECTION 4: SUMMARY OF 2013 RESULTS

SECTION 4.1: 2013 TOTAL PHOSPHORUS DATA

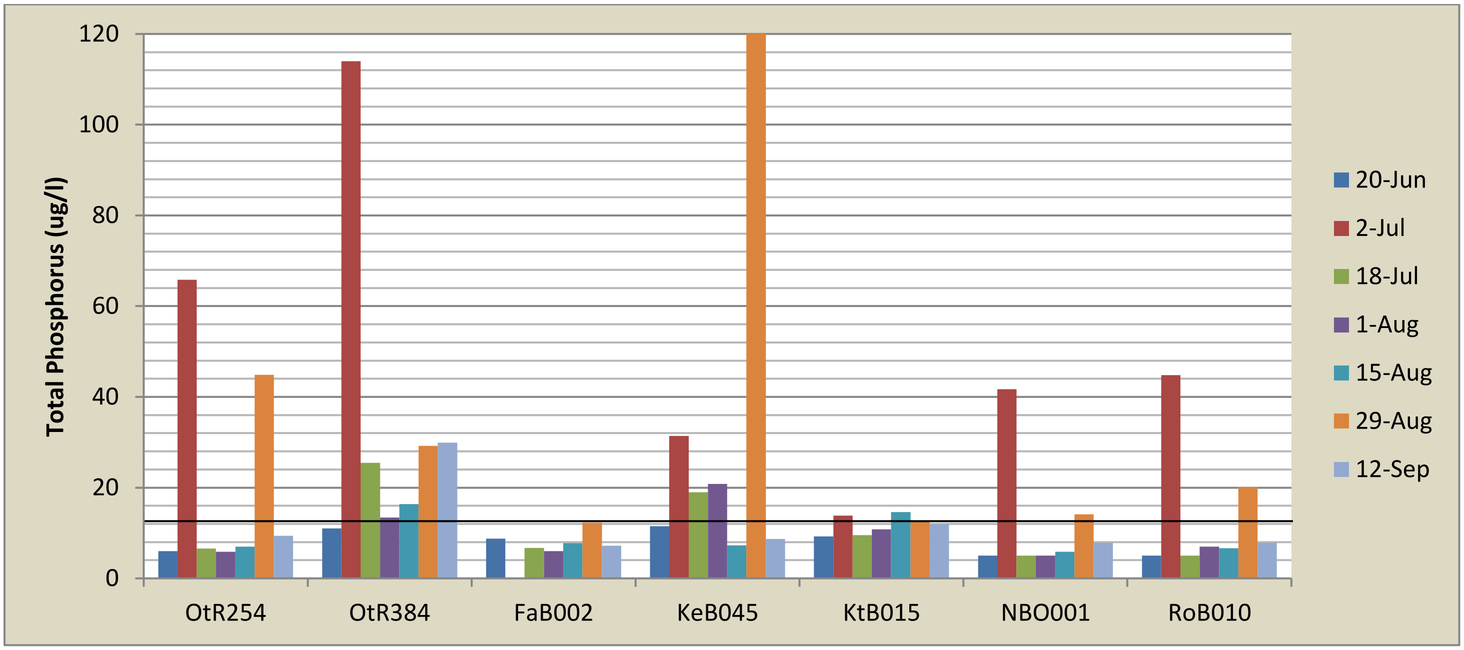


Figure 4a: 2013 Total Phosphorus Data (above Bridgewater WWTF)

As indicated in *figures 4a & 4b*, a significant percentage of data points exceeded Vermont standards regarding phosphorus concentrations in 2013 at 45%. Site to site variation in phosphorus levels stayed fairly uniform; however multiple sampling dates stand out as huge spikes, including July 2nd and August 29th. No notable trends seem to exist with respect to phosphorus levels in 2013.

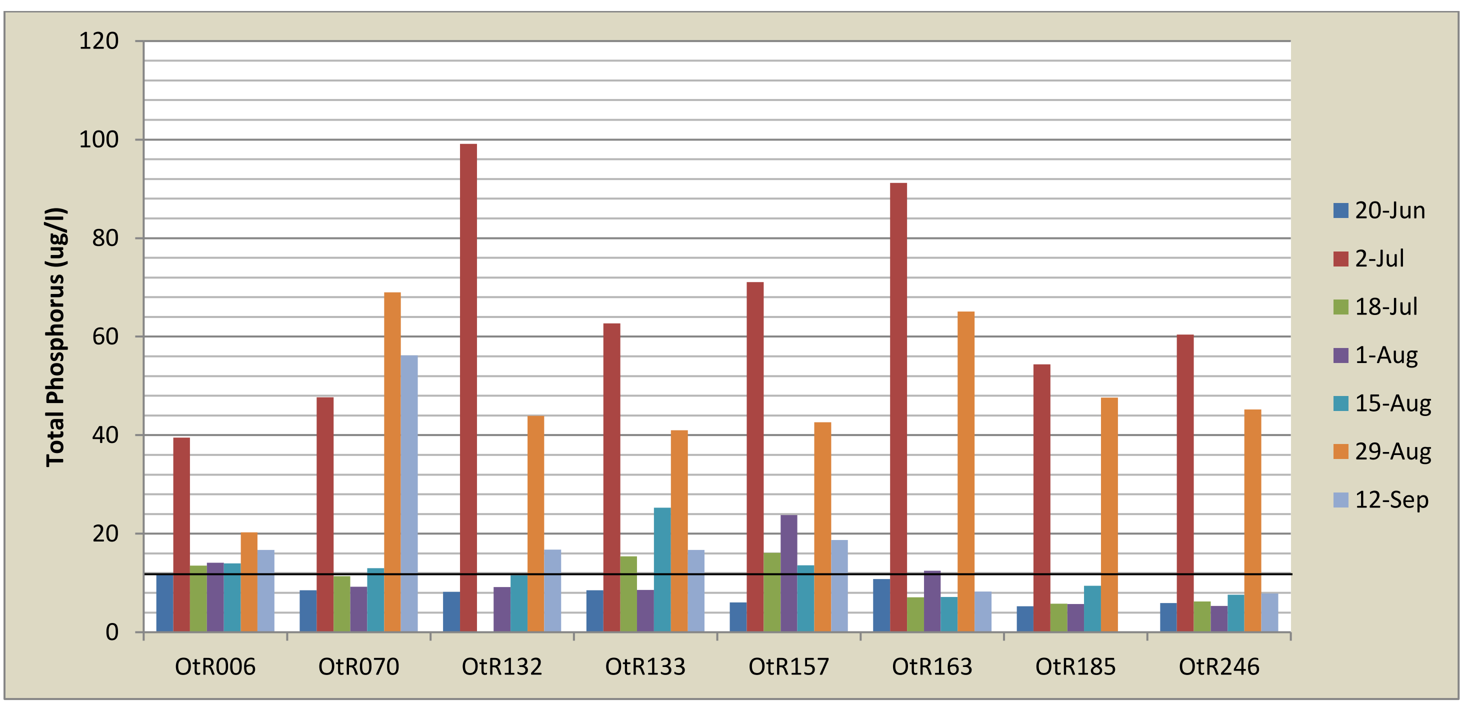


Figure 4b: 2013 Total Phosphorus Data (below Bridgewater WWTF)

SECTION 4.2: 2013 TURBIDITY DATA

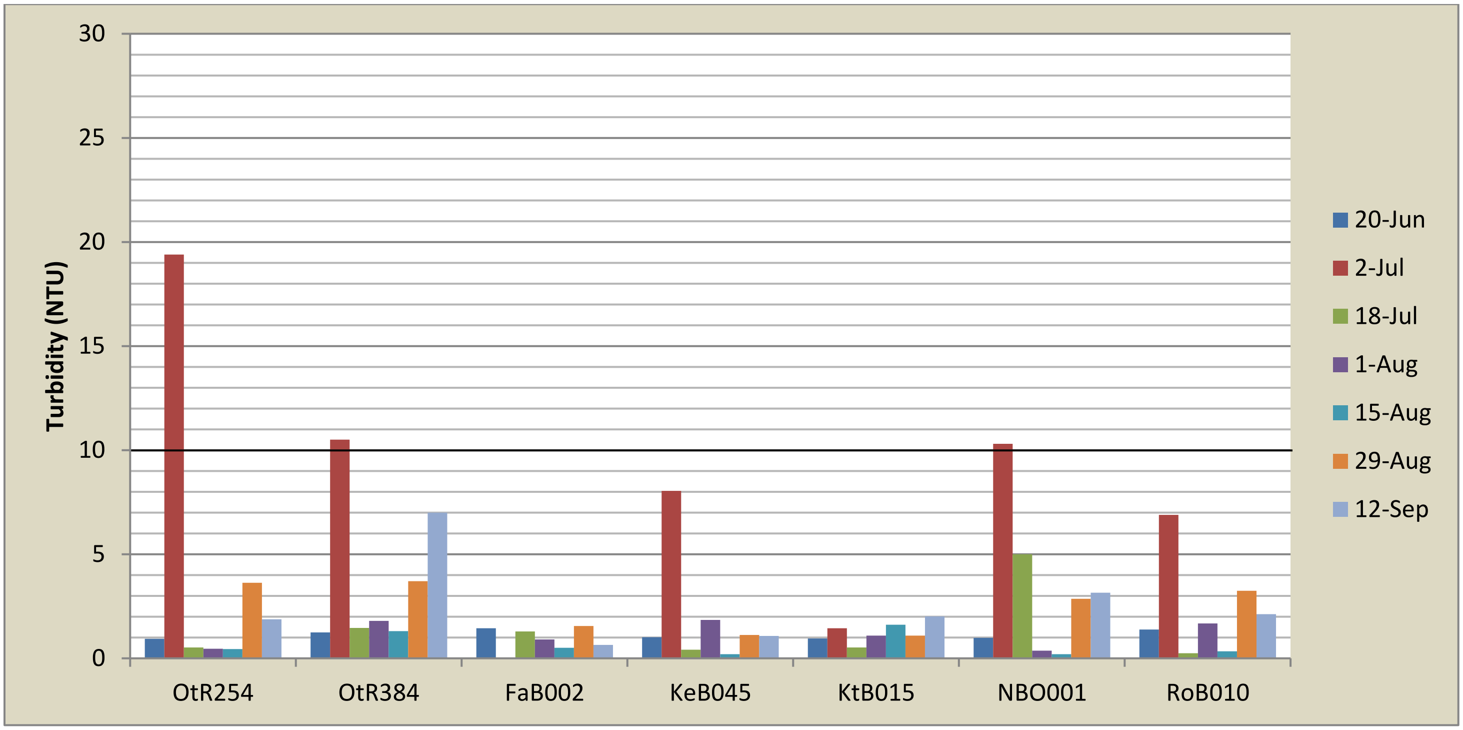


Figure 4c: 2013 Turbidity Data (above Bridgewater WWTF)

Figures 4c & 4d indicate that turbidity levels in 2013 were often well within compliance of state standard. July 2nd exceeded standards at almost every site and OtR070, OtR132, and OtR185 exceeded standards on August 29th. FaB002 and KtB015 exhibited relatively low and stable turbidity levels. No significant trends with regards to turbidity levels are apparent throughout the 2013 sampling season.

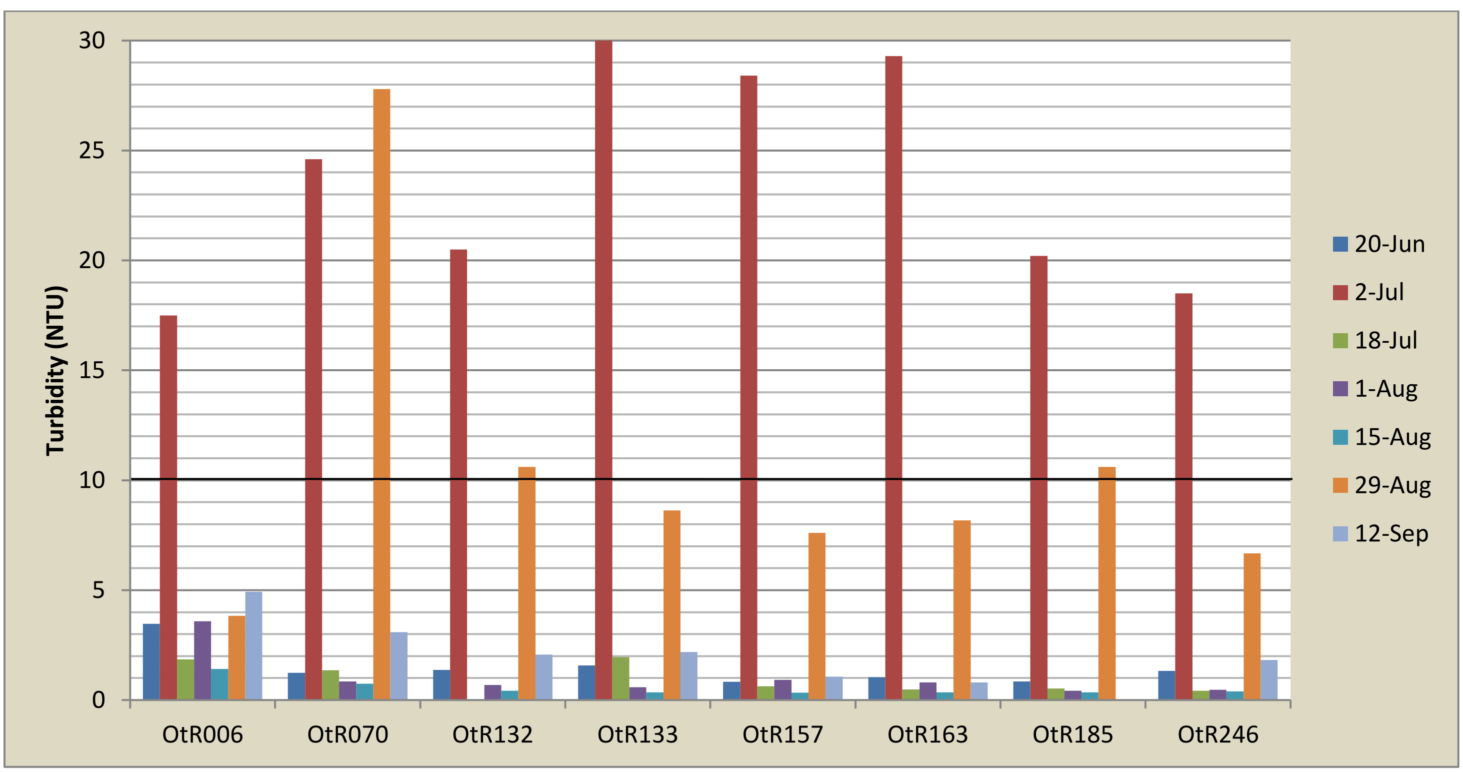


Figure 4d: 2013 Turbidity Data (below Bridgewater WWTF)

SECTION 4.3: 2013 CHLORIDE DATA

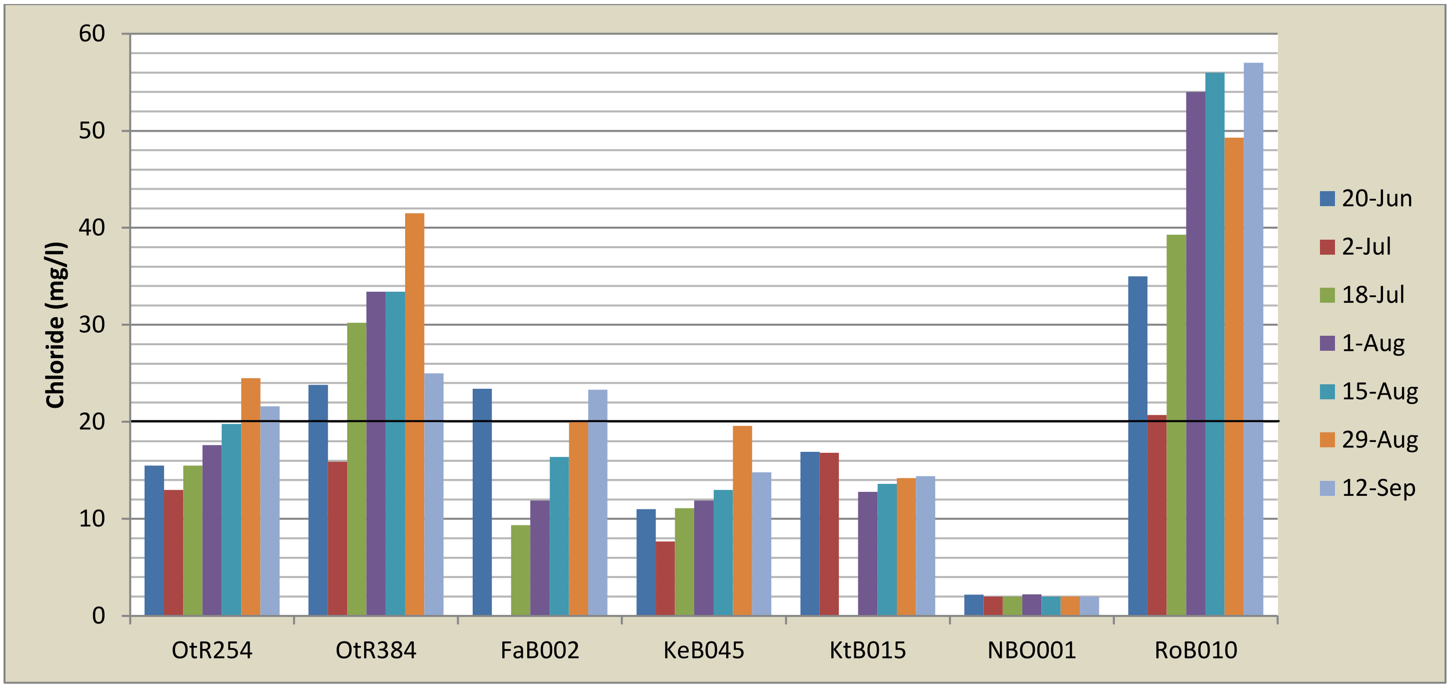


Figure 4e: 2013 Chloride Data (above Bridgewater WWTF)

Consistently high concentrations of chloride were found throughout the course of the 2013 sampling season at sites RoB010 on Roaring Brook near Killington and OtR384. By far the lowest and most stable concentrations were found at site NBO001. KtB015 also exhibited relatively stable concentrations. With the exception of these two sites, chloride concentrations showed a significantly increasing trend throughout the monitoring season, with RoB010 showing that trend most strongly. Chloride concentrations were somewhat lower generally at all sites which fall below the waste water treatment facility in Bridgewater.

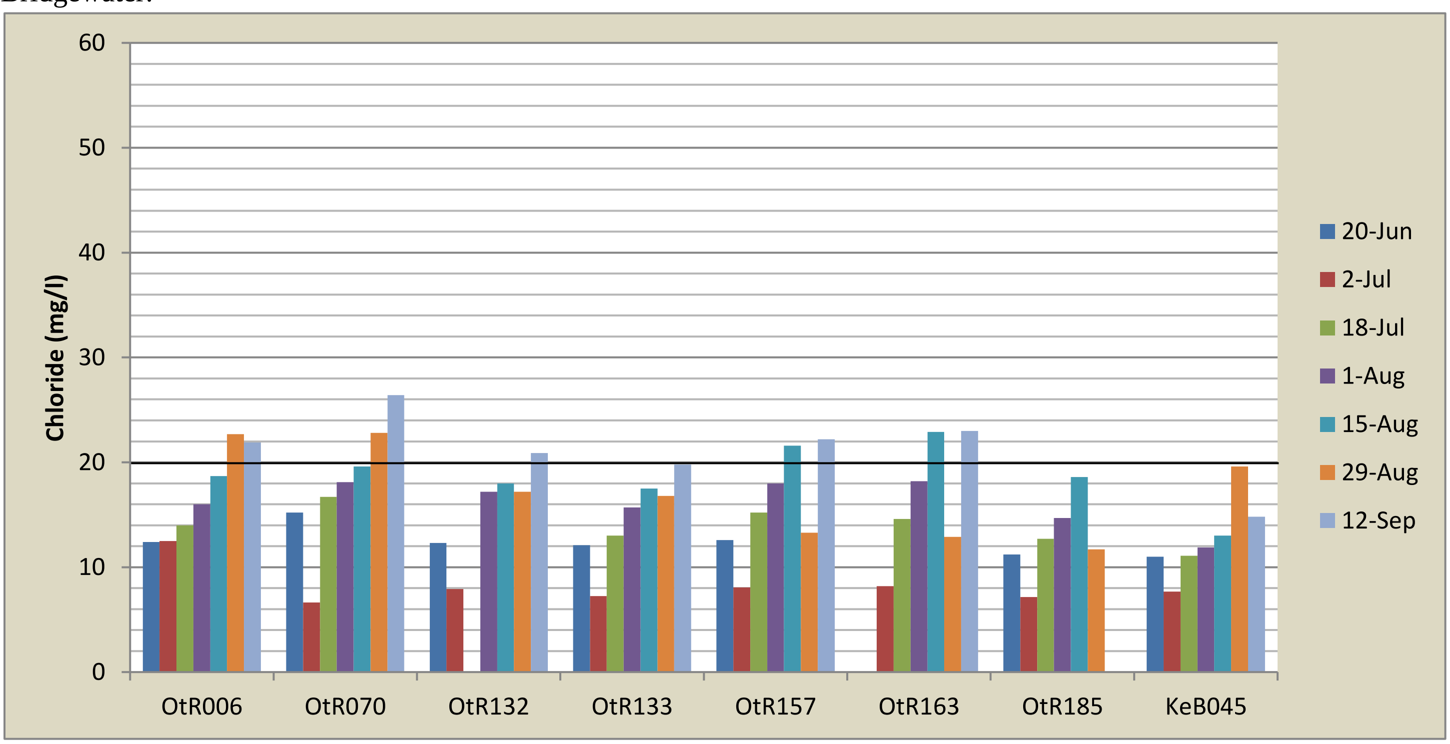


Figure 4f: 2013 Chloride Data (below Bridgewater WWTF)

SECTION 4.4: 2013 *E. COLI* DATA

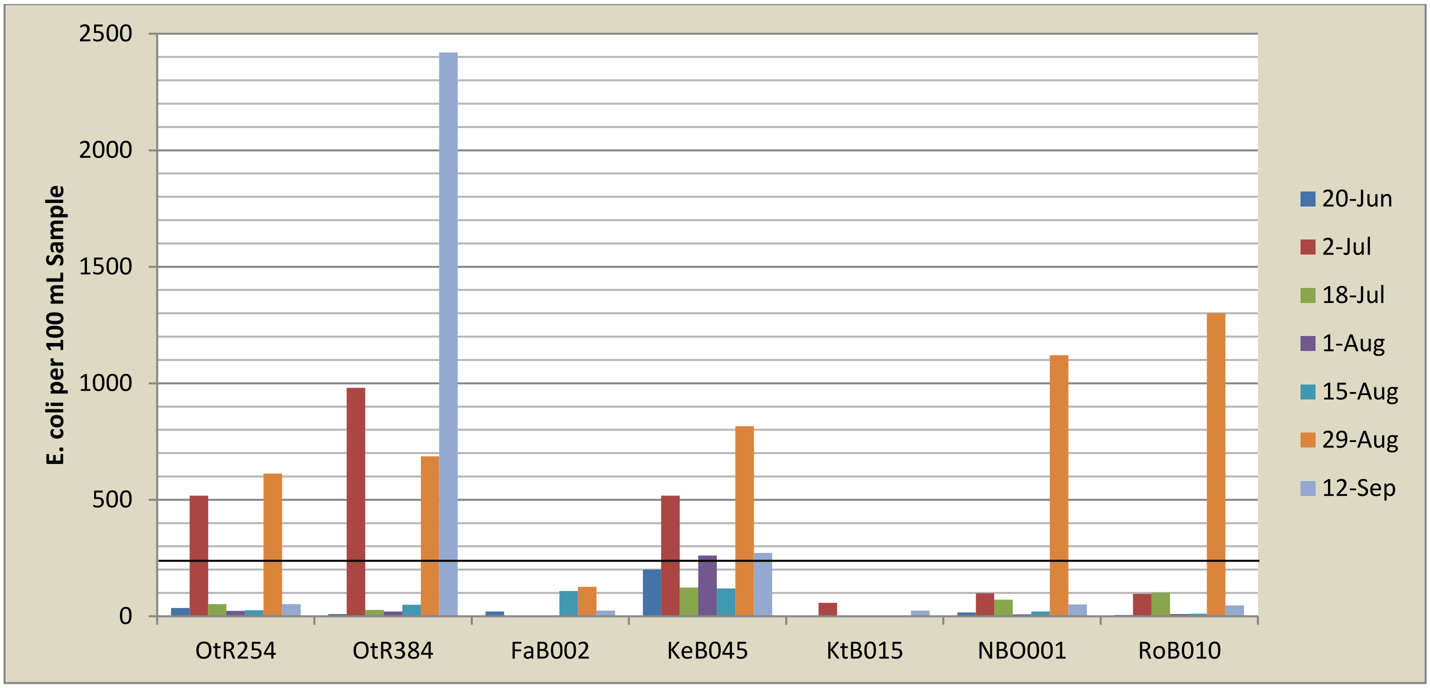


Figure 4g: 2013 E. coli Data (above Bridgewater WWTF)

E. coli concentrations throughout the 2013 monitoring season were generally considered suitable for swimming under state standards, with the exception of August 29th and July 2nd. Roughly 26% of *E. coli* samples collected exceeded standards. Many very significant spikes are observable on August 29th at several sites. Sites FaB002 and KtB015 remained very stable and suitable for swimming throughout the duration of the 2013 monitoring season. No significant increasing or declining trends are observable.

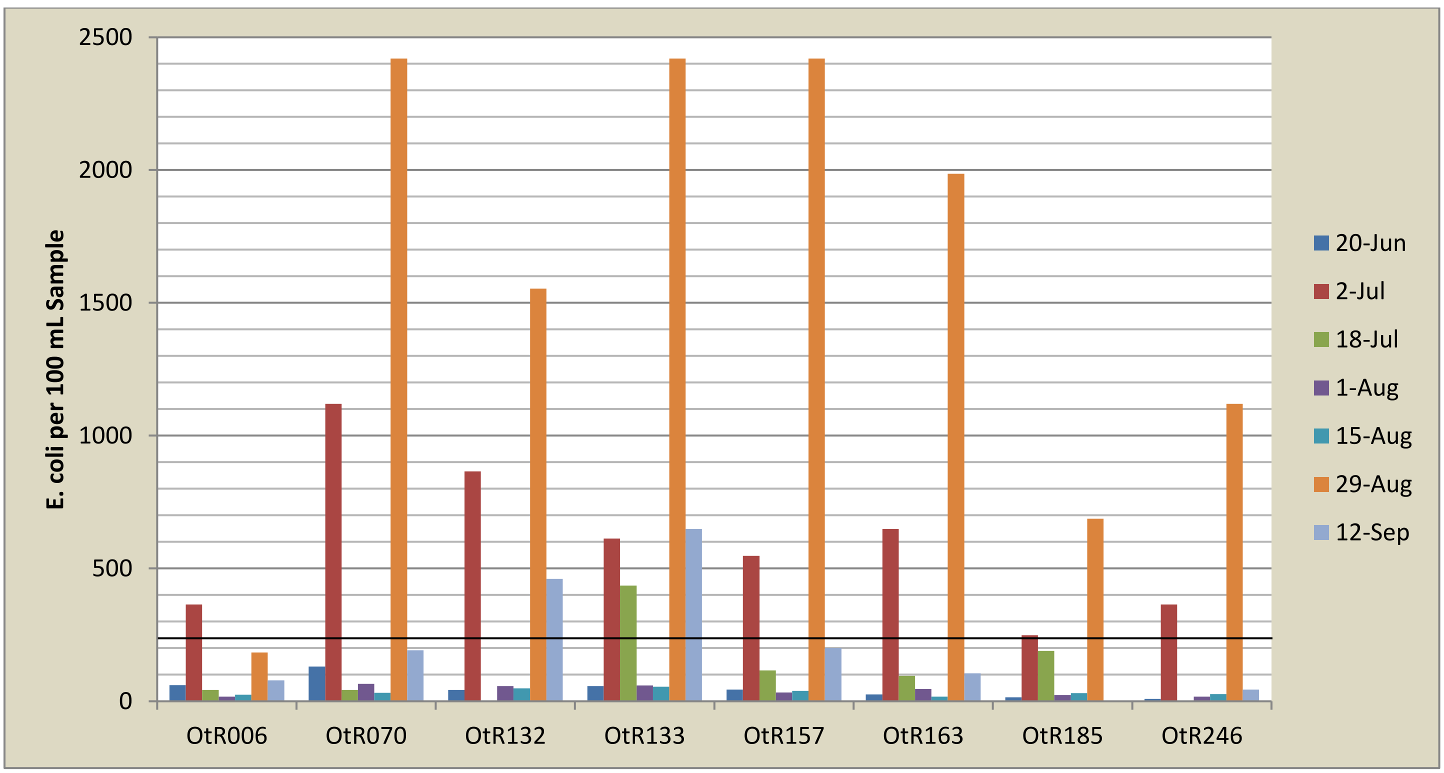


Figure 4h: 2013 E. coli Data (below Bridgewater WWTF)

SECTION 4.5: 2013 TOTAL NITROGEN DATA

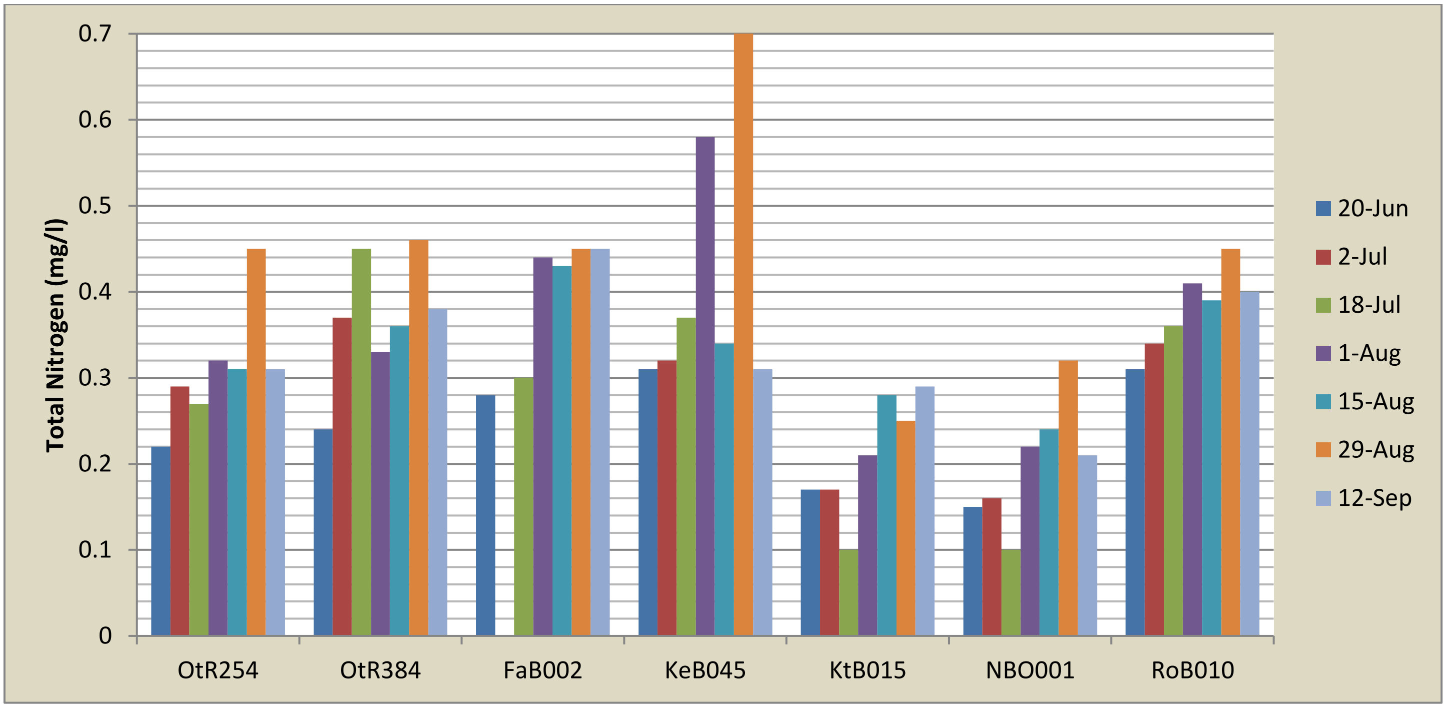


Figure 4i: 2013 Total Nitrogen Data (above Bridgewater WWTF)

Total Nitrogen concentrations during the 2013 season were in compliance with state standards across the board. None of the data points throughout the season exceeded standards. Nearly all sites exhibited a weak increasing trend in nitrogen concentrations throughout the course of the summer. Sites KtB015 and NBO001 stand out as having the lowest nitrogen concentrations though they do trend upward as the season progressed. A significant spike in nitrogen can be observed on August 29th at several sites. The USGS hydrograph on page 44 of this report indicates that this August 29 spike correlates to an enormous CFS spike, suggesting these high readings are attributable to a large precipitation event.

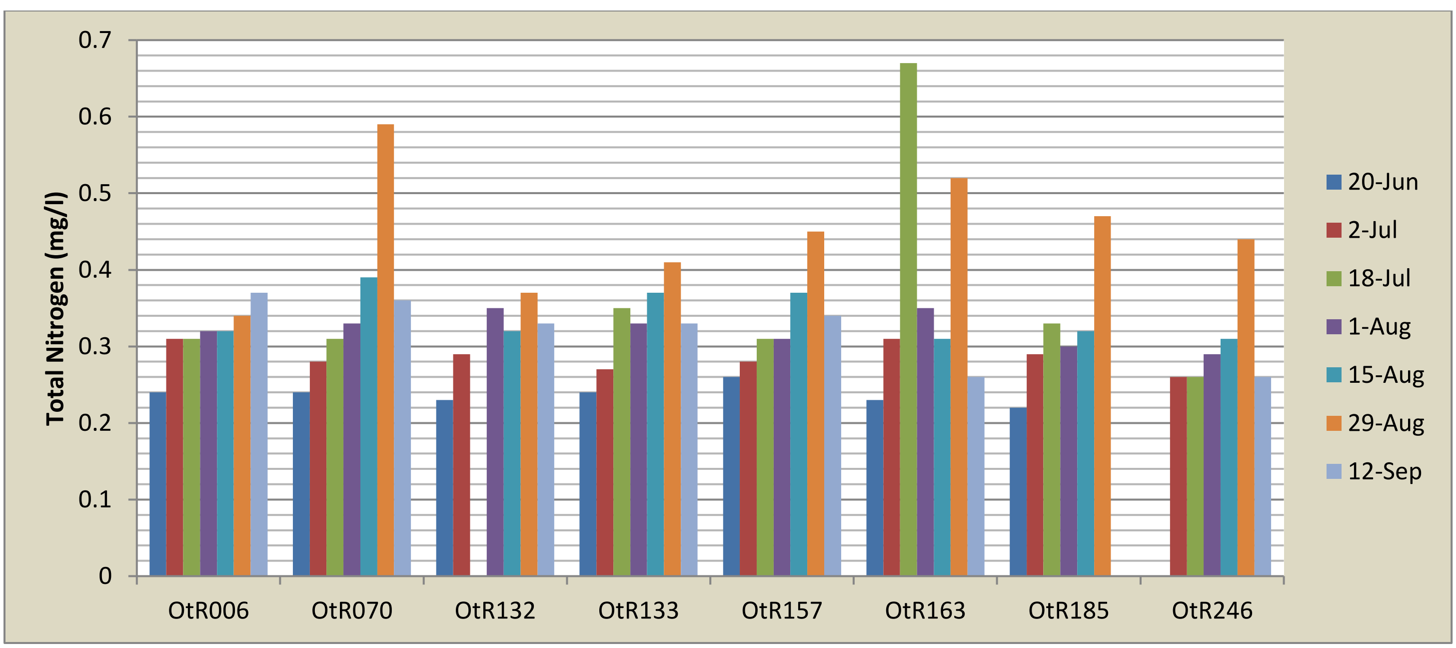


Figure 4j: 2013 Total Nitrogen Data (below Bridgewater WWTF)

SECTION 5: SUMMARY OF 2014 RESULTS

SECTION 5.1: 2014 TOTAL PHOSPHORUS DATA

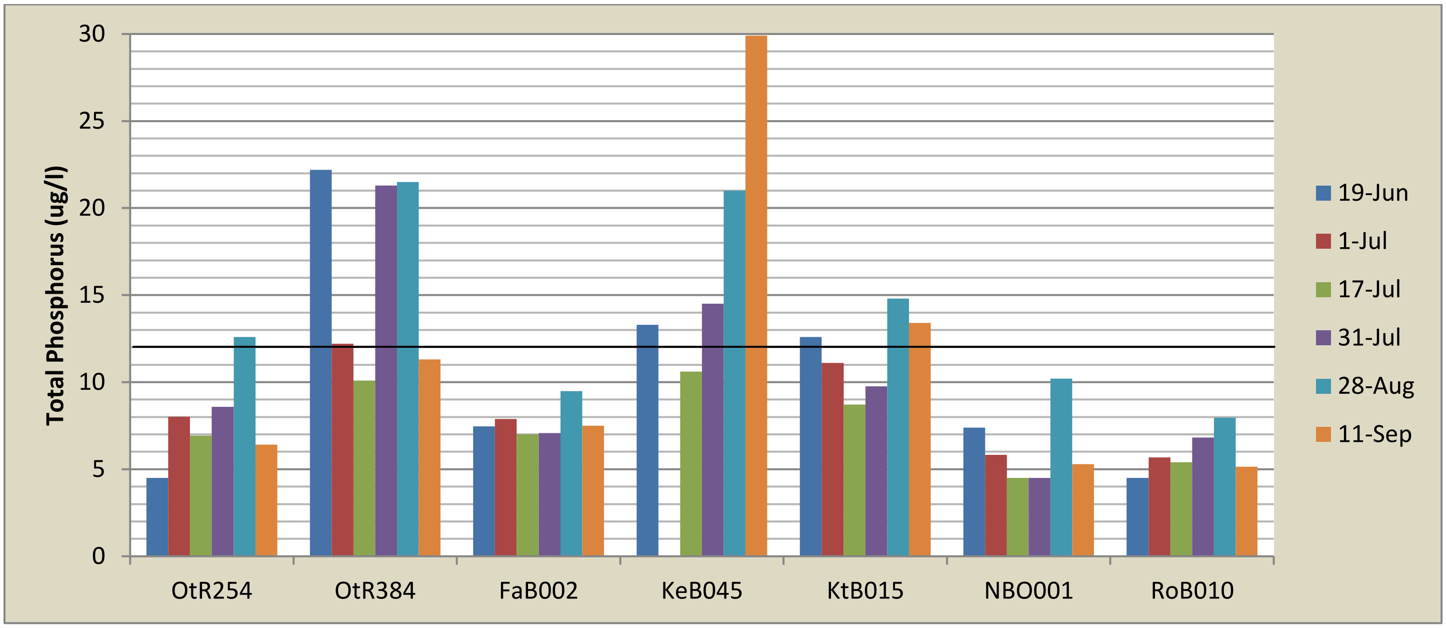


Figure 5a: 2014 Total Phosphorus Data (above Bridgewater WWTF)

Total phosphorus levels in 2014 achieved the greatest rate of compliance the program has seen to date, with only roughly 30% of data points exceeding state standards, down from about 78% during the summer of 2010. Phosphorus concentrations were generally slightly higher at all sites which fall below the Bridgewater waste water treatment facility, and also had a much greater rate of significant spikes. Sites OtR246, FaB002, NBO001, and RoB010 had relatively low phosphorus concentrations and each of those four sites remained in compliance throughout the entire monitoring season. Relatively high concentrations can be observed at sites OtR384 (Rabeck Road Bridge), OtR006 (Hartland Covered Bridge), and KeB045 (Kedron Brook). No noticeable increasing or descending trends are observable during the course of the 2014 monitoring season.

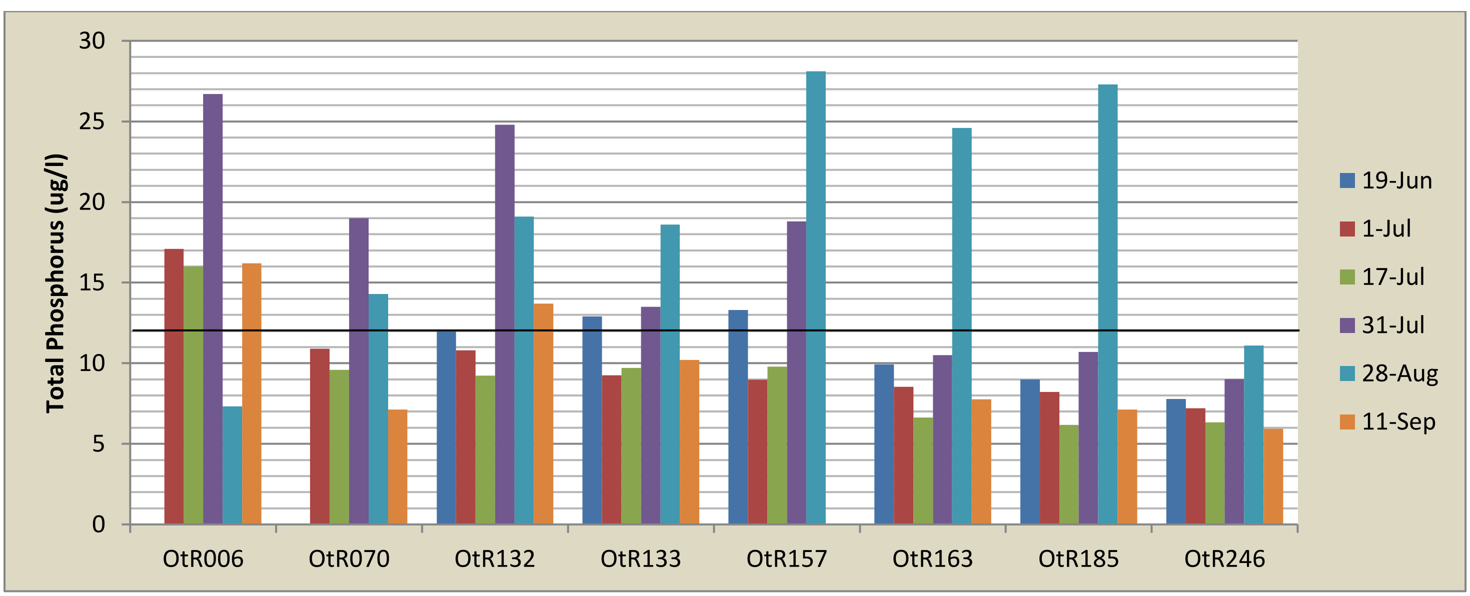


Figure 5b: 2014 Total Phosphorus Data (below Bridgewater WWTF)

SECTION 5.2: 2014 TURBIDITY DATA

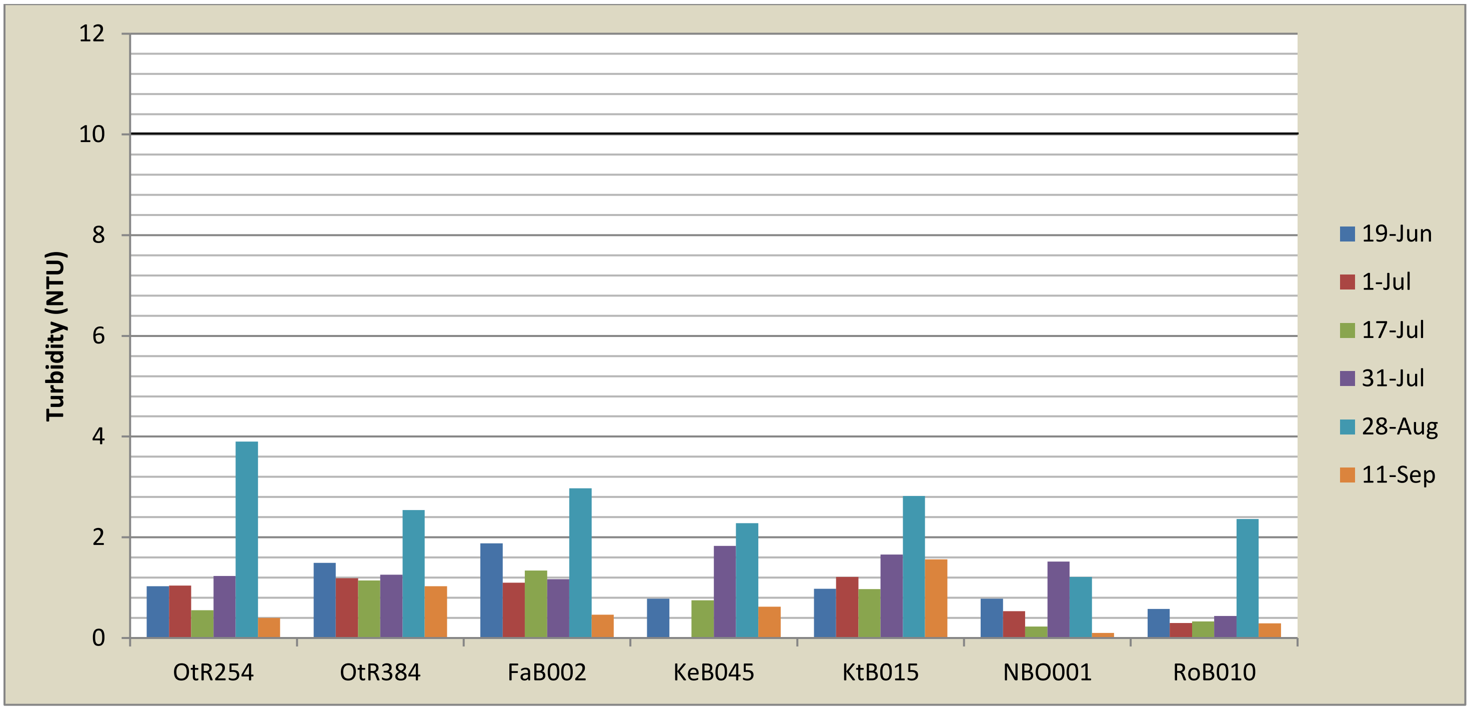


Figure 5c: 2014 Turbidity Data (above Bridgewater WWTF)

Turbidity levels in 2014 were generally within compliance of state standards, as only a mere 4% of data points exceeded those standards. All of the spikes in turbidity which exceeded state standards are located below the waste water treatment facility in Bridgewater (3 of those four falling on August 28) and overall turbidity levels are generally higher below the WWTF. The lowest turbidity levels can be found at sites NBO001 and RoB010, though all of the sites above the Bridgewater WWTF exhibit notably low turbidity readings. The highest turbidity readings appear to be located at site OtR006 at the Hartland covered bridge swim area.

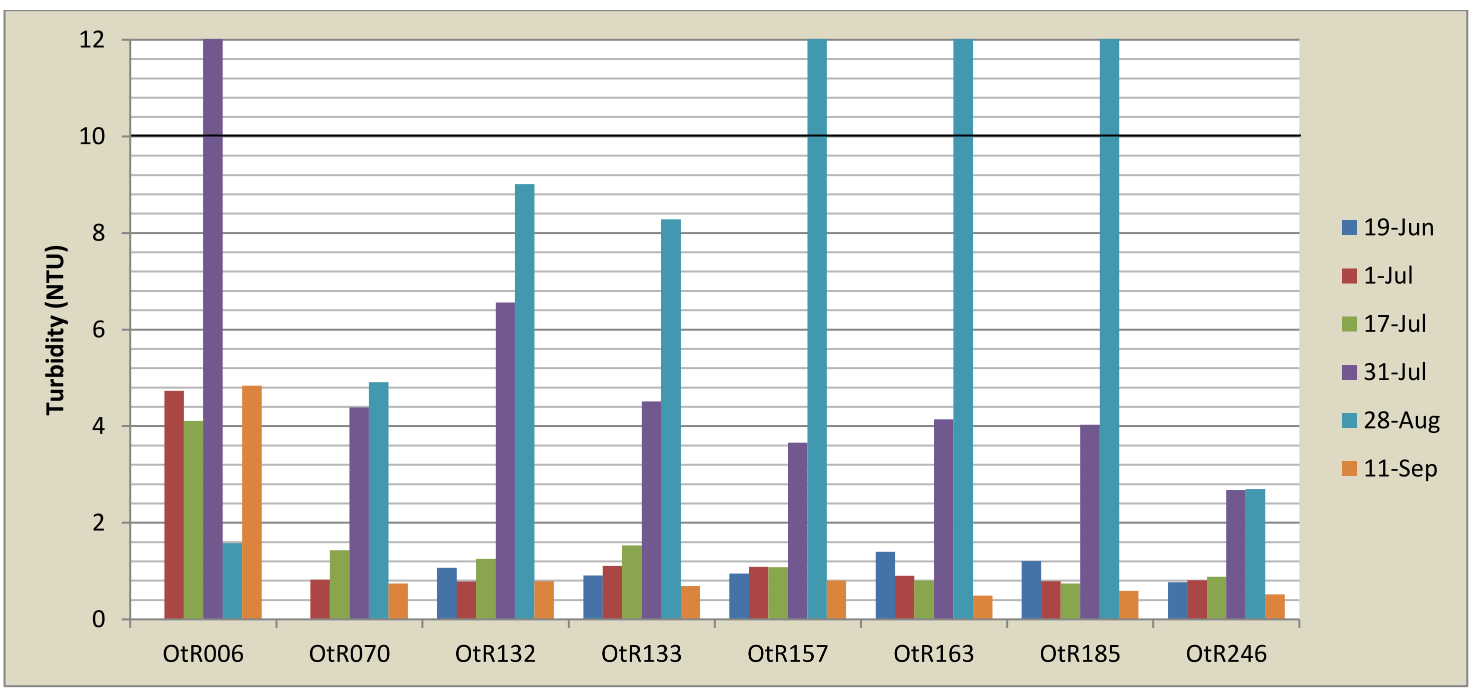


Figure 5d: 2014 Turbidity Data (below Bridgewater WWTF)

SECTION 5.3: 2014 CHLORIDE DATA

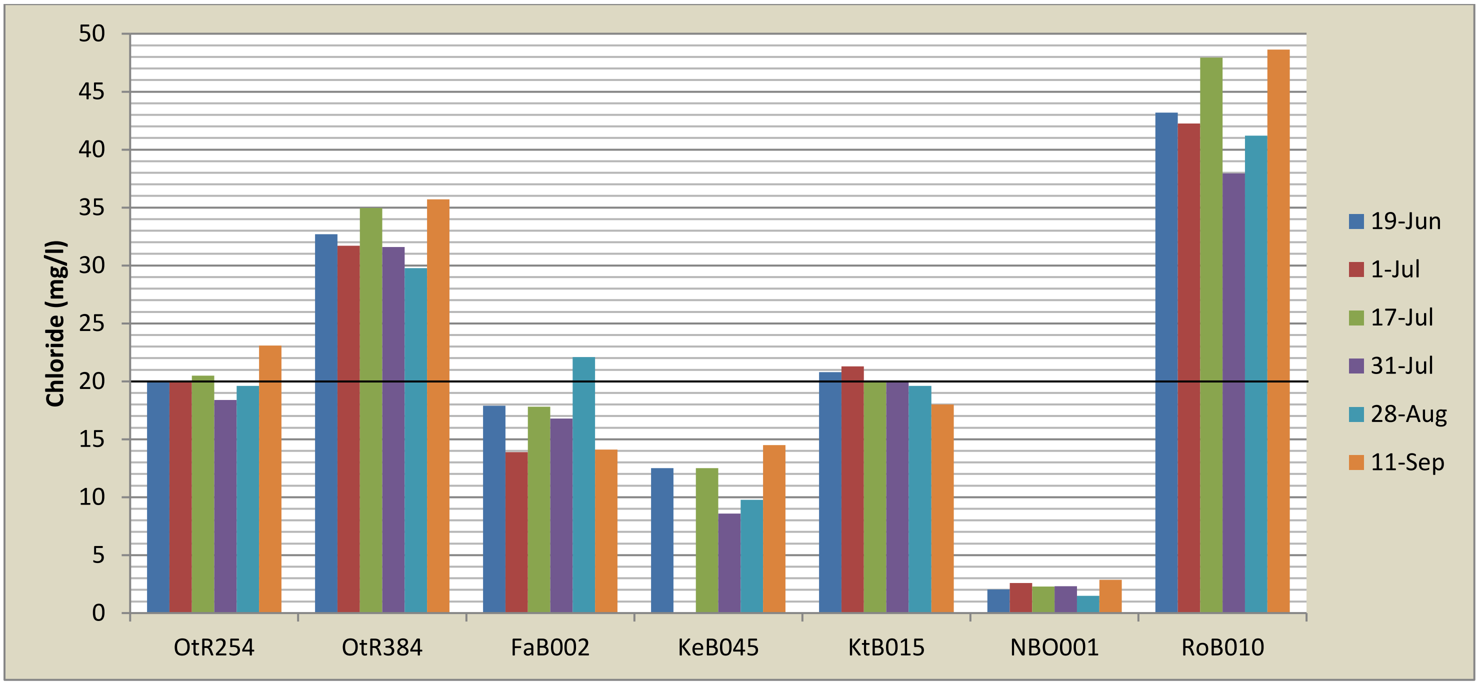


Figure 5e: 2014 Chloride Data (above Bridgewater WWTF)

Chloride concentrations in the Ottauquechee River Watershed in 2014 were generally significantly higher above the waste water treatment facility in Bridgewater, specifically at site RoB010 which had higher chloride concentrations than any other site during each of the 2014 sampling dates. This is likely a result of heavy road salting to accommodate safe vehicle travel to the Killington Ski Resort. Site OtR384 (Rabeck Road Bridge) also exhibits notably high chloride concentrations. Site NBO001 on the North Branch Ottauquechee River had by far the lowest and most consistent levels of chloride. Unlike 2010 and 2013 which both exhibited increasing trends in chloride concentrations throughout the summer, no significant trends are present in that respect during the summer of 2014.

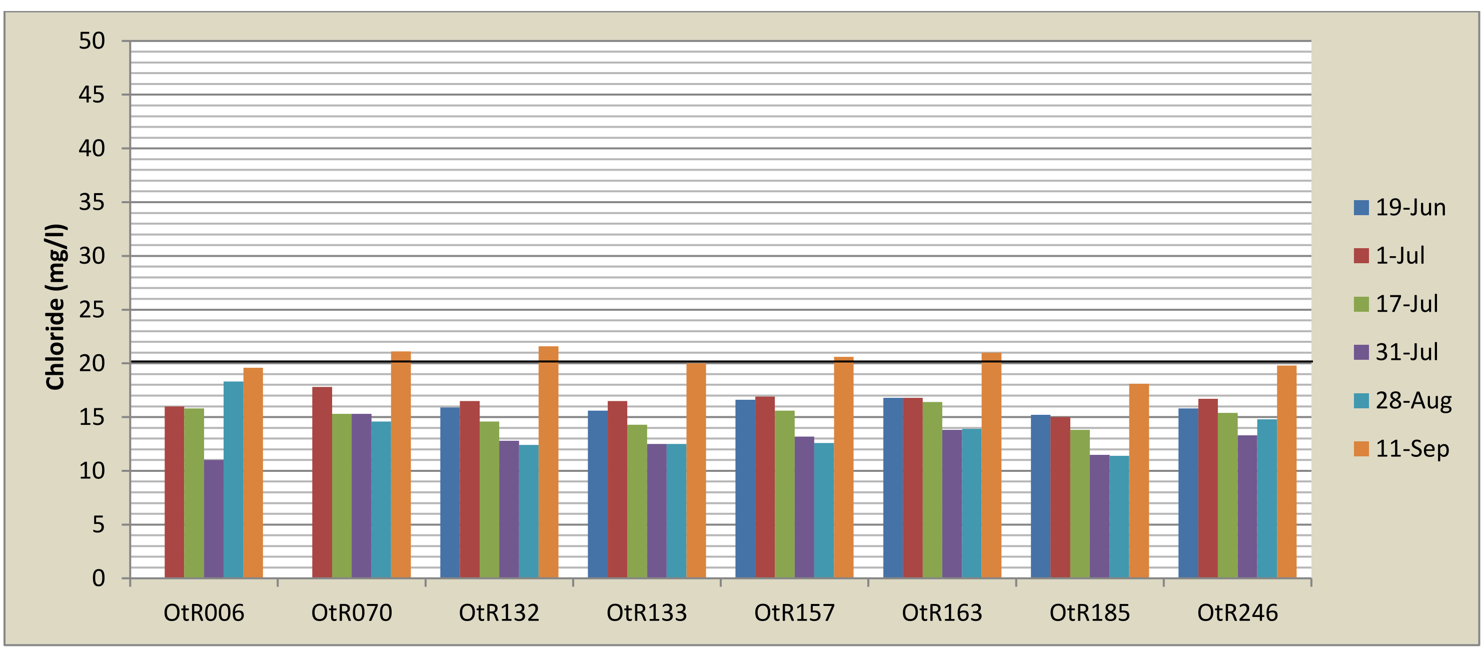


Figure 5f: 2014 Chloride Data (below Bridgewater WWTF)

SECTION 5.4: 2014 *E. COLI* DATA

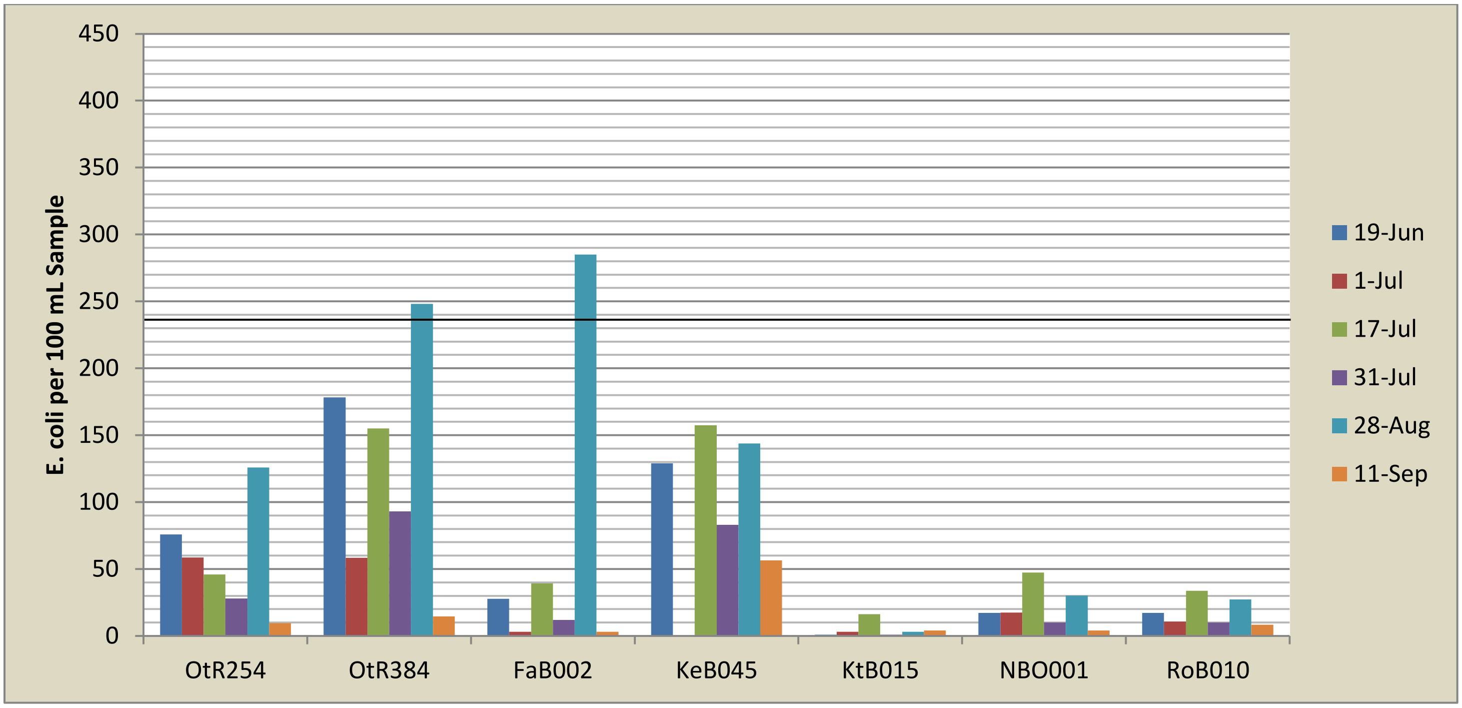


Figure 5g: 2014 E. coli Data (above Bridgewater WWTF)

E. coli bacteria concentrations in the Ottauquechee River Watershed in 2014 were generally in compliance with state and federal standards as only 8% of data points exceeded the 235 per 100 mL sample limit. A significant spike in *E. coli* bacteria is observable on August 28th at many sites. This correlates to a moderate spike in CFS values, suggesting this spike is attributable to a moderate precipitation event. Sites KtB015, NBO001, and RoB010 exhibit notably low bacteria counts. No significant increasing and descending trends are observable throughout the course of the sampling season; though bacteria counts are generally higher at all sites which fall below the Bridgewater waste water treatment facility.

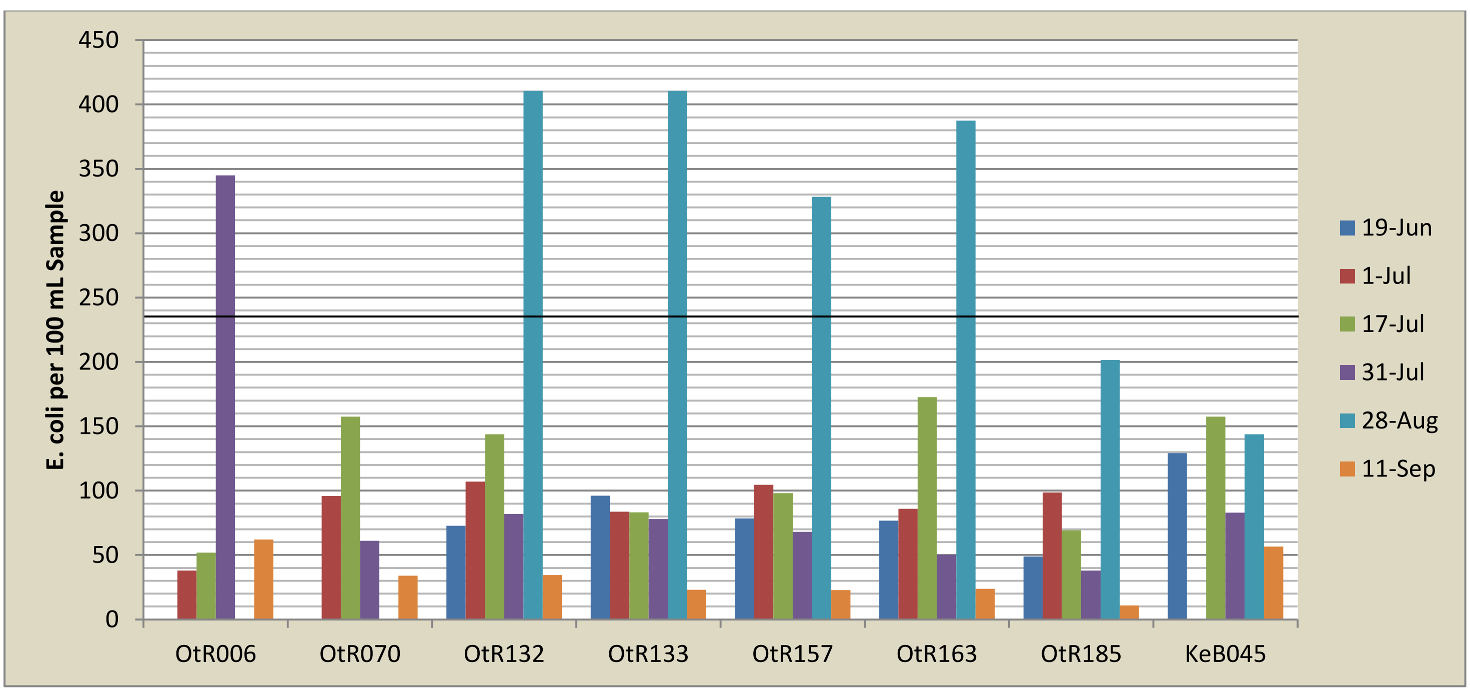


Figure 5h: 2014 E. coli Data (below Bridgewater WWTF)

SECTION 5.5: 2014 TOTAL NITROGEN DATA

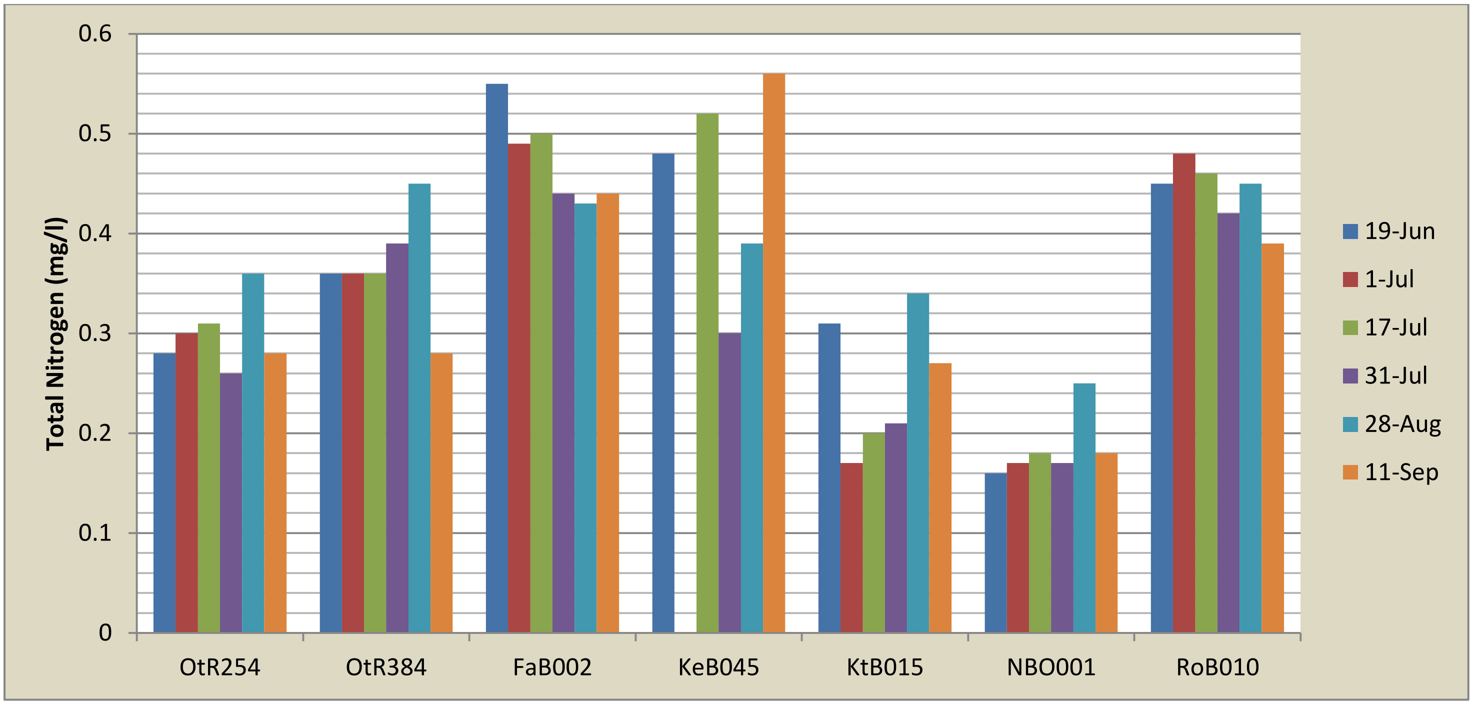


Figure 5i: 2014 Total Nitrogen Data (above Bridgewater WWTF)

All of the total nitrogen data points in the Ottauquechee River Watershed in 2014 were in compliance with state standards. Sites RoB010, FaB002, and KeB045 stand out as generally having the highest TN concentrations, while NBO001 is shown to have the lowest concentrations. No significant increasing or descending trends are evident throughout the course of the sampling season.

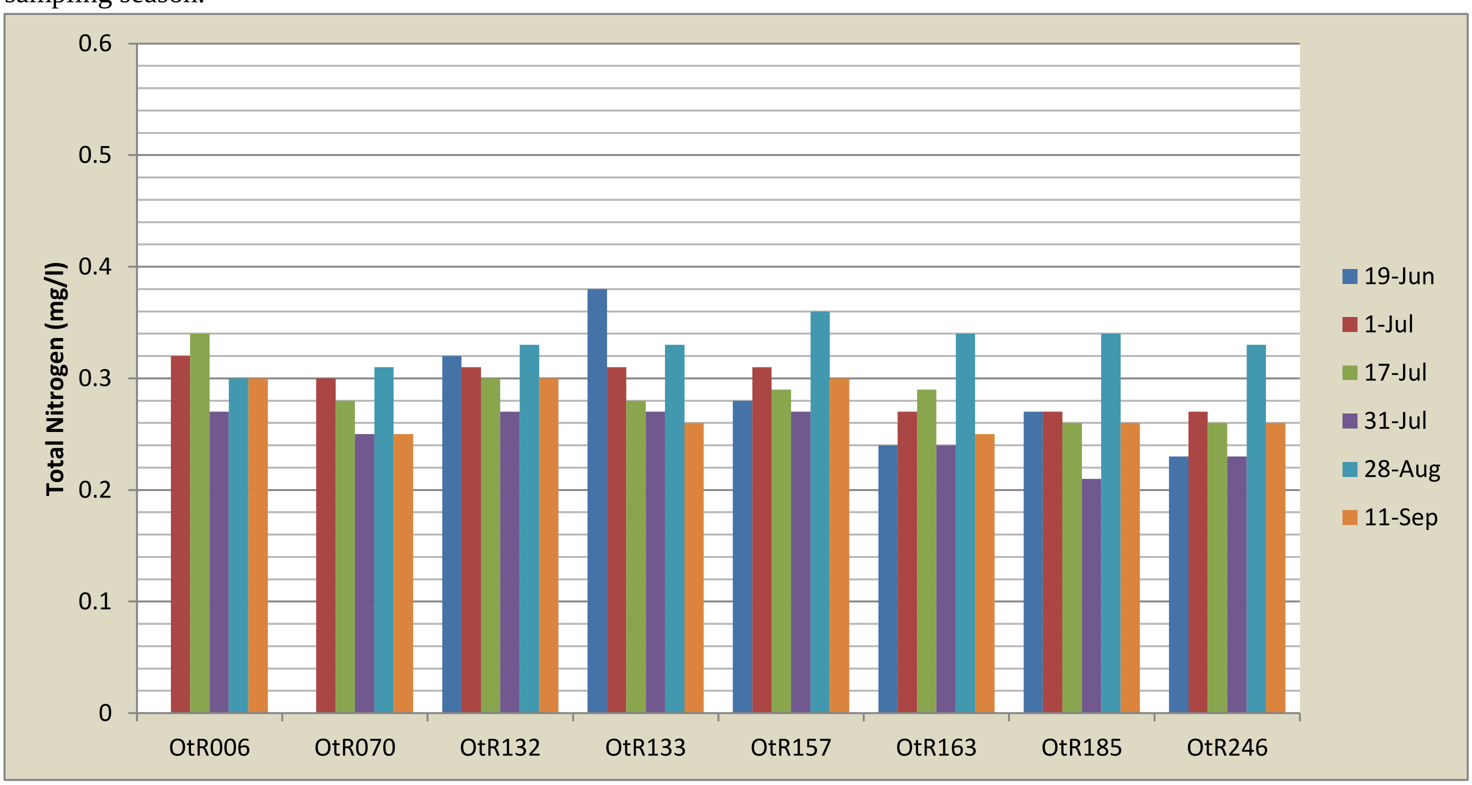


Figure 5j: 2014 Total Nitrogen Data (below Bridgewater WWTF)

SECTION 6: SUMMARY OF 2015 RESULTS

SECTION 6.1: 2015 TOTAL PHOSPHORUS DATA

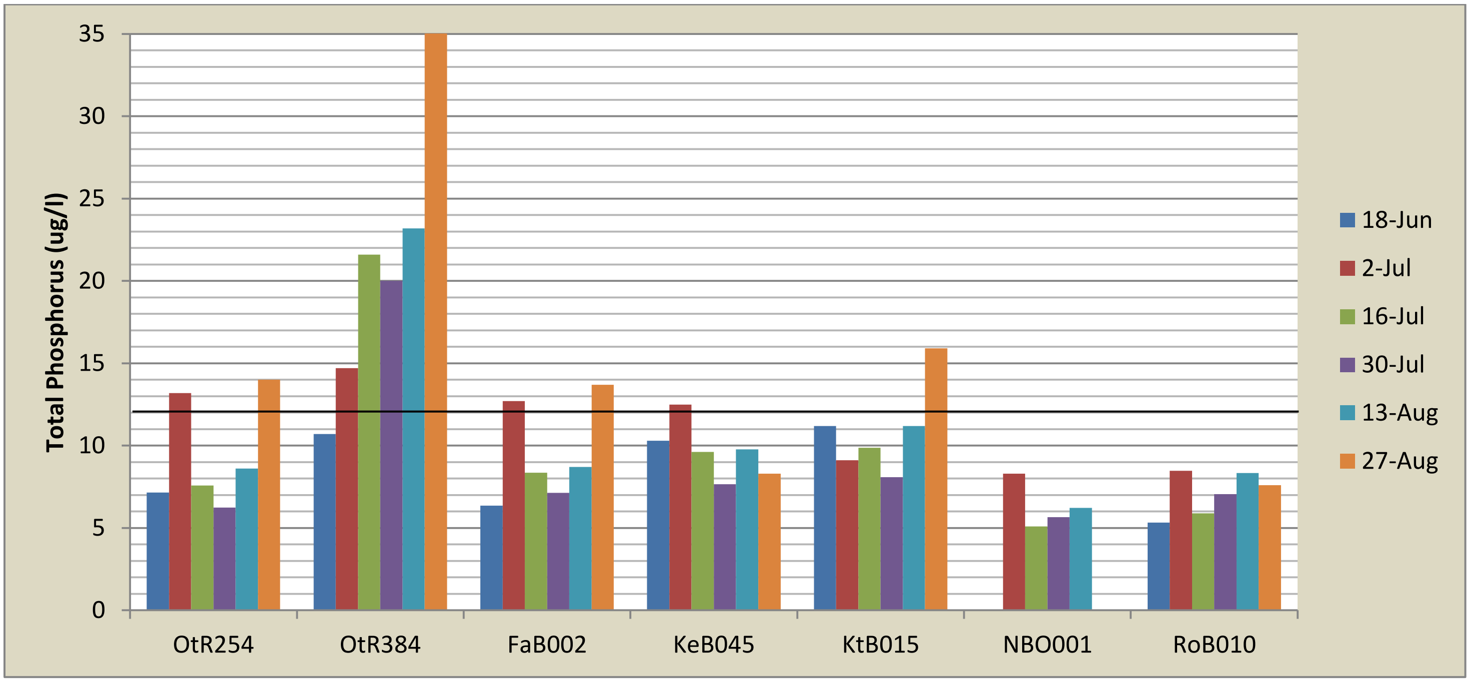


Figure 6a: 2015 Total Phosphorus Data (above Bridgewater WWTF)

Roughly 40% of total phosphorus data points collected in 2015 exceeded state standards (12 ug/l). The highest phosphorus concentrations can be found at site OtR384, as well as site OtR006, which exceeded standards during each sampling event carried out in 2015. The lowest total phosphorus concentrations can be found at sites NBO001 and RoB010. With the exception of site OtR384 which shows a distinct increasing trend throughout the course of the sampling season, no significant increasing or declining trends seem to exist.

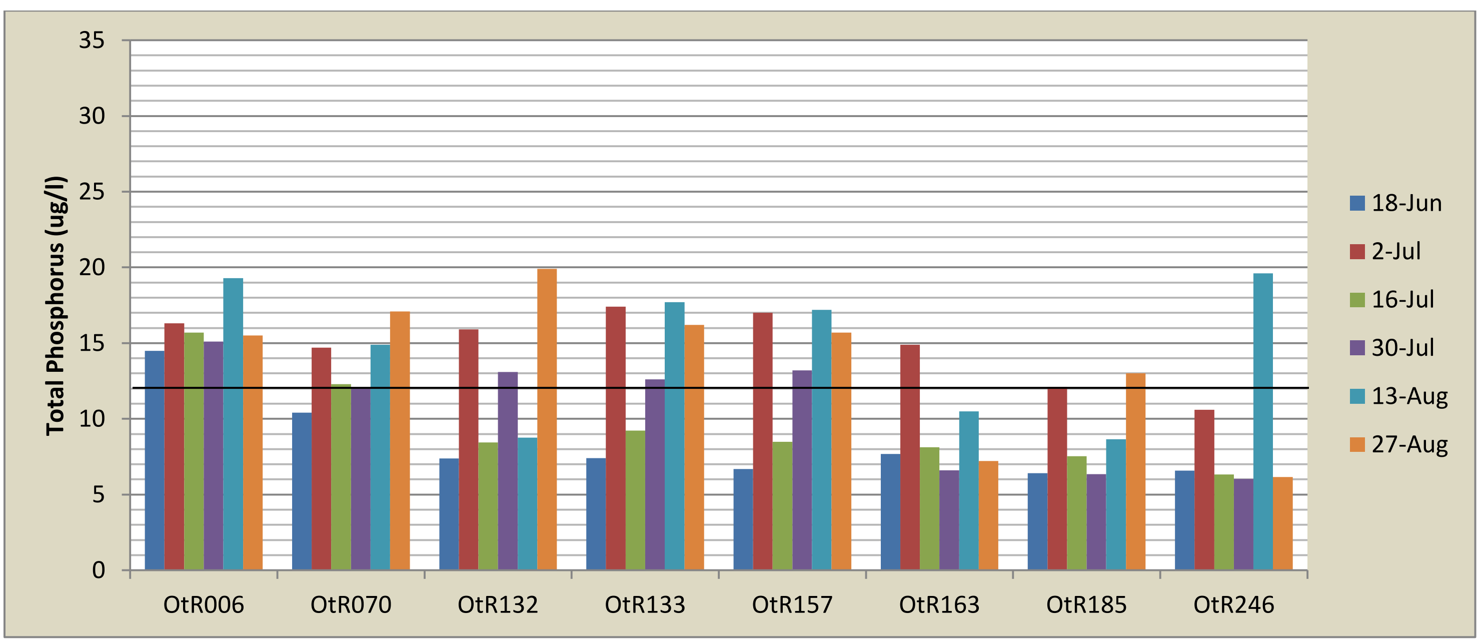


Figure 6b: 2015 Total Phosphorus Data (below Bridgewater WWTF)

SECTION 6.2: 2015 TURBIDITY DATA

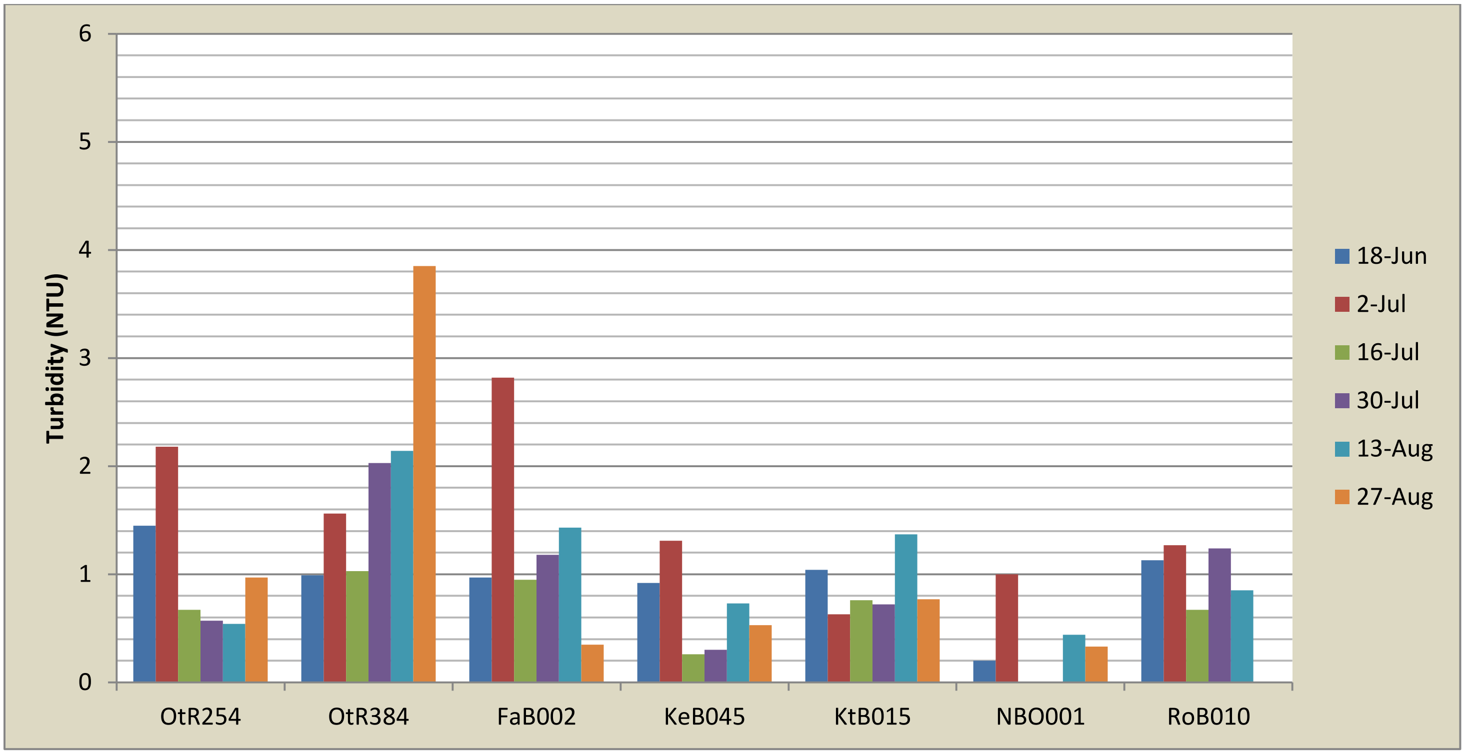


Figure 6c: 2015 Turbidity Data (above Bridgewater WWTF)

All of the 2015 turbidity data points are in compliance Vermont state standards (10 NTU). The most turbid site is shown to be OtR006 at the Hartland covered bridge swimming area, and the sites below the waste water treatment facility in Bridgewater are generally more turbid than those located above the facility. The least turbid sites include NBO001, RoB010, and KeB045.

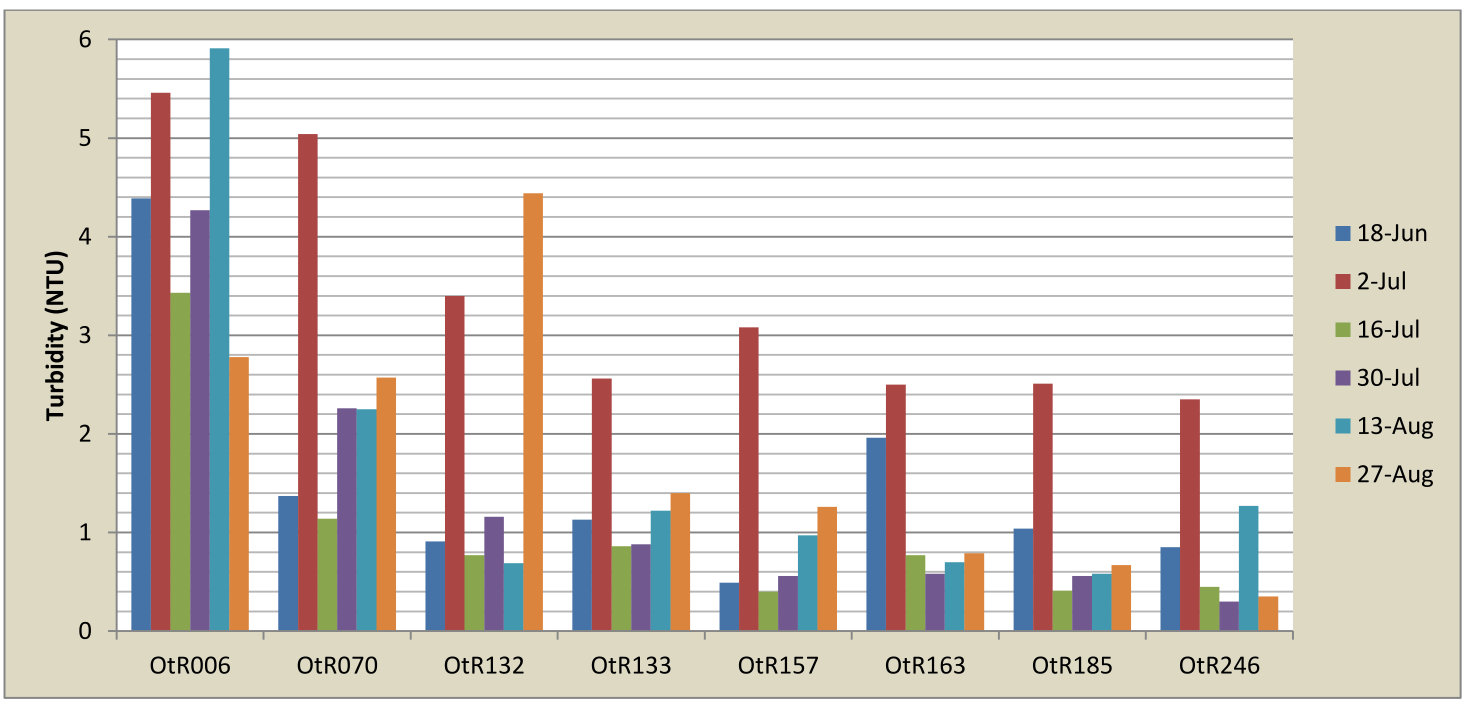


Figure 6d: 2015 Turbidity Data (below Bridgewater WWTF)

SECTION 6.3: 2015 CHLORIDE DATA

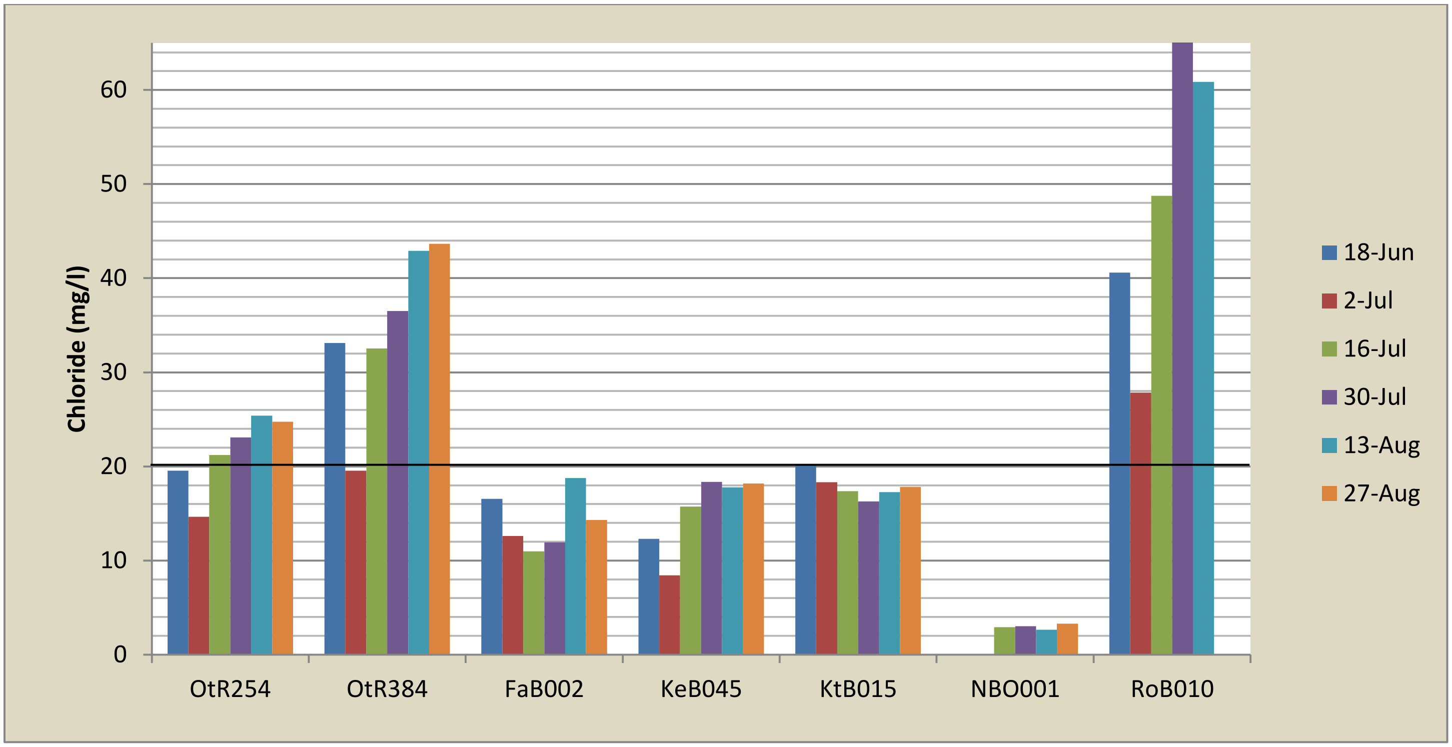


Figure 6e: 2015 Chloride Data (above Bridgewater WWTF)

A total of 38.9% of chloride data points collected in 2015 exceeded state standards (20 mg/l). The highest concentrations of chloride by far are located at sites OtR384 and RoB010. Nearly all of the sampling sites exhibit a generally increasing trend as the season progresses, excluding only sites FaB002, KtB015, and NBO001. Site NBO001 also possesses by far the lowest and most stable chloride concentrations. Chloride levels at all sites which fall below the waste water treatment facility in Bridgewater exhibit more consistent trends than those located above the facility.

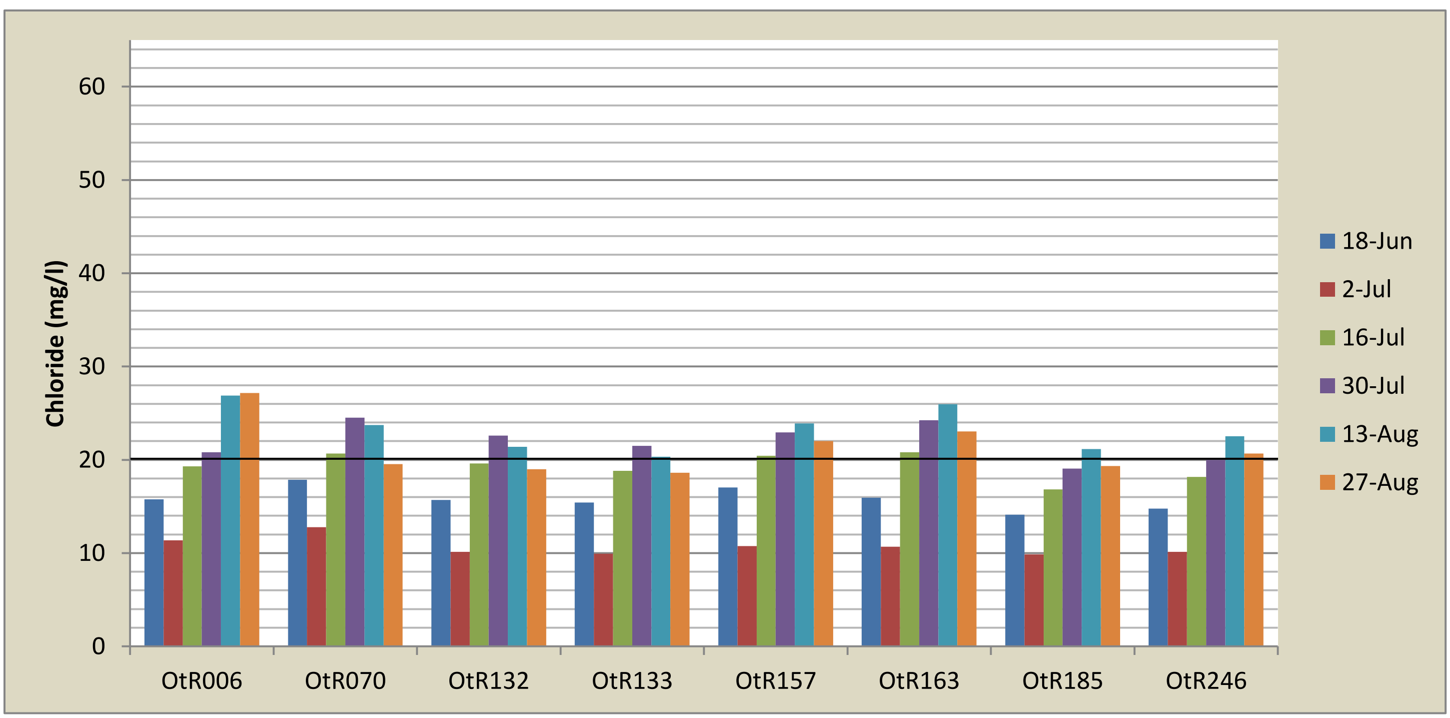


Figure 6f: 2015 Chloride Data (below Bridgewater WWTF)

SECTION 6.4: 2015 *E. COLI* DATA

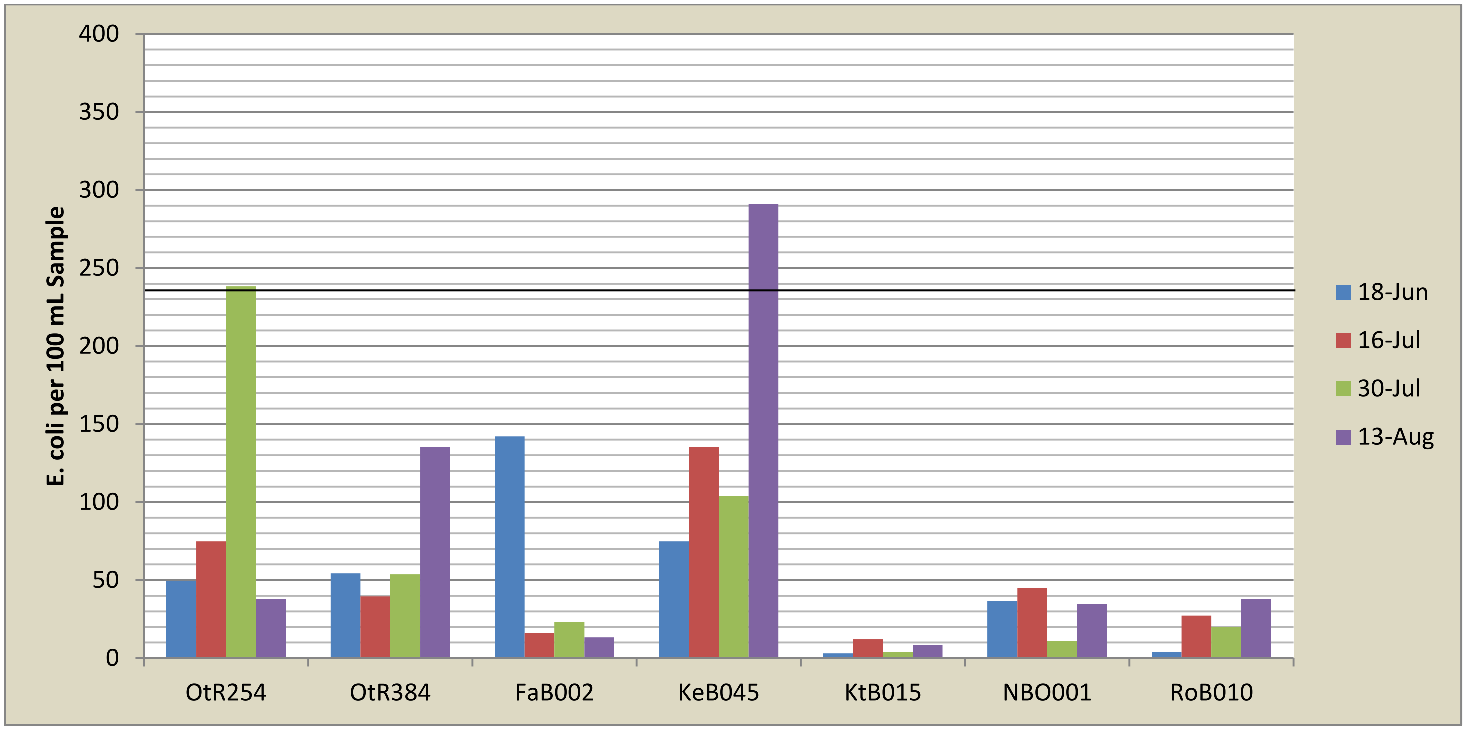


Figure 6g: 2015 E. coli Data (above Bridgewater WWTF)

The vast majority of *E. coli* bacteria data points collected during the 2015 monitoring season were within compliance with state standards. Only 8% of data points exceeded those standards (235 *E. coli* per 100 mL sample). *E. coli* bacteria were generally found in higher concentrations at all sites which fall below the waste water treatment facility in Bridgewater. Sites KtB015, NBO001, and RoB010 consistently show notably low concentrations of *E. coli* bacteria. No significant increasing or decreasing trends seem to exist throughout the course of the 2015 monitoring season.

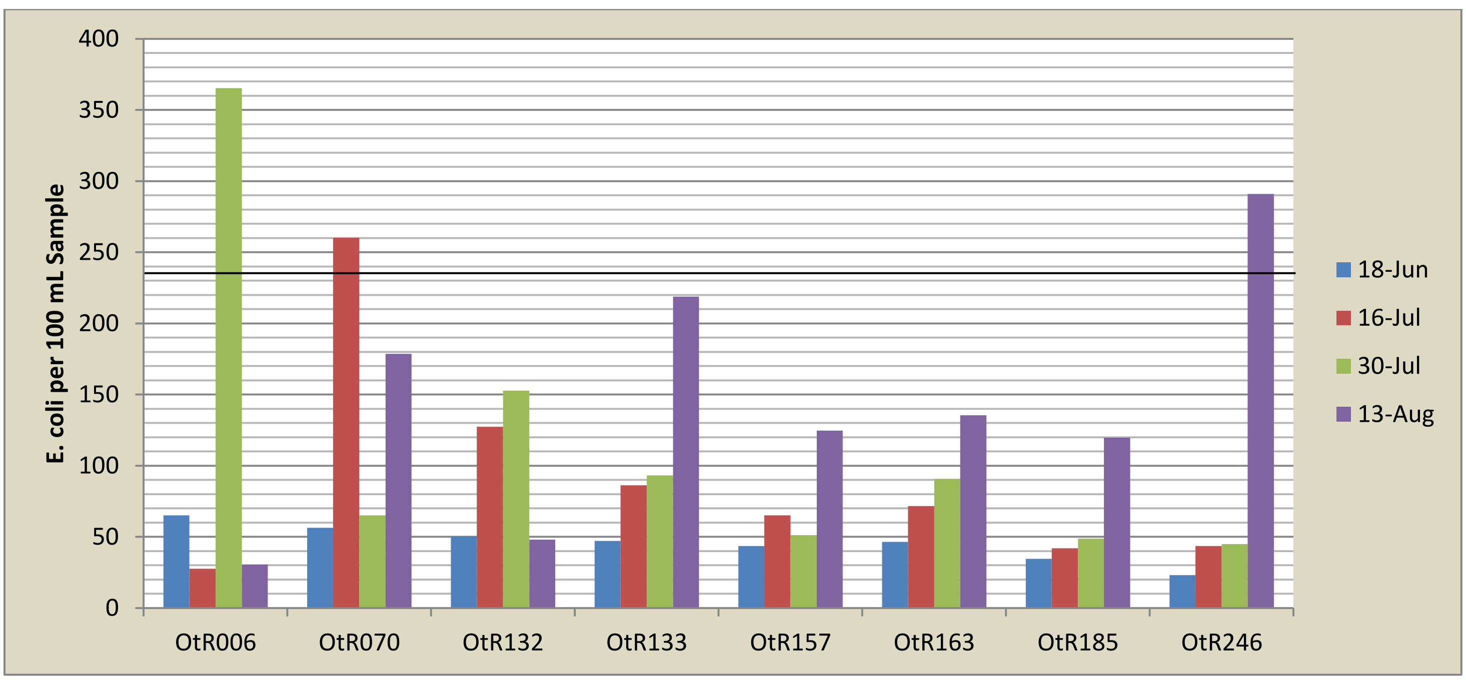


Figure 6h: 2015 E. coli Data (below Bridgewater WWTF)

SECTION 6.5: 2015 TOTAL NITROGEN DATA

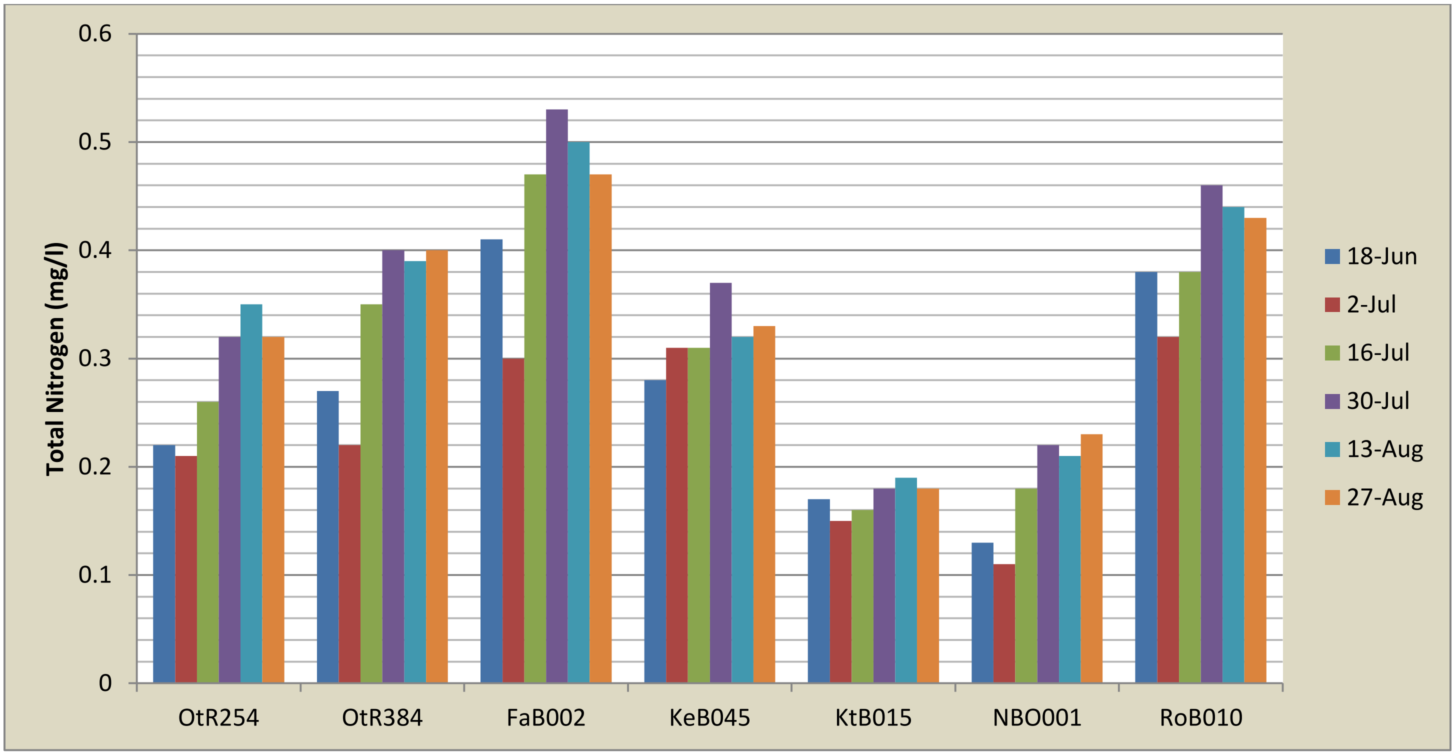


Figure 6i: 2015 Total Nitrogen Data (above Bridgewater WWTF)

All of the 2015 total nitrogen data points are well within compliance of state standards (5 mg/l). The highest concentrations of nitrogen can be found at sites FaB002 and RoB010 while the lowest concentrations are found at sites KtB015 and NBO001. A fairly loose increasing trend in nitrogen concentrations can be found at nearly all sites throughout the 2015 monitoring season.

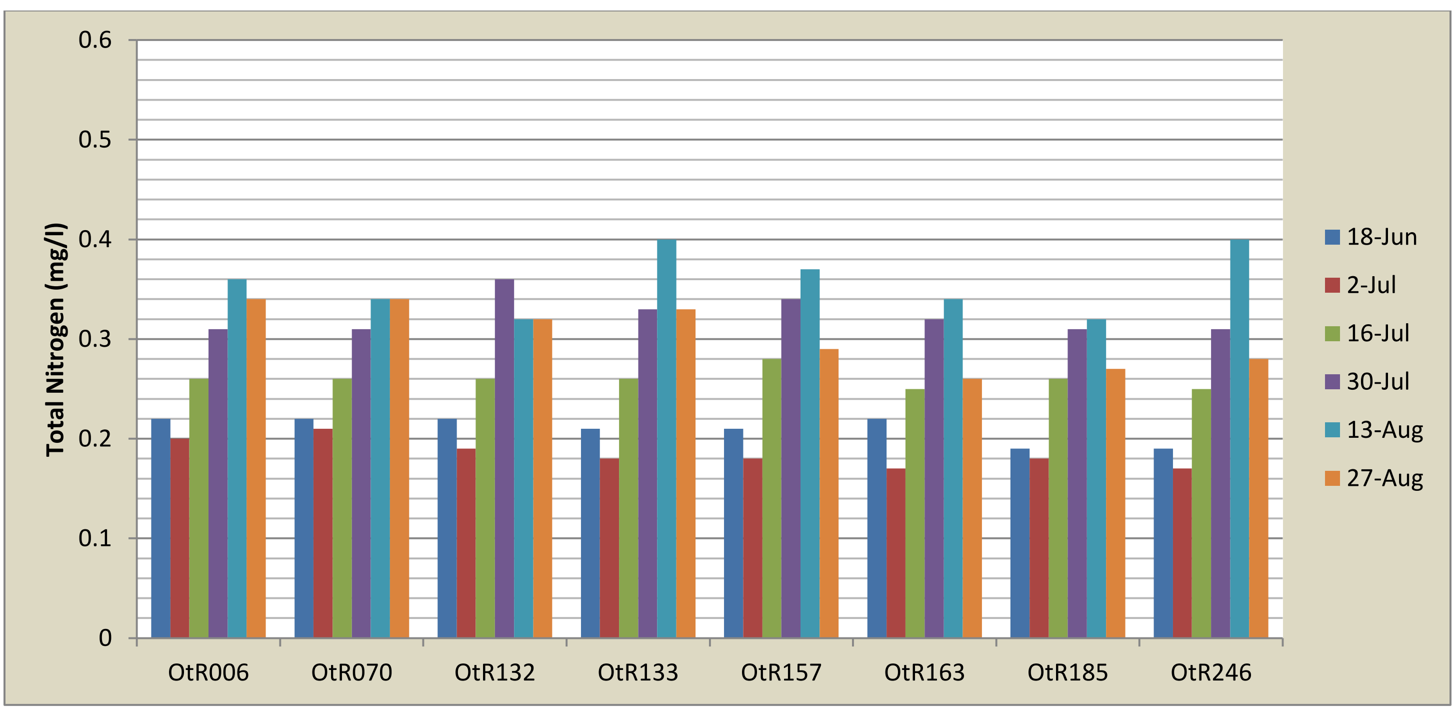


Figure 6j: 2015 Total Nitrogen Data (below Bridgewater WWTF

SECTION 7: SUMMARY OF 2016 RESULTS

SECTION 7.1: 2016 CHLORIDE DATA

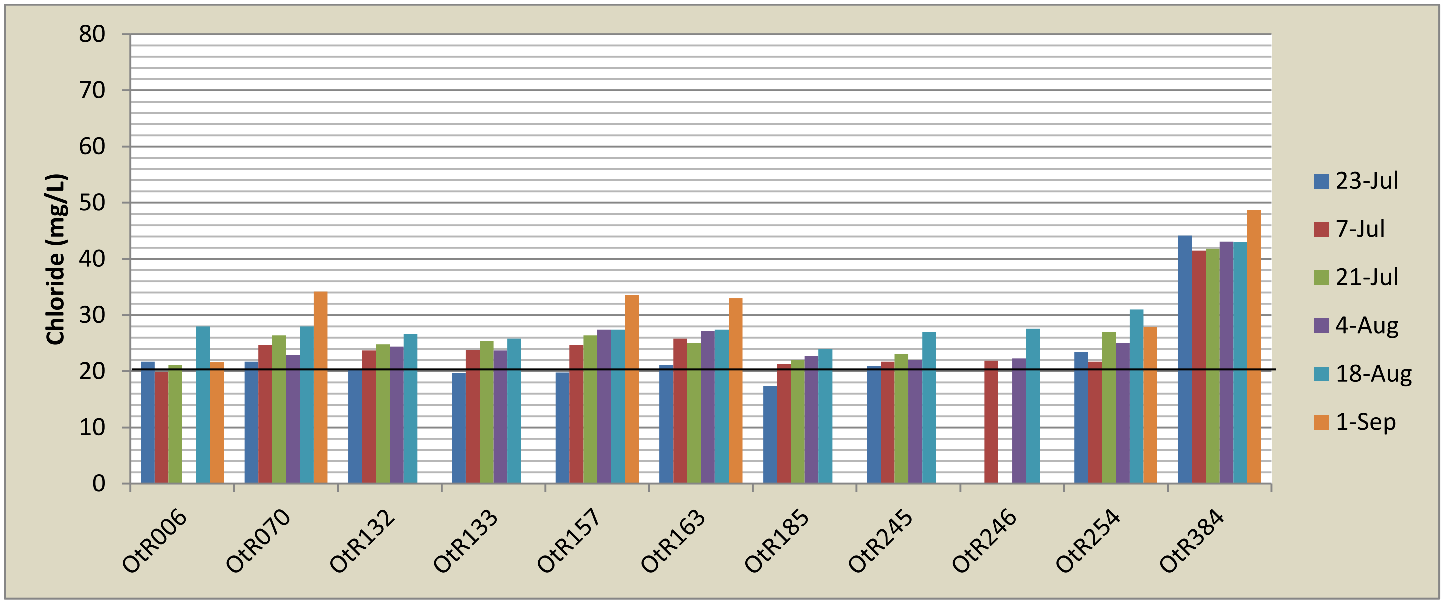


Figure 7a: 2016 Chloride Data (Main Stem Ottauquechee)

Nearly three quarters of chloride data points in 2016 exceed state standards (20 mg/L) at 71.29%. Chloride concentrations are shown to be extremely high in Roaring Brook, likely attributable to road ice treatment around the Killington Ski Resort to mitigate car accidents attributable to icy conditions. The vast majority of data points exceed standards in the Main Stem Ottauquechee River; however these levels are not nearly as high as what is shown in Roaring Brook. A generally increasing trend in chloride concentrations throughout the summer can be observed at nearly every site, most notably in Roaring Brook. As in past sampling seasons, site NBO001 on the North Branch Ottauquechee exhibits by far the lowest Chloride concentrations. Kedron Brook and Falls Brook also exhibit relatively low chloride concentrations.

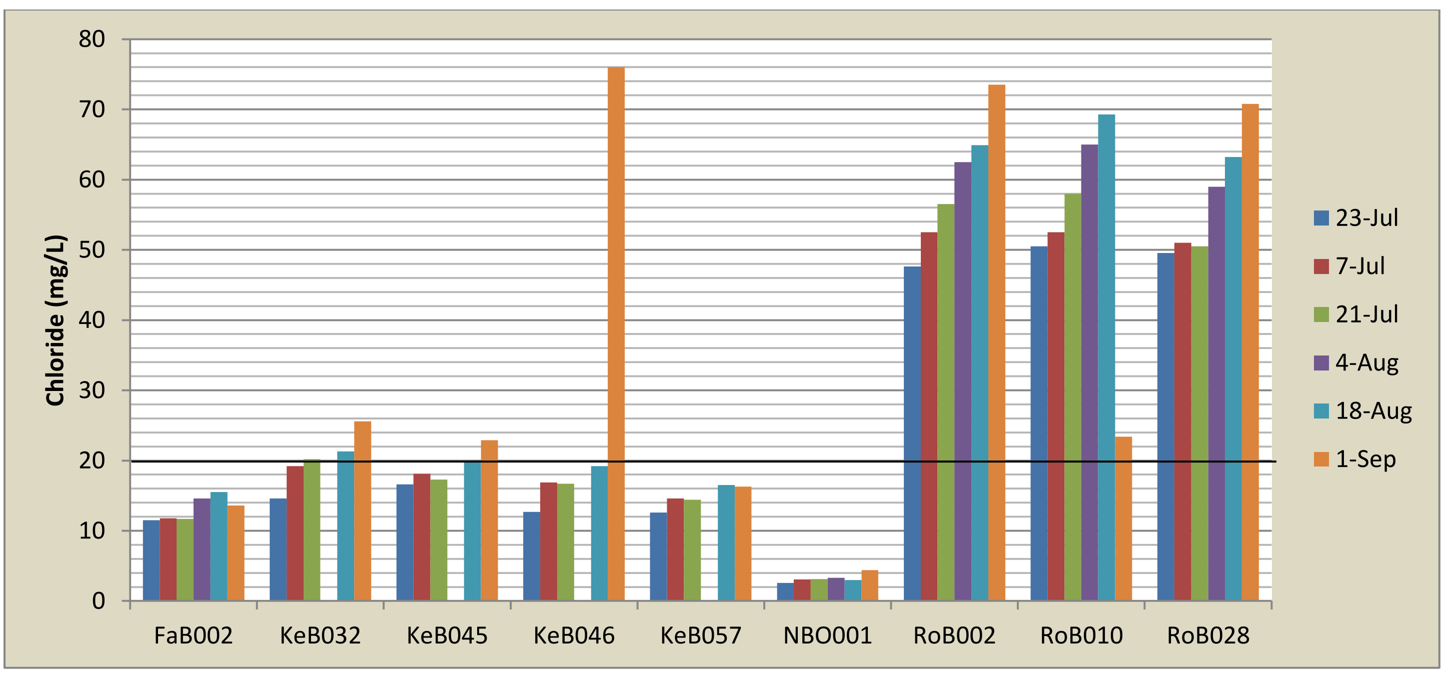


Figure 7b: 2016 Chloride Data (Ottauquechee Tributaries)

SECTION 7.2: 2016 TOTAL PHOSPHORUS DATA

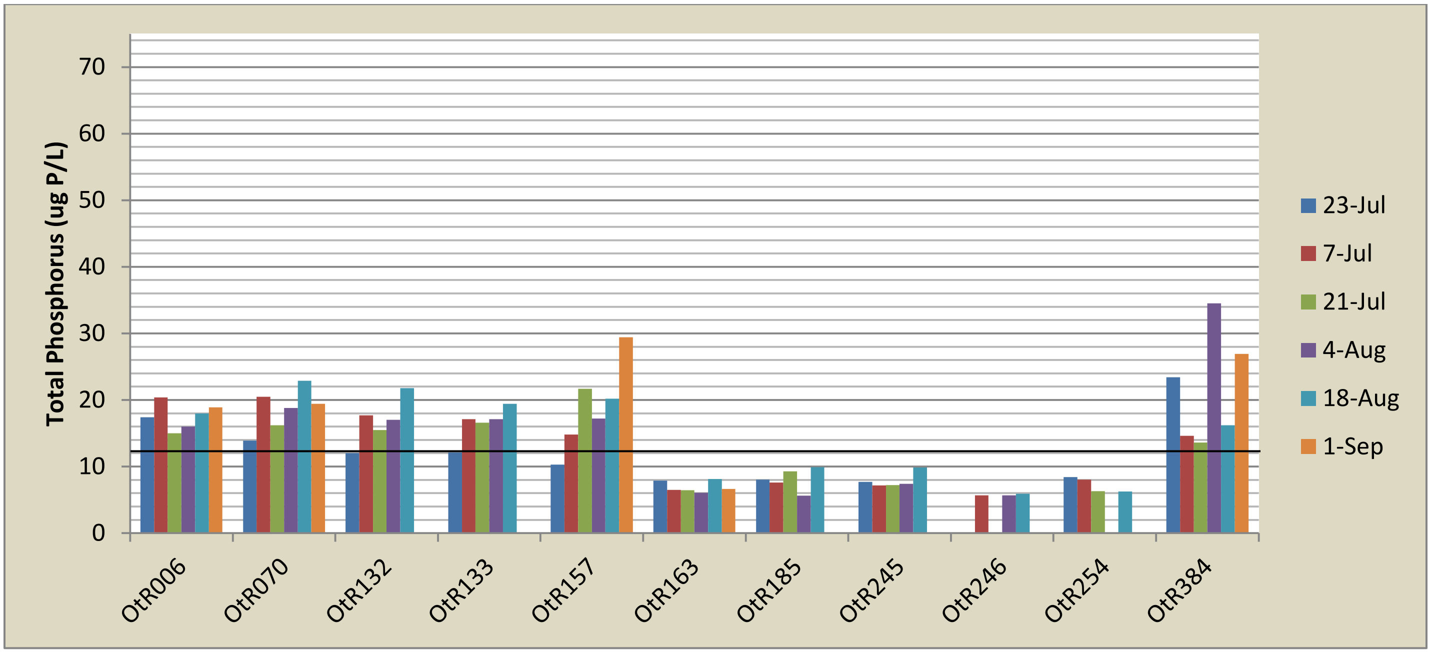


Figure 7c: 2016 Total Phosphorus Data (Main Stem Ottauquechee)

Approximately 33% of all Total Phosphorus data points exceeded state standards (12 ug P/L) in 2016. The majority of those exceeding data points were within the Main Stem Ottauquechee River as it approaches the confluence with the Connecticut River. Concentrations of phosphorus in the Main Stem Ottauquechee are generally in compliance with state standards starting at the site nearest the Woodstock WWTF on the upstream end (OtR163) until the river reaches the Rabeck Road Bridge (OtR384), at which point Total Phosphorus concentrations increase and exceed state standards again. The North Branch Ottauquechee site and every Roaring Brook site exhibit relatively low TP concentrations. There is shown to be high variability in TP concentrations along Kedron Brook, likely attributable to the presence of agricultural activities where concentrations are high or lack thereof where concentrations are low.

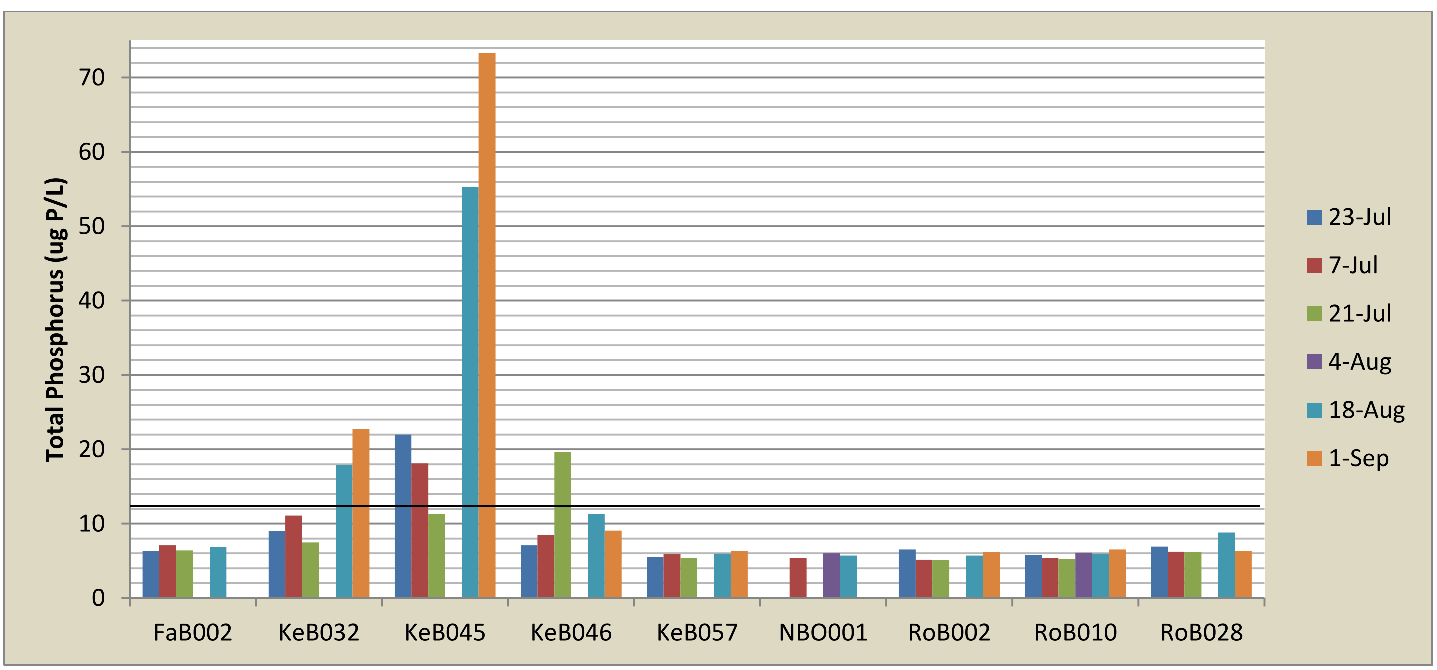


Figure 7d: 2016 Total Phosphorus Data (Ottauquechee Tributaries)

SECTION 7.3: 2016 TOTAL NITROGEN DATA

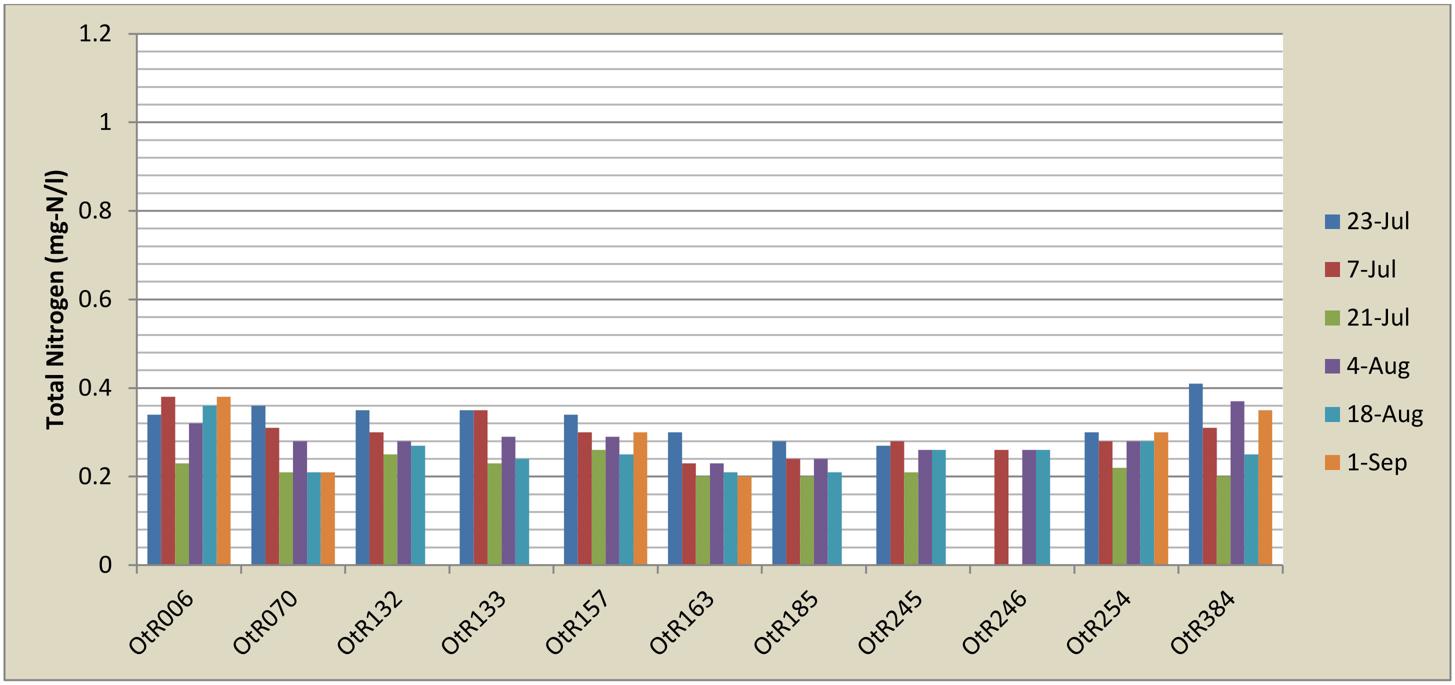


Figure 7e: 2016 Total Nitrogen Data (Main Stem Ottauquechee)

100% of the 2016 Total Nitrogen data points are well within compliance with current state standards (5 mg/L). Total Nitrogen concentrations appear to be slightly higher within the tributaries relative to the Main Stem Ottauquechee. The highest concentrations appear in parts of Kedron Brook and Roaring Brook. There are no measurable increasing or descending trends observable in TN concentrations at any sites throughout the 2016 monitoring season.

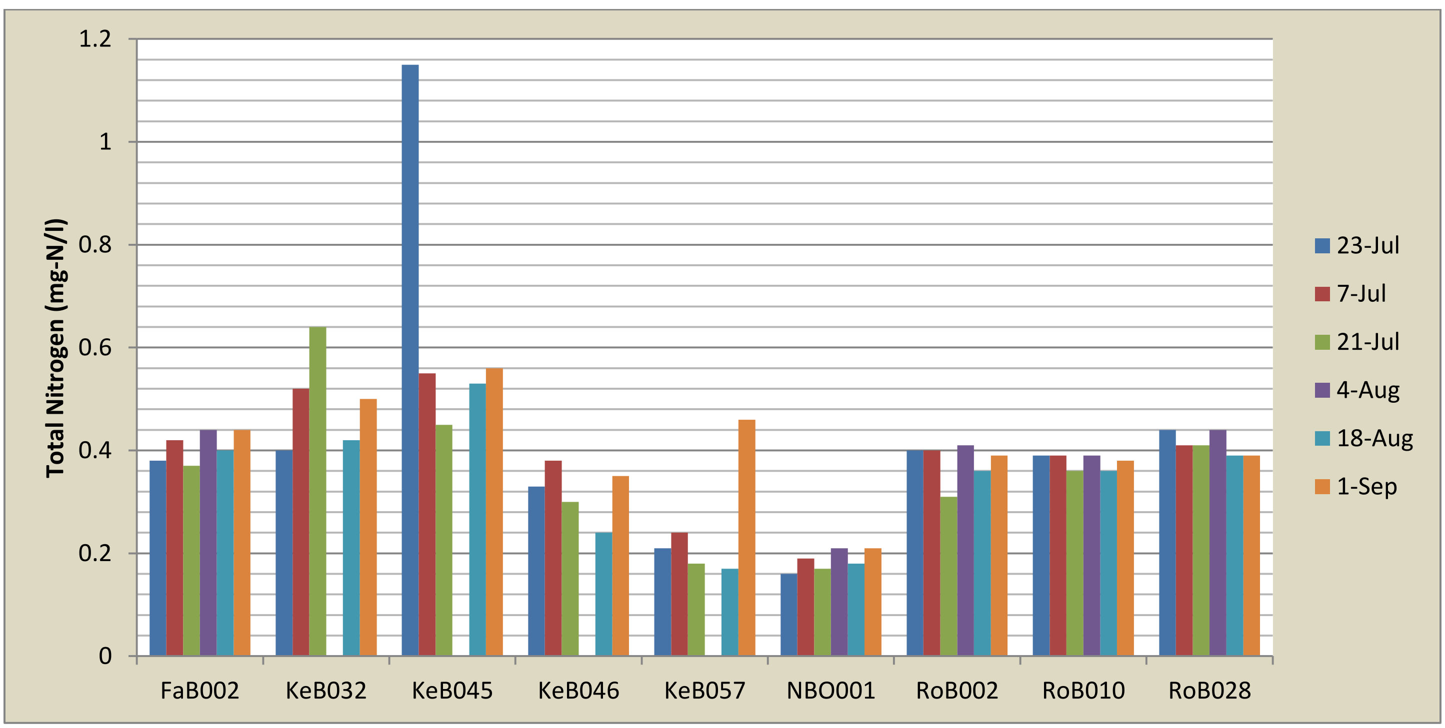


Figure 7f: 2016 Total Nitrogen Data (Ottauquechee Tributaries)

SECTION 7.4: 2016 *E. COLI* DATA

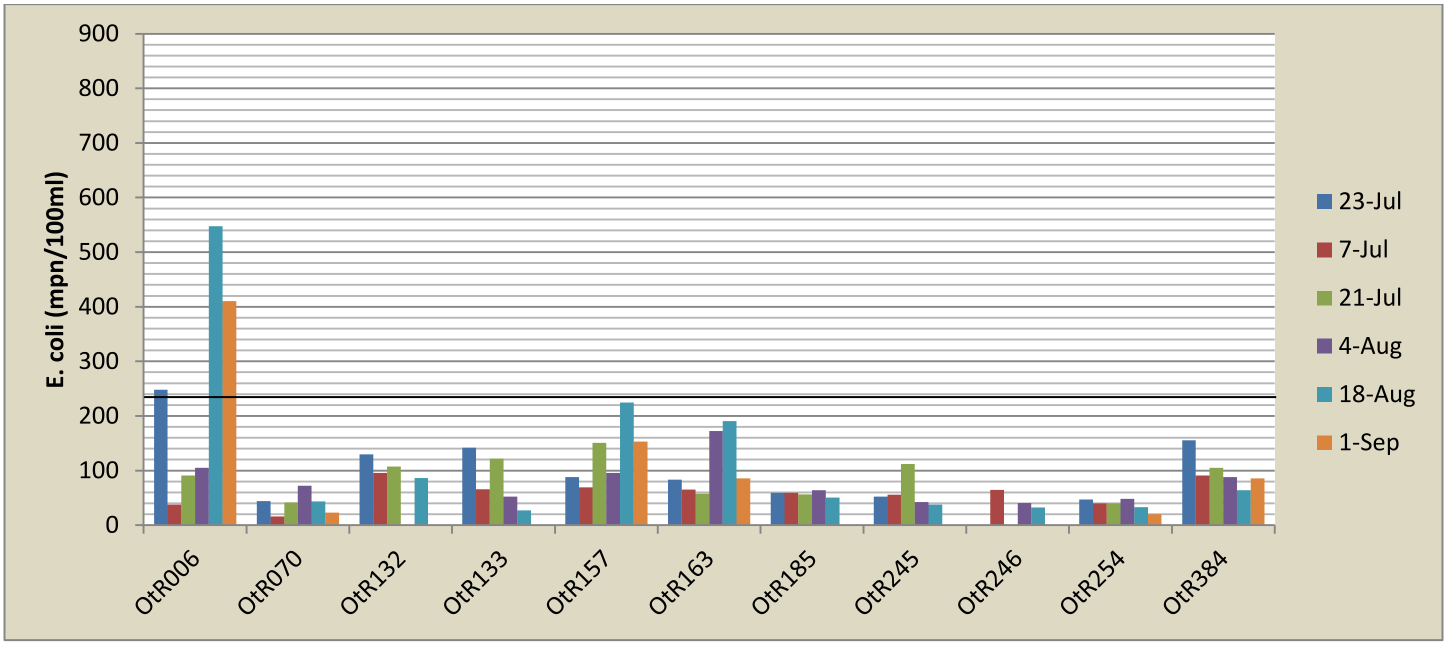


Figure 7g: 2016 E. coli Data (Main Stem Ottauquechee)

Very similar to the 2014 and 2015 monitoring seasons, only 8.49% of *E. coli* samples collected during the 2016 season exceeded state standards (235 mpn/100ml), down from 26% in 2013. With the exception of one data point on Roaring Brook, all of the samples which were not in compliance during the 2016 season were on Kedron Brook and site OtR006 (Hartland covered bridge swimming area) on the Main Stem Ottauquechee. These spikes in *E. coli* concentrations are likely attributable to agricultural activities given the site's close downstream proximity to farming operations. With the exception of site OtR006, no data points exceeded state standards along the Main Stem Ottauquechee during the 2016 monitoring season. Falls Brook and the two downstream most sites on Roaring Brook exhibited the lowest *E. coli* concentrations while Kedron Brook possessed the highest concentrations.

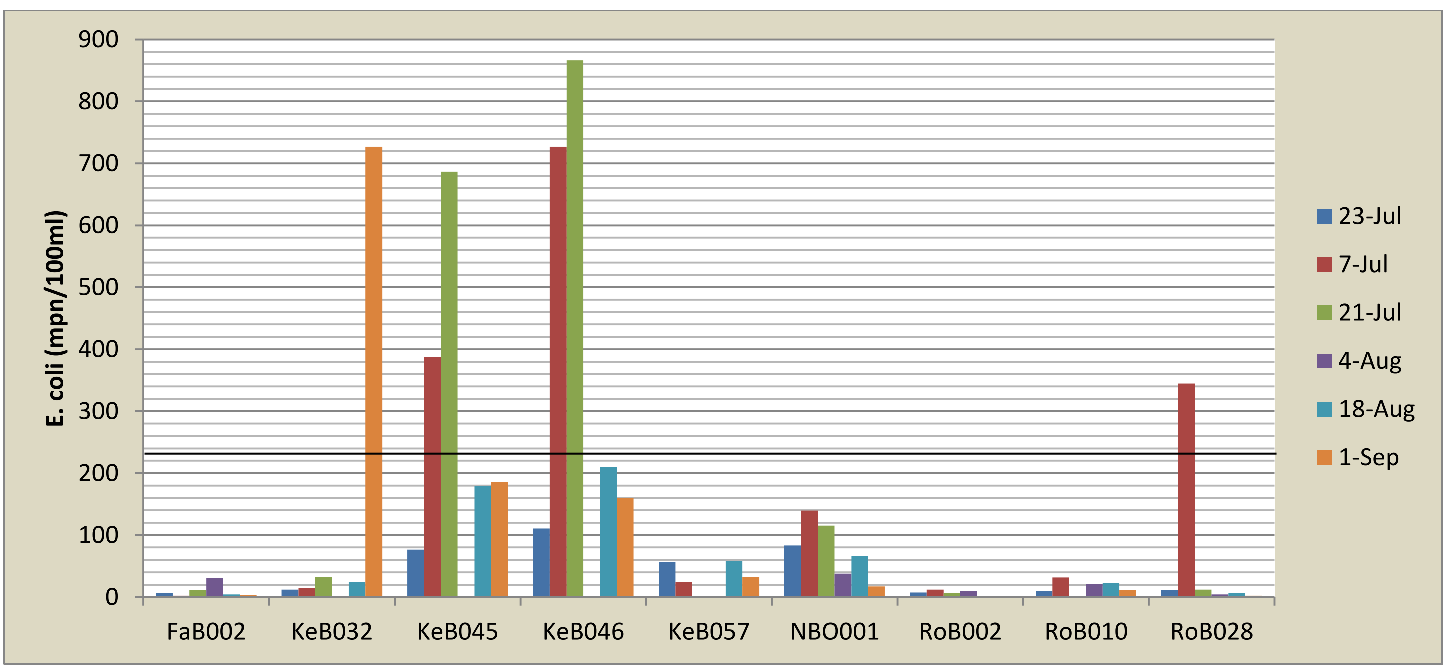


Figure 7h: 2016 E. coli Data (Ottauquechee Tributaries)

SECTION 7.5: 2016 TURBIDITY DATA

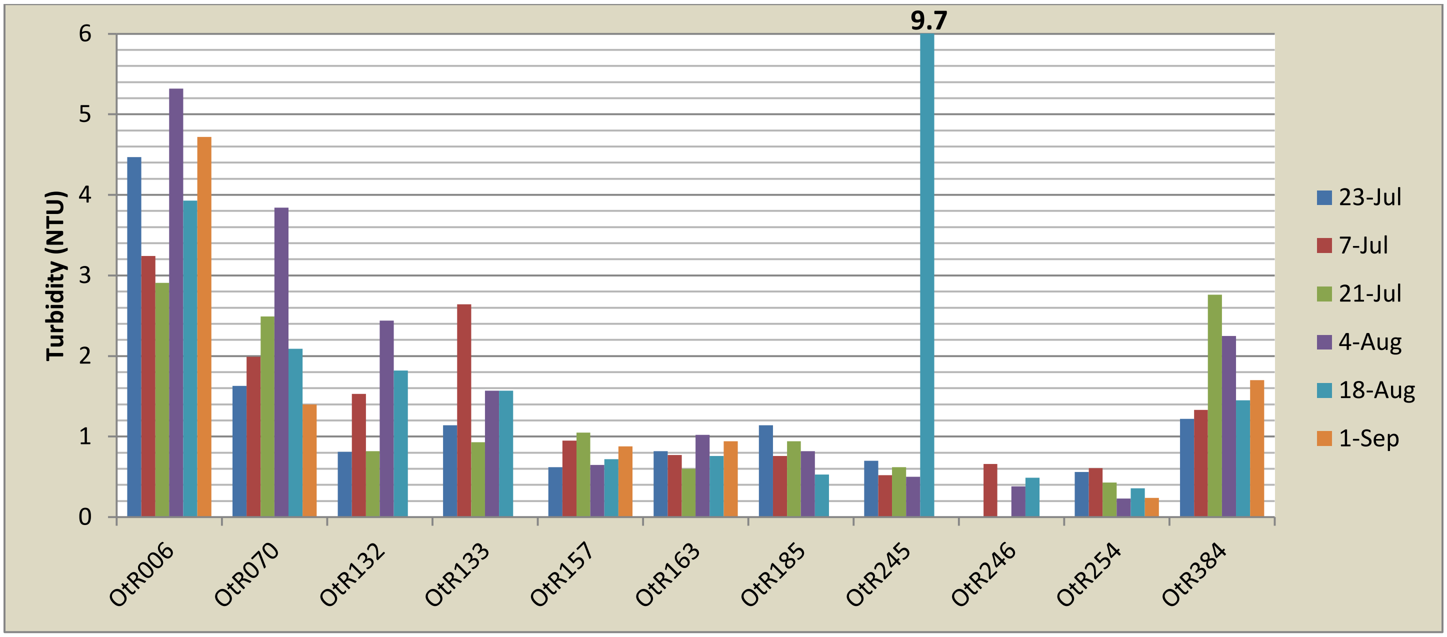


Figure 7i: 2016 Turbidity Data (Main Stem Ottauquechee)

100% of turbidity samples collected during the 2016 monitoring season were in compliance with current state standards (10 NTU). However, on August 18 site OtR245 (below Bridgewater WWTF) registered a value of 9.7 NTU, just 0.3 NTU shy of exceeding standards. At no point during the 2016 monitoring season did an Ottauquechee tributary site exceed a value of 1 NTU. In *Figure 7j* below, there appears to be many missing sample values. This is because the value generated at the lab was <0.2 (less than 0.2), thus a graphical representation of those values could not be generated. The four downstream most Main Stem Ottauquechee sites, as well as site OtR384 were shown to be the most turbid throughout the course of the 2016 monitoring season.

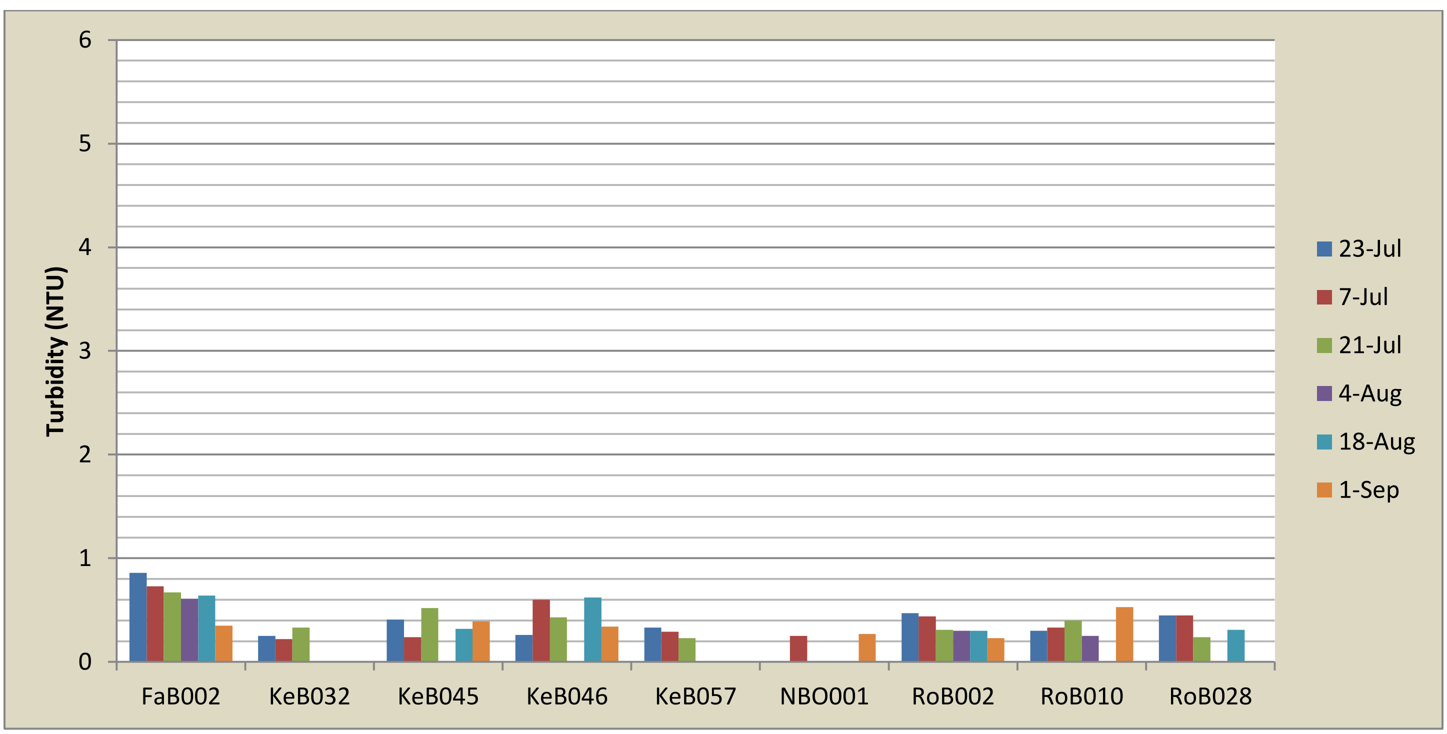


Figure 7j: 2016 Turbidity Data (Ottauquechee Tributaries)

SECTION 8: SUMMARY OF 2017 RESULTS

SECTION 8.1: 2017 PHOSPHORUS DATA

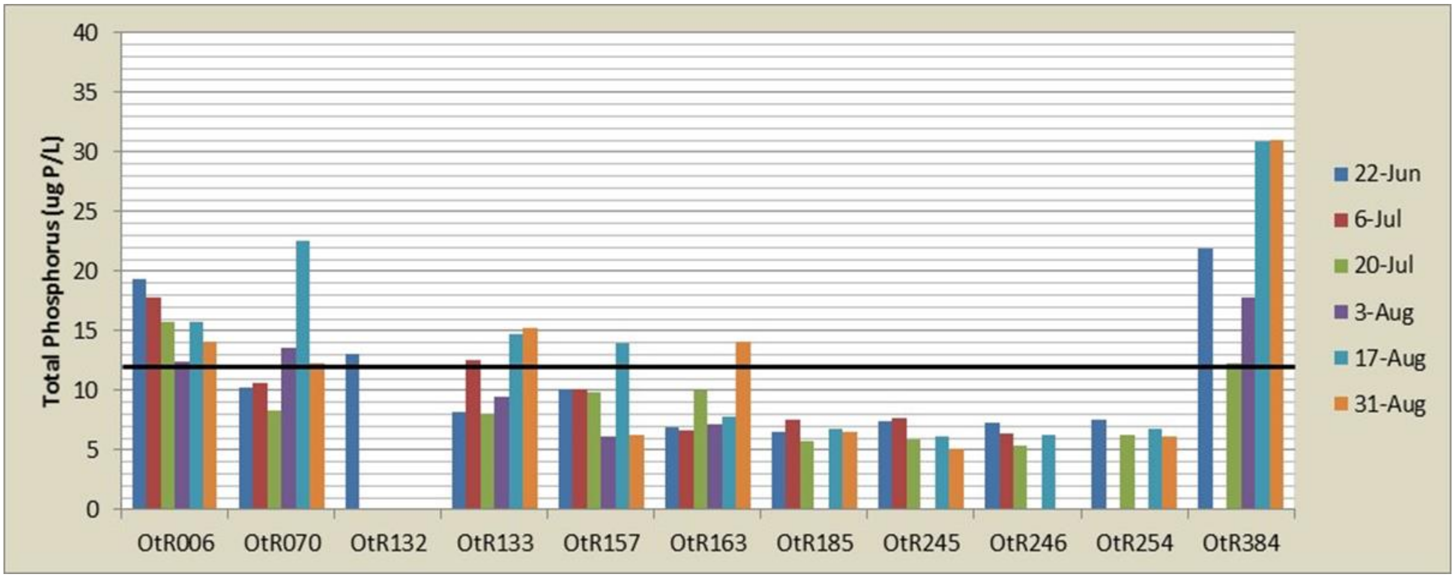


Figure 8a: 2017 Total Phosphorus Data (Main Stem Ottauquechee)

In 2017, approximately 23% of all Total Phosphorus data points exceeded state standards (12 ug P/L). The majority of those exceeding data points were concentrated near the confluence of the Main Stem Ottauquechee River and the Connecticut River. One site consistently above the state standard was OtR006 which is just below the Hartland covered bridge. This area is a popular swimming spot during the summer months and it is possible that the high phosphorus concentrations stemmed from anthropogenic sources. The upstream reaches of the Main Stem Ottauquechee were primarily in compliance with state standards with the exception of the Rabeck Road Bridge (OtR384) where concentrations rose up to three times the state standard. Both the North Branch Ottauquechee site and each Roaring Brook site exhibited fairly low TP concentrations. Again, the high variability in TP concentrations along Kedron Brook is likely due to the presence or absence of agricultural activities nearby.

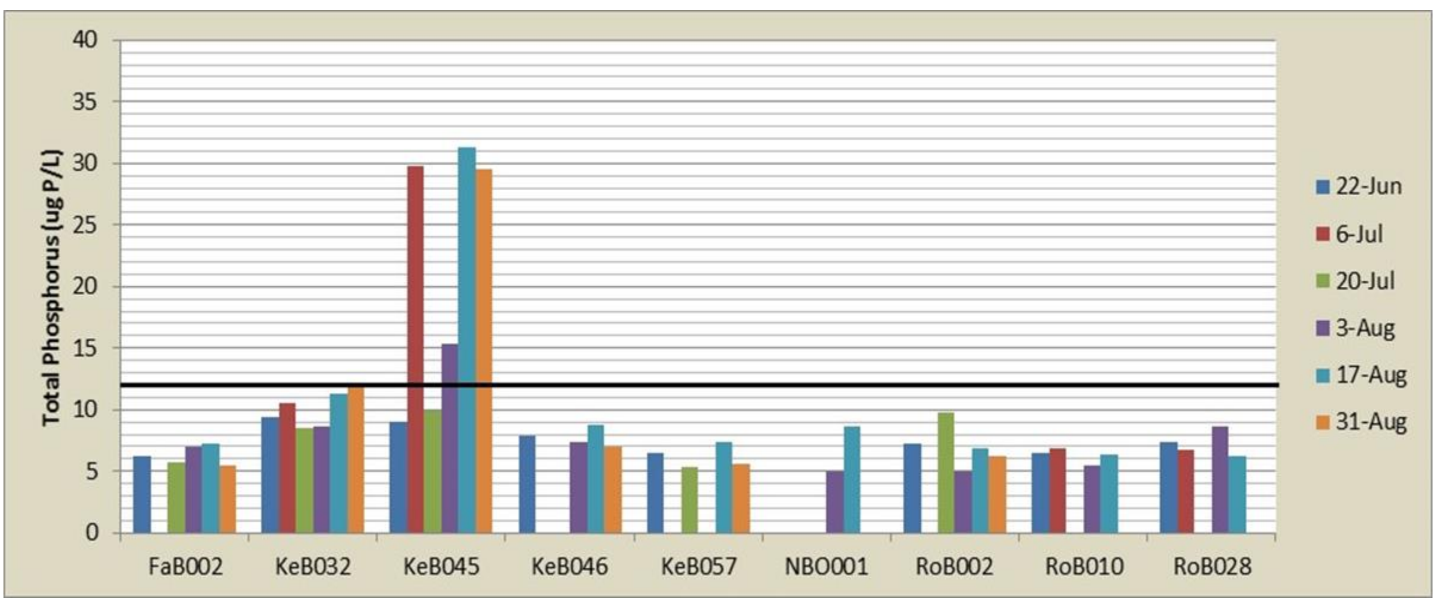


Figure 8b: 2017 Total Phosphorus Data (Main Stem Ottauquechee)

SECTION 8.2: 2017 TURBIDITY DATA

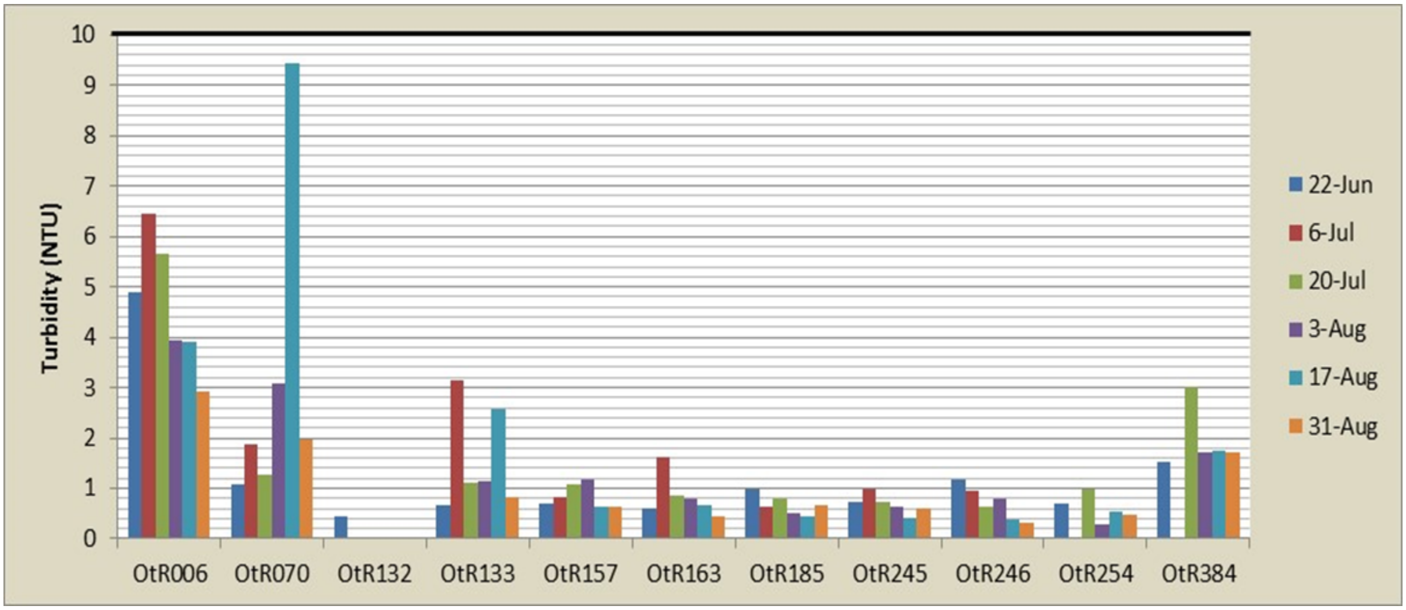


Figure 8c: 2017 Turbidity Data (Main Stem Ottauquechee)

Similar to the 2016 monitoring season, 100% of the 2017 turbidity samples are in compliance with current state standards (10 NTU). Sites with consistently high turbidity levels relative to others include OtR006 and OtR070, both of which are closest to the confluence of the Main Stem Ottauquechee and the Connecticut River. It is important to note that one sample from site OtR070 on August 17 registered a value of 9.45 NTU, only 0.55 NTU off from exceeding the state standard. Most sites along Ottauquechee tributaries did remain below 2 NTU aside from three samples that rose above this value.

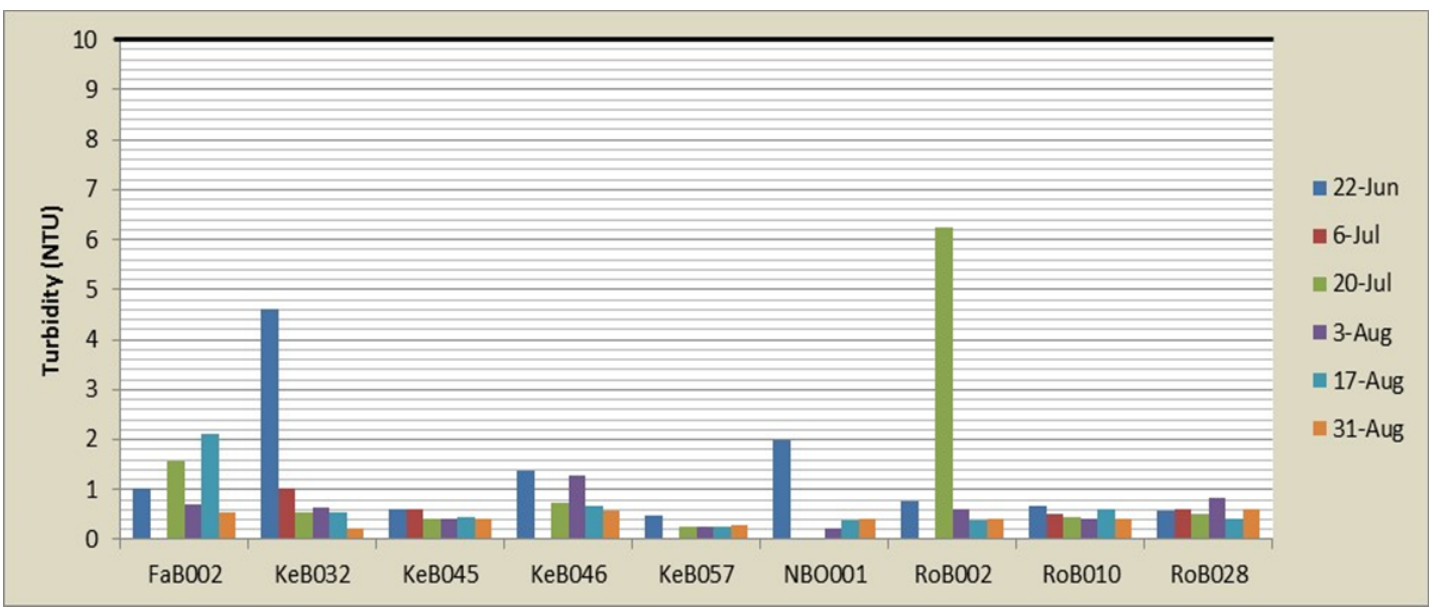


Figure 8d: 2017 Turbidity Data (Ottauquechee Tributaries)

SECTION 8.3: 2017 CHLORIDE DATA

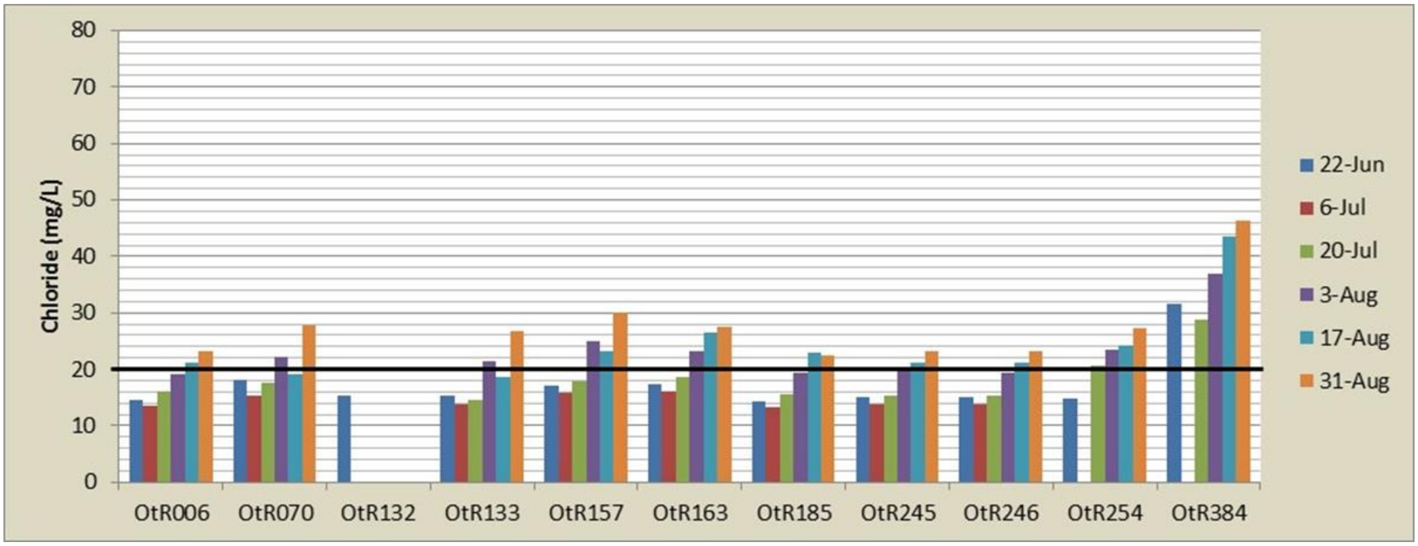


Figure 8e: 2017 Chloride Data (Main Stem Ottauquechee)

In 2017, 41% of chloride data points exceeded the state standard of 20 mg/L. The majority of sites along the Main Stem Ottauquechee were above this standard on both August 17 and August 31 aside from OtR384, the main stem site furthest from the Connecticut River confluence, which was consistently above the standard for *all* sampling dates. The heightened concentrations during the second half of August may be due to an increase in rainfall. USGS flow gage readings from the Ottauquechee River near West Bridgewater show a definitive spike in discharge rates on August 4, 19, and 23 with the discharge rate on August 23 being the greatest at approximately 140ft3/s. It is possible that the run-off from roadways during each of these rainfall events contributed to the increasing concentration of chloride seen in the second half of August. Sites with the overall highest concentrations of chloride were all found along Roaring Brook and registered levels over *three* times the state standard. This can likely be attributed to lasting effects from road ice treatment around the Killington Ski Resort during the winter months. The remaining Ottauquechee tributary sites along Falls Brook and Kedron Brook showed relatively low chloride concentrations, never reaching above 19 mg/L. As consistent with past sampling seasons, all sites exhibited a generally increasing trend as the season progressed.

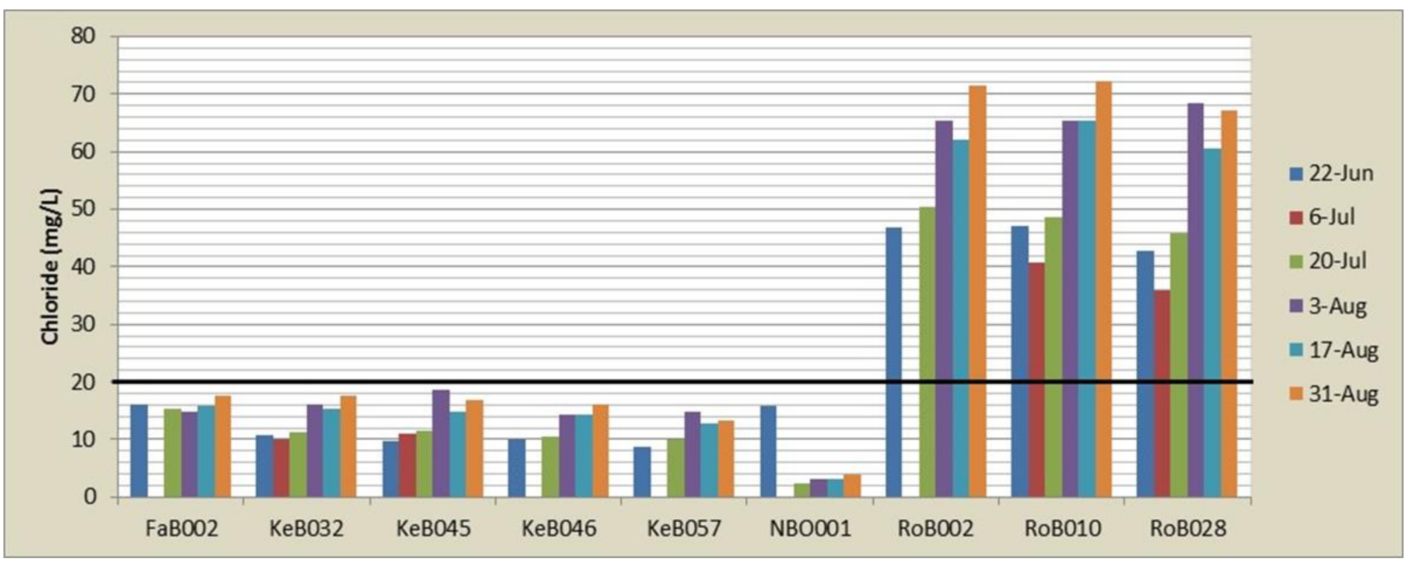


Figure 8f: 2017 Chloride Data (Ottauquechee Tributaries)

SECTION 8.4: 2017 *E. COLI* DATA

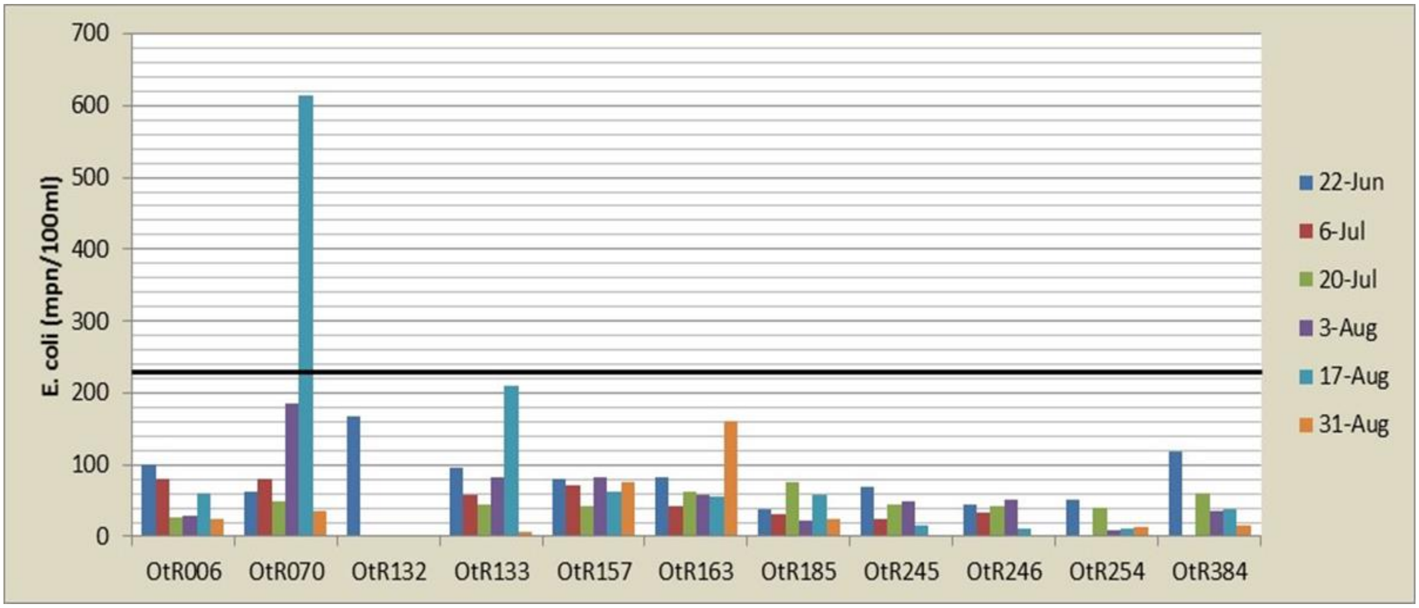


Figure 8g: 2017 E. coli Data (Main Stem Ottauquechee)

During the 2017 sampling season, only 4% of the samples collected exceeded the state standards for *E. coli* (235 mpn/100ml), showing a slight decrease from the 8% level that has consistently been recorded over the past three monitoring seasons (2014-2016). The samples exceeding standards were located along two Kedron Brook sites, KeB045 & KeB046, as well as one main stem site, OtR070. Each of these sites was located either above or below a WWTF which could likely have contributed to the high concentrations recorded. Roaring Brook, Falls Brook and the North Branch exhibited the lowest *E. coli* concentrations within the Ottauquechee tributaries, never reaching above 100 mpn/100ml). The upper reaches of the Main Stem Ottauquechee also exhibited relatively low E. coli concentrations. Between sites OtR185 and OtR254, levels did not exceed 75 mpn/100ml.

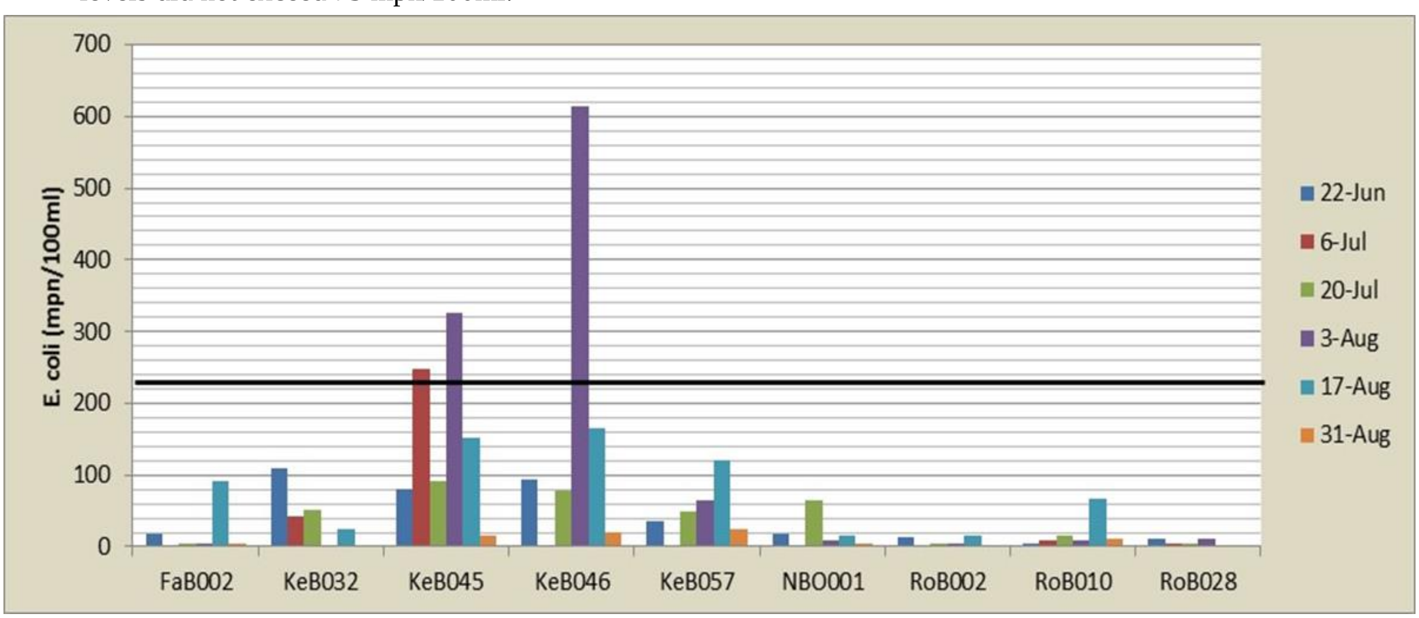


Figure 8h: 2017 E. coli Data (Ottauquechee Tributaries)

SECTION 8.5: 2017 TOTAL NITROGEN DATA

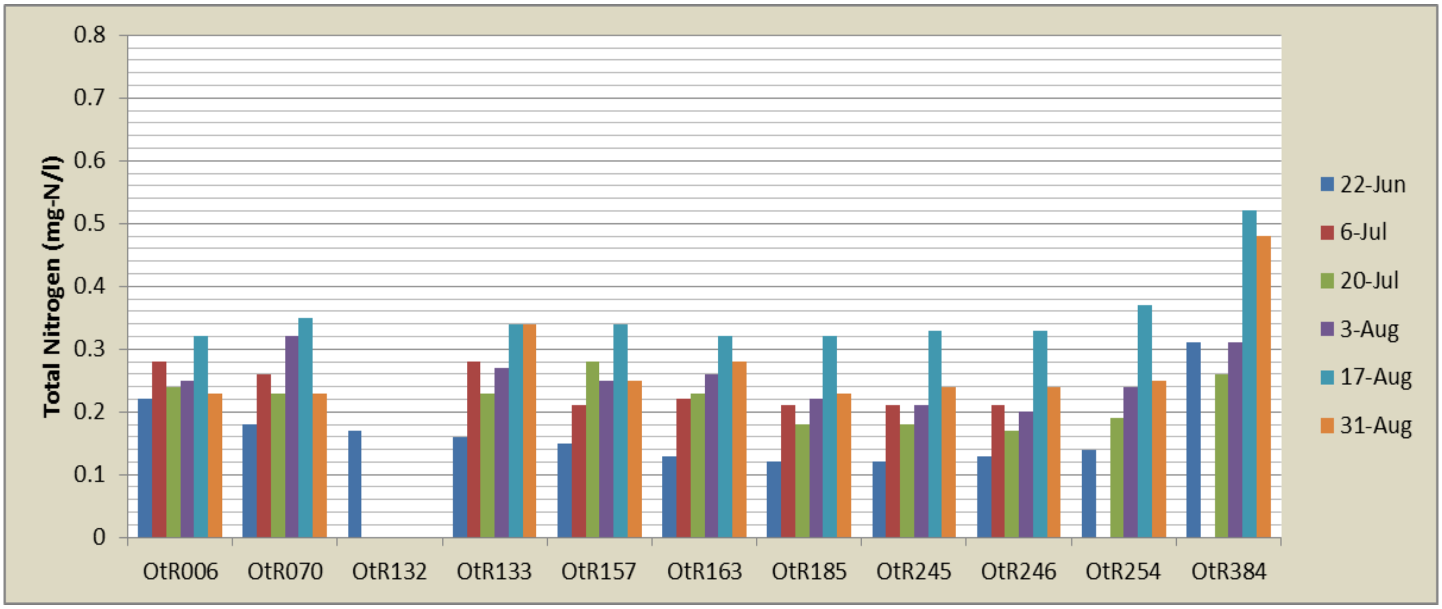


Figure 8i: 2017 Total Nitrogen Data (Main Stream Ottauquechee)

All 2017 Total Nitrogen data points did not exceed current state standards (5 mg/L). Consistent with past sampling years, the Total Nitrogen concentrations within the Ottauquechee tributaries appear to be slightly higher relative to those within the Main Stem Ottauquechee. Total Nitrogen levels also remained fairly constant throughout the entire reach of the Main Stream Ottauquechee.

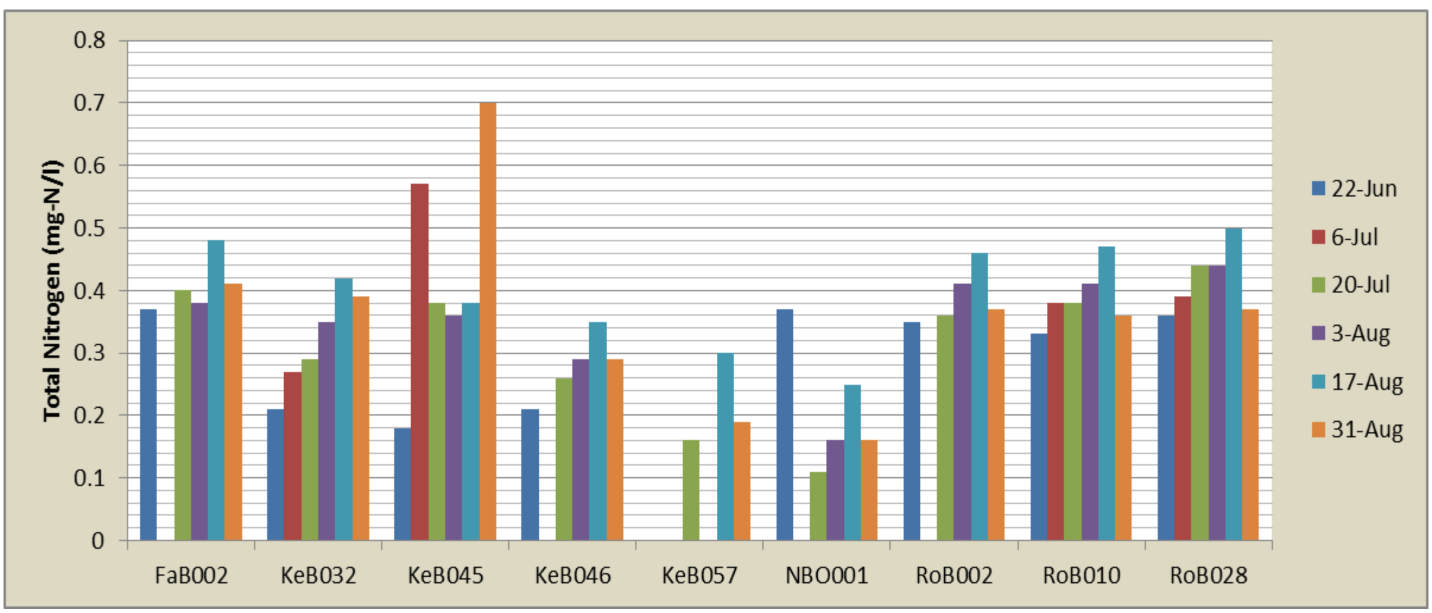


Figure 8j: 2017 Total Nitrogen Data (Ottauquechee Tributaries)

SECTION 8.6: Additional Kedron Brook Sampling Results

Four additional sites were tested in September and October 2017 due to additional funding becoming available. Endyne, Inc. provided analytical services for these samples. The sites will also be added to the list of sites being tested during the 2018 monitoring season.

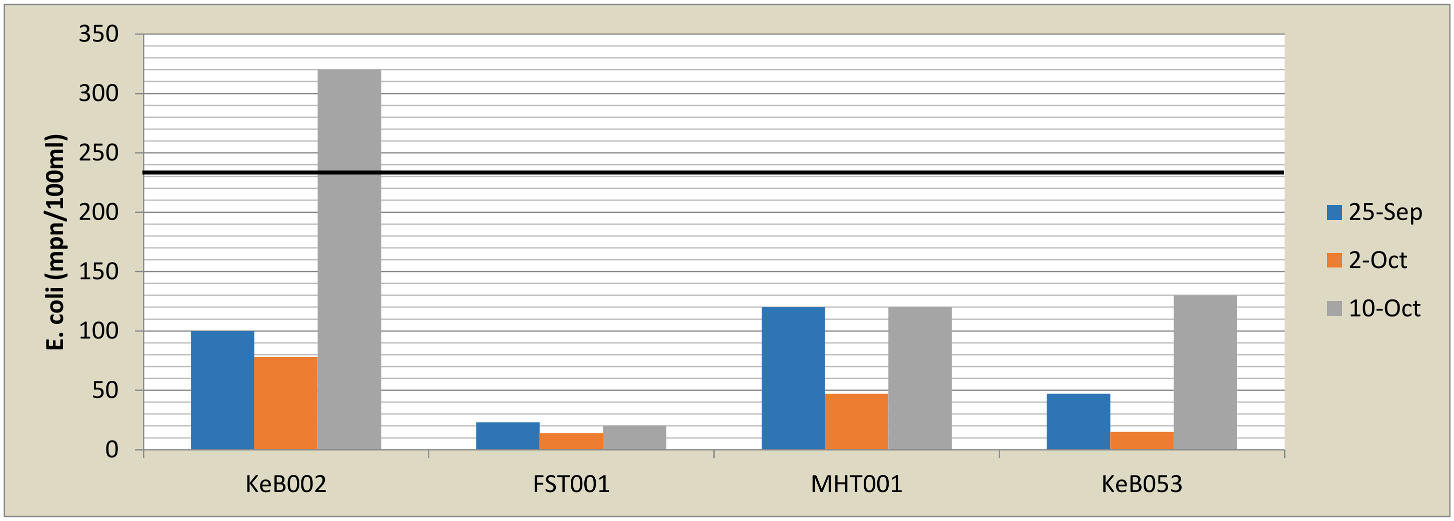


Figure 8k: 2017 E. coli Data (Kedron Brook & Tributaries)

A total of four additional sites were sampled for *E. coli* and phosphorus in September and October 2017. Two samples were taken directly along Kedron Brook (KeB002 and KeB053) and two were taken along its tributaries (FST001 and MHT001). *E. coli* concentrations never reached above the state standard (235 mpn/100ml) apart from October 10 where the site KeB002 reached a level of 320 mpn/100ml. Phosphorus concentrations also never exceeded state standards (12 ug/L) and only met the standard once on September 25 at site KeB002. Also to note, the shaded bars in the graph below represent a concentration of <5 ug/L. The method used to analyze phosphorus concentrations in each sample cannot pinpoint an accurate value below 5 ug/L and therefore a reading of <5 ug/L is given.

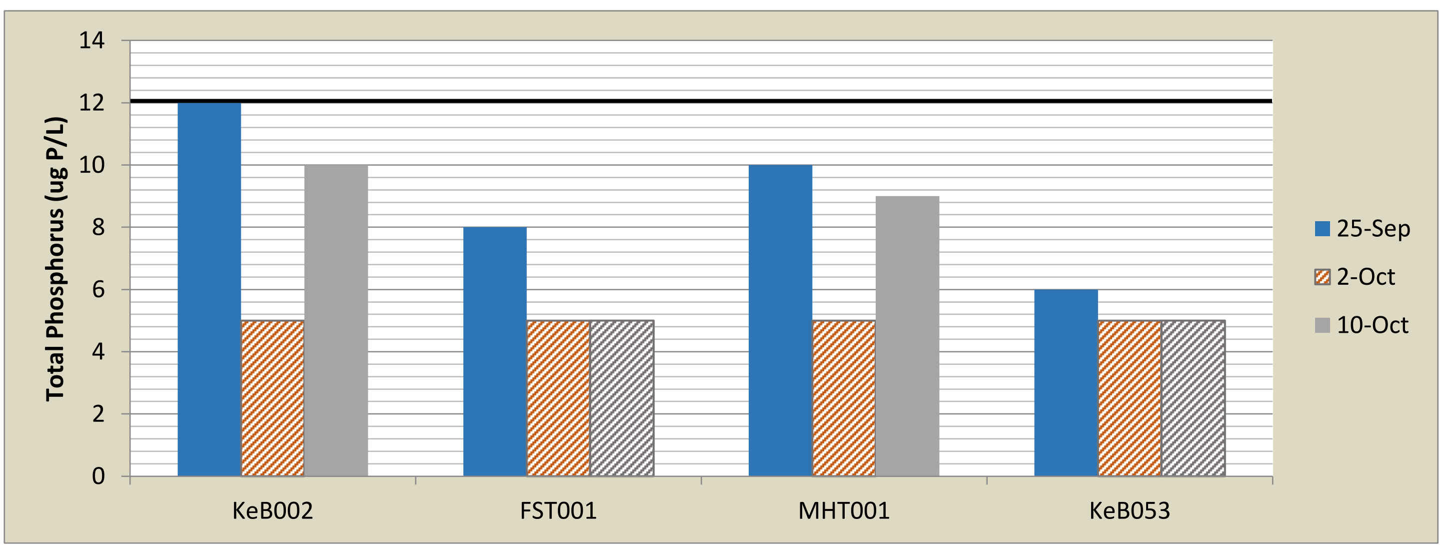


Figure 8l: 2017 Total Phosphorus Data (Kedron Brook & Tributaries)

SECTION 9: DATA COMPLETENESS

2010 – Number of sampling events & Data completeness								
I = Intended, A = Actual								
	Chloride		Phosphorus		E. coli.		Turbidity	
	I	A	I	A	I	A	I	A
FaB002	7	7	7	7	7	7	7	7
KeB045	7	6	7	6	7	6	7	6
KtB015	7	7	7	7	7	7	7	7
NBO001	7	6	7	6	7	6	7	6
OtR006	7	7	7	7	7	7	7	7
OtR133	7	7	7	7	7	7	7	7
OtR185	7	7	7	7	7	7	7	7
OtR254	7	6	7	6	7	6	7	6
OtR384	7	7	7	7	7	7	7	7
RoB010	7	7	7	7	7	7	7	7
Total	70	67	70	67	70	67	70	67
% complete	96%		96%		96%		96%	
Field Duplicates	7	7	7	7	7	7	7	7
Blanks	7	5	7	5	7	5	7	5

2011 - Number of sampling events & Data completeness
I = Intended, A = Actual

	Chloride		E. coli.		Turbidity		Nitrogen	
	I	A	I	A	I	A	I	A
OtR006	7	***4**	7	***4**	7	***4**	7	***4**
OtR070	7	***4**	7	***4**	7	***4**	7	***4**
OtR132	7	***4**	7	***4**	7	***4**	7	***4**
OtR133	7	***4**	7	***4**	7	***4**	7	***4**
OtR157	7	***4**	7	***4**	7	***4**	7	***4**
OtR163	7	***4**	7	***4**	7	***4**	7	***4**
OtR185	7	***4**	7	***4**	7	***4**	7	***4**
OtR245	7	***4**	7	***4**	7	***4**	7	***4**
OtR254	7	***4**	7	***4**	7	***4**	7	***4**
OtR384	7	***4**	7	***4**	7	***4**	7	***4**
FaB002	7	***4**	7	***4**	7	***4**	7	***4**
KeB045	7	***4**	7	***4**	7	***4**	7	***4**
KtB015	7	***4**	7	***4**	7	***4**	7	***4**
NBO001	7	***4**	7	***4**	7	***4**	7	***4**
RoB010	7	***4**	7	***4**	7	***4**	7	***4**
Total	105	60	105	60	105	60	105	60
% complete	57%		57%		57%		57%	
Field Duplicates	7	ND	7	ND	7	ND	7	ND
Blanks	7	ND	7	ND	7	ND	7	ND

**Bolded values indicate that a particular site & parameter did not meet the standards of statistical validity listed in the QAPP (at least 5 data points needed for statistical validity)*

2013 - Number of sampling events & Data completeness										
I = Intended, A = Actual										
	Chloride		Phosphorus		E. coli.		Turbidity		Nitrogen	
	I	A	I	A	I	A	I	A	I	A
OtR006	7	7	7	7	7	7	7	7	7	7
OtR070	7	7	7	7	7	7	7	7	7	7
OtR132	7	6	7	6	7	6	7	6	7	6
OtR133	7	7	7	7	7	7	7	7	7	7
OtR157	7	7	7	7	7	7	7	7	7	7
OtR163	7	6	7	7	7	7	7	7	7	7
OtR185	7	6	7	6	7	6	7	6	7	6
OtR245	7	7	7	7	7	7	7	6	7	6
OtR254	7	7	7	7	7	7	7	7	7	7
OtR384	7	7	7	7	7	7	7	7	7	7
FaB002	7	6	7	6	7	6	7	6	7	6
KeB045	7	7	7	7	7	7	7	7	7	7
KtB015	7	6	7	7	7	7	7	7	7	7
NBO001	7	7	7	7	7	7	7	7	7	7
RoB010	7	7	7	7	7	7	7	7	7	7
Total	105	100	105	102	105	102	105	102	105	101
% complete	95%		97%		97%		97%		96%	
Field Duplicates	7	ND	7	ND	7	ND	7	ND	7	ND
Blanks	7	ND	7	ND	7	ND	7	ND	7	ND

2014 - Number of sampling events & Data completeness										
I = Intended, A = Actual										
	Chloride		Phosphorus		E. coli.		Turbidity		Nitrogen	
	I	A	I	A	I	A	I	A	I	A
OtR006	7	5	7	5	7	***4**	7	5	7	5
OtR070	7	5	7	5	7	***4**	7	5	7	5
OtR132	7	6	7	6	7	6	7	6	7	6
OtR133	7	6	7	6	7	6	7	6	7	6
OtR157	7	6	7	5	7	6	7	6	7	6
OtR163	7	6	7	6	7	6	7	6	7	6
OtR185	7	6	7	6	7	6	7	6	7	6
OtR245	7	6	7	6	7	6	7	6	7	6
OtR254	7	6	7	6	7	6	7	6	7	6
OtR384	7	6	7	6	7	6	7	6	7	6
FaB002	7	6	7	6	7	6	7	6	7	6
KeB045	7	5	7	5	7	***4**	7	5	7	5
KtB015	7	6	7	6	7	6	7	6	7	6
NBO001	7	6	7	6	7	6	7	6	7	6
RoB010	7	6	7	6	7	6	7	6	7	6
Total	105	87	105	86	105	84	105	87	105	87
% complete	83%		82%		80%		83%		83%	
Field Duplicates	7	5	7	5	7	5	7	5	7	5
Blanks	7	5	7	5	7	4	7	5	7	5
**Bolded values indicate that a particular site & parameter did not meet the standards of statistical validity listed in the QAPP (at least 5 data points needed for statistical validity)*										

2015 - Number of sampling events & Data completeness										
I = Intended, A = Actual										
	Chloride		Phosphorus		E. coli.		Turbidity		Nitrogen	
	I	A	I	A	I	A	I	A	I	A
OtR006	7	6	7	6	7	***4**	7	6	7	6
OtR070	7	6	7	6	7	***4**	7	6	7	6
OtR132	7	6	7	6	7	***4**	7	6	7	6
OtR133	7	6	7	6	7	***4**	7	6	7	6
OtR157	7	6	7	6	7	***4**	7	6	7	6
OtR163	7	6	7	6	7	***4**	7	6	7	6
OtR185	7	6	7	6	7	***4**	7	6	7	6
OtR245	7	6	7	6	7	***4**	7	6	7	6
OtR254	7	6	7	6	7	***4**	7	6	7	6
OtR384	7	6	7	6	7	***4**	7	6	7	6
FaB002	7	6	7	6	7	***4**	7	6	7	6
KeB045	7	6	7	6	7	***4**	7	6	7	6
KtB015	7	6	7	6	7	***4**	7	6	7	6
NBO001	7	6	7	6	7	***4**	7	6	7	6
RoB010	7	5	7	6	7	***4**	7	6	7	6
Total	105	89	105	90	105	60	105	90	105	90
% complete	84.8%		85.7%		57%		85.7%		85.7%	
Field Duplicates	7	5	7	5	7	3	7	5	7	5
Blanks	7	4	7	4	7	3	7	4	7	4
**Bolded values indicate that a particular site & parameter did not meet the standards of statistical validity listed in the QAPP (at least 5 data points needed for statistical validity)*										

2016 - Number of sampling events & Data completeness										
I = Intended, A = Actual										
	Chloride		Phosphorus		E. coli.		Turbidity		Nitrogen	
	I	A	I	A	I	A	I	A	I	A
OtR006	6	5	6	6	6	6	6	6	6	6
OtR070	6	6	6	6	6	6	6	6	6	6
OtR132	6	5	6	5	6	***4**	6	5	6	5
OtR133	6	5	6	5	6	5	6	5	6	5
OtR157	6	6	6	6	6	6	6	6	6	6
OtR163	6	6	6	6	6	6	6	6	6	6
OtR185	6	5	6	5	6	5	6	5	6	5
OtR245	6	5	6	5	6	5	6	5	6	5
OtR246	4	***3**	4	***3**	4	***3**	4	***3**	4	***3**
OtR254	6	6	6	6	6	6	6	6	6	6
OtR384	6	6	6	6	6	6	6	6	6	6
FaB002	6	6	6	6	6	6	6	6	6	6
KeB032	6	5	6	5	6	5	6	5	6	5
KeB045	6	5	6	5	6	5	6	5	6	5
KeB046	6	5	6	5	6	5	6	5	6	5
KeB057	6	5	6	5	6	***4**	6	5	6	5
NBO001	6	6	6	6	6	6	6	6	6	6
RoB002	6	6	6	6	6	6	6	6	6	6
RoB010	6	6	6	6	6	5	6	6	6	6
RoB028	6	6	6	6	6	6	6	6	6	6
Total	118	108	118	109	118	106	118	109	118	109
% complete	91.5%		92.3%		89.8%		92.3%		92.3%	
Field Duplicates	12	12	12	12	12	12	12	12	12	12
Blanks	12	12	12	12	12	12	12	12	12	12
**Bolded values indicate that a particular site & parameter did not meet the standards of statistical validity listed in the QAPP (at least 5 data points needed for statistical validity)*										

2017 - Number of sampling events & Data completeness										
I = Intended, A = Actual										
	Chloride		Phosphorus		E. coli.		Turbidity		Nitrogen	
	I	A	I	A	I	A	I	A	I	A
OtR006	6	6	6	6	6	6	6	6	6	6
OtR070	6	6	6	6	6	6	6	6	6	6
OtR132	6	***1**	6	***1**	6	***1**	6	***1**	6	***1**
OtR133	6	6	6	6	6	6	6	6	6	6
OtR157	6	6	6	6	6	6	6	6	6	6
OtR163	6	6	6	6	6	6	6	6	6	6
OtR185	6	6	6	6	6	6	6	6	6	6
OtR245	6	6	6	6	6	6	6	6	6	6
OtR246	6	6	6	6	6	5	6	6	6	6
OtR254	6	5	6	5	6	5	6	5	6	5
OtR384	6	5	6	5	6	5	6	5	6	5
FaB002	6	5	6	5	6	5	6	5	6	5
KeB032	6	6	6	6	6	5	6	6	6	6
KeB045	6	6	6	6	6	6	6	6	6	6
KeB046	6	5	6	***4**	6	5	6	5	6	5
KeB057	6	5	6	5	6	5	6	5	6	***4**
NBO001	6	5	6	***4**	6	5	6	5	6	5
RoB002	6	5	6	5	6	5	6	5	6	5
RoB010	6	6	6	5	6	6	6	6	6	6
RoB028	6	5	6	5	6	6	6	6	6	6
Total	120	108	120	105	120	106	120	108	120	107
% complete	90.0%		87.5%		88.3%		90.0%		89.2%	
Field Duplicates	11	11	11	11	11	11	11	11	11	11
Blanks	12	11	12	11	12	12	12	12	12	12

**Bolded values indicate that a particular site & parameter did not meet the standards of statistical validity listed in the QAPP (at least 5 data points needed for statistical validity)*

SECTION 10: QUALITY CONTROL DATA

**Data from the 2013 monitoring season was QC'd and reviewed prior to storage; however the data is no longer available and is not included in this report. QC/QC data from the 2011 monitoring season is not available and thus is not included in this report. However, data from 2011 did not meet the standards of statistical validity listed in the QAPP due to Tropical Storm Irene, thus that data is included in the appendices of this report simply as a reference.*

SECTION 10.1: 2010 QUALITY CONTROL DATA

2010 Field Duplicate Data									
FD=Duplicate Value, A=Actual Value									
Date	Site ID	Cl-		TP		E. coli		TURB	
		FD	A	FD	A	FD	A	FD	A
7/01/10	KeB045	8.58	8.81	31.8	14.7	214	218	0.82	0.2
7/15/10	FaB002	22.4	22.7	17	16.4	276	291	1.26	1.63
7/29/10	OtR185	12.8	12.8	14.6	19	126	326	3.53	2.16
8/12/10	RoB010	50.8	51.8	6.55	6.06	37	36	2.01	0.65
8/26/10	OtR006	18.4	18.1	18.3	18.5	58	49	1.42	1.17
9/09/10	OtR133	22.3	22.1	23.2	22.1	18	18	2.45	2.54
9/23/10	KtB015	13.8	13.8	12.7	12.5	3	1	1.06	1.11

2010 Relative Percent Difference of Field Duplicates to Actual Sample Values					
		Parameter			
Date	Site ID	Cl-	TP	E. coli	TURB
7/01/10	KeB045	2.6%	*73.5%	1.9%	*121.6%
7/15/10	FaB002	1.3%	3.6%	5.3%	25.6%
7/29/10	OtR185	0%	26.2%	*88.5%	*48.2%
8/12/10	RoB010	1.9%	7.8%	2.7%	*102.3%
8/26/10	OtR006	1.6%	1.1%	16.8%	*19.3%
9/09/10	OtR133	0.9%	4.9%	0%	3.6%
9/23/10	KtB015	0%	1.6%	100%	4.6%
Average RPD		1.21%	16.95%	30.74%	46.44%
*Bolded values indicate that those values exceeded the precision standards listed in the QAPP					

SECTION 10.2: 2014 QUALITY CONTROL DATA

2014 Field Duplicate Data												
FD=Duplicate Value, A=Actual Value												
Date	**Site ID**	**Cl-**		**E. coli**		**TN**		**TP**		**TURB**		
		FD	**A**	**FD**	**A**	**FD**	**A**	**FD**	**A**	**FD**	**A**	
7/01/14	FaB002	13.2	13.9	3.06	3.06	0.49	0.49	6.91	7.89	1.18	1.1	
7/17/14	KeB045	12.4	12.5	209.82	157.56	0.51	0.52	12.6	10.6	0.58	0.75	
7/31/14	OtR006	11.2	11	225	345	0.27	0.27	27.4	26.7	18.2	18.9	
8/28/14	OtR384	29.13	29.76	248.09	248.09	0.42	0.45	22.6	21.5	2.81	2.54	
9/11/14	OtR132	21.6	21.6	21.57	34.51	0.28	0.3	13.2	13.7	0.72	0.79	

2014 RPD of Field Duplicates to Actual Sample Values						
		Parameter				
Date	**Site ID**	**Cl-**	**E. coli**	**TN**	**TP**	**TURB**
7/01/14	FaB002	***5.16%**	0%	0%	13.24%	7.01%
7/17/14	KeB045	0.8%	28.45%	1.94%	***17.24%**	***25.56%**
7/31/14	OtR006	1.8%	42.1%	0%	2.58%	3.77%
8/28/14	OtR384	2.14%	0%	6.89%	4.98%	10.09%
9/11/14	OtR132	0%	46%	6.89%	3.71%	9.27%
Average RPD		1.98%	23.31%	3.14%	8.35%	11.14%

**Bolded values indicate that those values exceeded the precision standards listed in the QAPP*

2014 Field Blank Data											
FB=Field Blank Value, A=Actual Value											
Date	**Site ID**	**Cl-**		**E. coli**		**TN**		**TP**		**TURB**	
		FB	**A**	**FB**	**A**	**FB**	**A**	**FB**	**A**	**FB**	**A**
6/19/14	OtR384	<2	32.7	<1	178.21	<0.1	0.36	5.29	22.2	<0.2	1.49
7/17/14	FaB002	<2	17.8	<1	39.29	<0.1	0.5	<5	7.01	<0.2	1.34
7/31/14	OtR157	<2	13.2	<1	68	<0.1	0.27	<5	18.8	<0.2	3.66
8/28/14	OtR070	<2	14.6	NT	NT	<0.1	0.31	<5	14.3	<0.2	4.91
9/11/14	OtR133	<2	20	<1	23.07	<0.1	0.26	<5	10.2	<0.2	0.69

SECTION 10.3: 2015 QUALITY CONTROL DATA

2015 Field Duplicate Data

FD=Duplicate Value, A=Actual Value

Date	Site ID	Cl-		E. coli		TN		TP		TURB	
		FD	A	FD	A	FD	A	FD	A	FD	A
6/18/15	N/A	NT	-	NT	-	NT	-	NT	-	NT	-
7/02/15	OtR132	10.22	10.12	NT	-	.19	.19	19.9	15.9	3.52	3.4
7/16/15	OtR157	20.14	20.43	49.54	65.04	.27	.28	7.87	8.48	.36	.4
7/30/15	OtR185	19.11	19.06	39.66	48.74	.32	.31	7.36	6.35	.67	.56
8/13/15	OtR254	24.9	25.4	45	37.86	.35	.35	11.3	8.6	.77	.54
8/27/14	FaB002	14.5	14.31	NT	-	.47	.47	5.71	13.7	.35	.35

2015 RPD of Field Duplicates to Actual Sample Values

		Parameter				
Date	Site ID	Cl-	E. coli	TN	TP	TURB
7/02/15	OtR132	.98%	N/A	0%	22.34%	3.47%
7/16/15	OtR157	1.43%	27.07%	3.64%	7.47%	10.52%
7/30/15	OtR185	.26%	20.54%	3.22%	14.74%	***18.03%**
8/13/15	OtR254	1.98%	17.23%	0%	27.13%	***35.38%**
8/27/15	FaB002	1.32%	N/A	0%	***82.37%**	0%
Average RPD		1.19%	21.61%	1.37%	30.81%	13.48%

**Bolded values indicate that those values exceeded the precision standards for field duplicates listed in the QAPP*

2015 Field Blank Data

FB=Field Blank Value, A=Actual Value

Date	Site ID	Cl-		E. coli		TN		TP		TURB	
		FB	A	FB	A	FB	A	FB	A	FB	A
7/02/15	OtR133	<2	9.93	NT	NT	<0.1	.18	<5	17.4	<0.2	2.56
7/16/15	OtR163	21.19	20.82	69.68	71.73	.25	.25	7.68	8.12	.35	.77
7/30/15	OtR245	<2	20	<1	45	<0.1	.31	<5	6.03	.56	.3
8/13/15	OtR384	<2	42.92	<1	135.37	<0.1	.39	<5	23.2	<0.2	2.14

SECTION 10.4: 2016 QUALITY CONTROL DATA

2016 Field Duplicate vs. Actual Value											
FD=Duplicate Value, A=Actual Value											
Date	**Site ID**	**Cl-**		**TP**		**E. coli**		**TURB**		**TN**	
		FD	**A**	**FD**	**A**	**FD**	**A**	**FD**	**A**	**FD**	**A**
6/23/16	OtR006	22	21.7	17.4	17.4	290.93	248.09	4.12	4.47	.35	.34
6/23/16	OtR070	21	21.7	13.8	13.9	37.34	44.12	1.82	1.63	.36	.36
7/07/16	OtR132	23.9	23.7	15.4	17.7	102.21	95.9	1.35	1.53	.31	.3
7/07/16	OtR133	23.8	23.8	17.9	17.1	79.36	65.68	1.87	2.64	.31	.35
7/21/16	OtR157	26.2	26.4	17.4	21.7	108.6	151	.48	1.05	.25	.26
7/21/16	OtR163	25.4	25	5.02	6.44	53.81	57.31	.65	.6	.19	.2
8/04/16	OtR185	22.6	22.7	6.46	5.65	65.65	63.82	.52	.82	.24	.24
8/04/16	OtR245	22.2	22	<5	7.43	68.28	42.54	1.53	.5	.27	.26
8/18/16	OtR254	31.4	31	6.83	6.27	34.98	33.1	.38	.36	.27	.28
8/18/16	OtR384	43.05	43	20.4	16.2	56.33	63.28	1.47	1.45	.24	.25
9/01/16	FaB002	13.8	13.6	7.78	<5	7.31	3.06	.89	.35	.45	.44
9/01/16	KeB045	23.6	22.9	71.8	73.3	193.49	186	.89	.39	.56	.56

2016 Relative Percent Difference (RPD) of Field Duplicates to Actual Values						
		Parameter				
Date	**Site**	**Cl-**	**TP**	**E. coli**	**TURB**	**TN**
6/23/16	OtR006	1.37%	0.00%	15.90%	8.15%	2.90%
6/23/16	OtR070	3.28%	0.72%	16.65%	11.01%	0.00%
7/07/16	OtR132	0.84%	13.90%	6.37%	12.50%	3.28%
7/07/16	OtR133	0.00%	4.57%	18.86%	***34.15%**	***12.12%**
7/21/16	OtR157	0.76%	21.99%	32.67%	***74.51%**	3.92%
7/21/16	OtR163	1.59%	24.78%	6.30%	8.00%	5.13%
8/04/16	OtR185	0.44%	13.38%	2.83%	***44.78%**	0.00%
8/04/16	OtR245	0.90%	NV	46.45%	***101.48%**	3.77%
8/18/16	OtR254	1.28%	8.55%	5.52%	5.41%	3.64%
8/18/16	OtR384	0.12%	22.95%	11.62%	1.37%	4.08%
9/01/16	FaB002	1.46%	NV	***81.97%**	***87.10%**	2.25%
9/01/16	KeB045	3.01%	2.07%	3.95%	***78.13%**	0.00%
Average RPD		1.25%	11.29%	20.76%	38.88%	3.42%
**Bolded values indicate that those values exceed the precision standards listed in the QAPP; NV = No Value (Either the actual value or the field duplicate value read as <5, thus an RPD could not be calculated).*						

SECTION 10.5: 2017 QUALITY CONTROL DATA

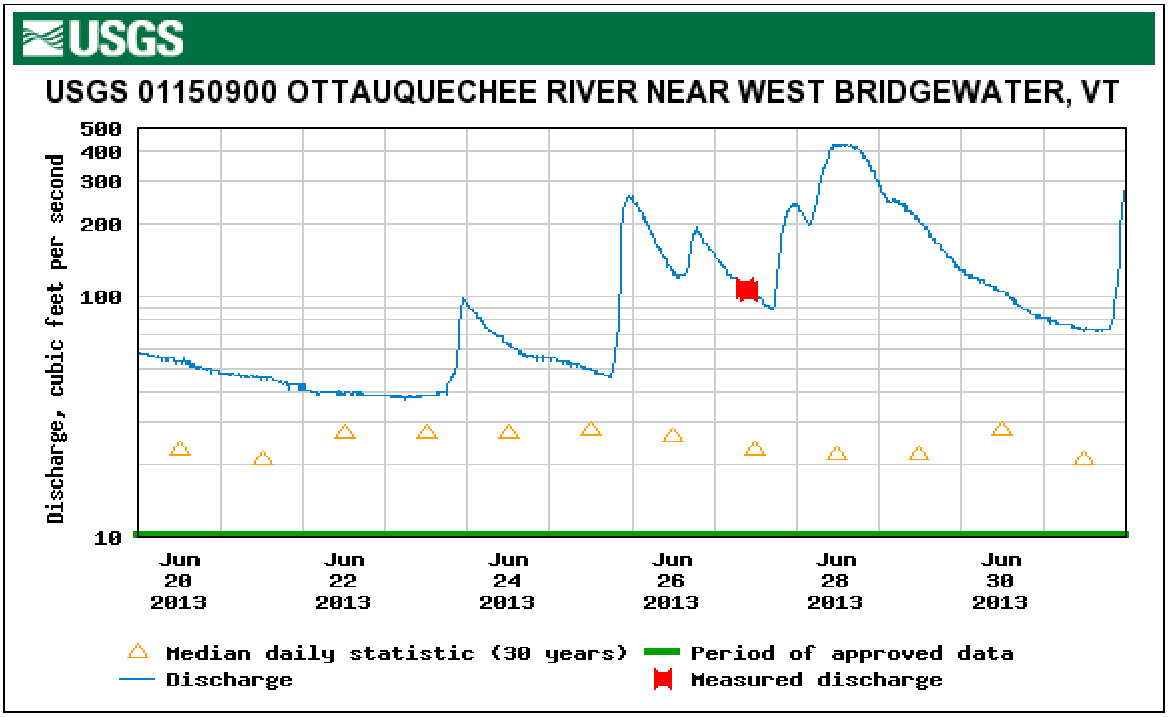
2017 Field Duplicate vs. Actual Value											
FD=Duplicate Value, A=Actual Value											
Date	**Site ID**	**Cl-**		**TP**		**E. coli**		**TURB**		**TN**	
		FD	**A**	**FD**	**A**	**FD**	**A**	**FD**	**A**	**FD**	**A**
6/22/17	OtR006	14.2	14.6	18.4	19.3	98.8	101	5.17	4.89	0.20	0.22
6/22/17	OtR070	18.2	18.2	10.5	10.2	60.2	62.4	0.91	1.08	0.16	0.18
7/06/17	OtR133	13.7	13.9	11.5	12.5	64.4	57.1	1.97	3.14	0.27	0.28
7/20/17	OtR157	17.6	17.8	8.18	9.88	43.2	41.4	0.64	1.08	0.26	0.28
7/20/17	OtR163	19.1	18.5	9.56	9.93	75.4	62.7	2.42	0.86	0.24	0.23
8/03/17	OtR245	19.4	19.3	<5	<5	63.1	50.4	0.63	0.79	0.22	0.20
8/03/17	OtR246	19.4	19.9	<5	<5	45.5	49.6	10.0	0.63	0.20	0.21
8/17/17	RoB002	59.0	62.0	6.20	6.85	14.6	16.0	0.40	0.37	0.46	0.46
8/17/17	RoB010	59.5	65.5	6.79	6.36	7.31	67.0	0.63	0.62	0.49	0.47
8/31/17	OtR006	23.1	23.2	14.2	14.1	23.8	25.6	3.43	2.91	0.24	14.1
8/31/17	OtR070	27.3	27.7	13.3	12.3	31.5	35.9	1.83	1.97	0.22	12.3

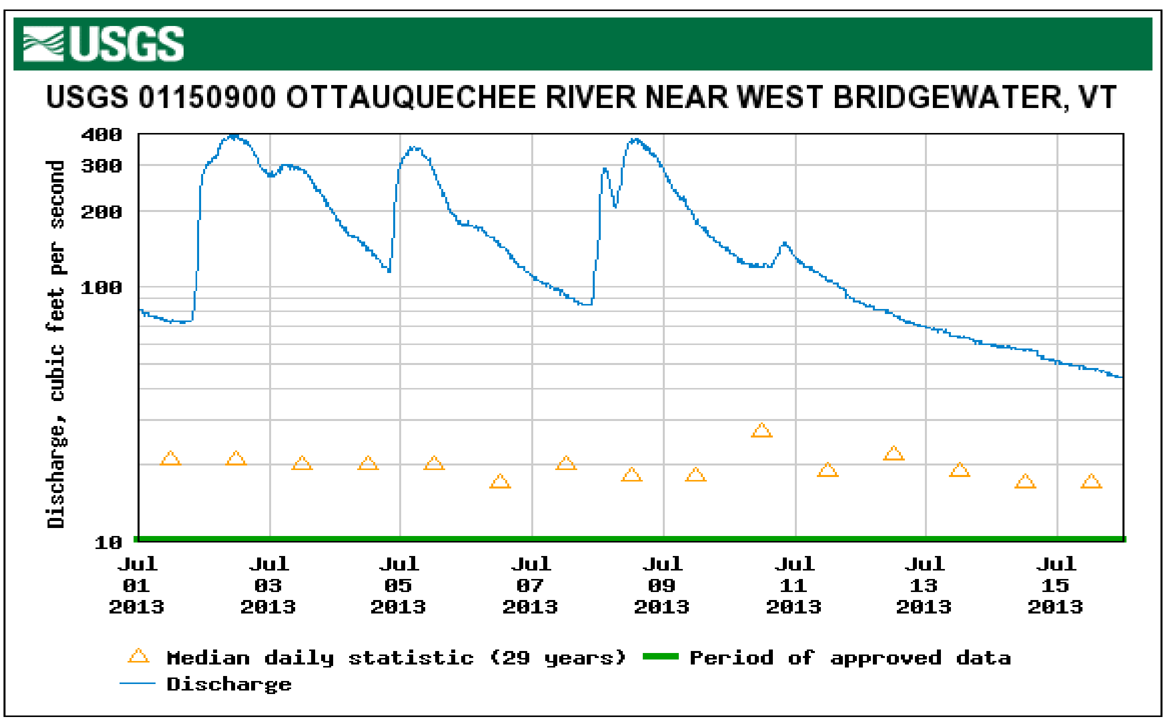
2017 Relative Percent Difference (RPD) of Field Duplicates to Actual Values						
		Parameter				
Date	**Site**	**Cl-**	**TP**	**E. coli**	**TURB**	**TN**
6/22/17	OtR006	1.39%	2.40%	1.31%	2.80%	4.76%
6/22/17	OtR070	0.00%	1.40%	1.87%	8.50%	5.88%
7/06/17	OtR133	0.72%	4.20%	6.00%	***22.9%**	1.82%
7/20/17	OtR157	0.56%	9.40%	2.20%	***25.6%**	3.70%
7/20/17	OtR163	1.60%	1.90%	9.23%	***47.6%**	2.13%
8/03/17	OtR245	0.26%	NV	11.2%	11.3%	4.76%
8/03/17	OtR246	1.27%	NV	4.31%	***88.1%**	2.44%
8/17/17	RoB002	2.48%	5.00%	4.31%	3.90%	0.00%
8/17/17	RoB010	4.80%	3.30%	***80.3%**	0.80%	2.08%
8/31/17	OtR006	0.22%	0.40%	3.67%	8.20%	***96.65%**
8/31/17	OtR070	0.73%	3.90%	6.64%	3.70%	***96.49%**
Average RPD		1.28%	3.54%	11.92%	20.31%	20.07%
**Bolded values indicate that those values exceed the precision standards listed in the QAPP; NV = No Value (Either the actual value or the field duplicate value read as <5, thus an RPD could not be calculated).*						

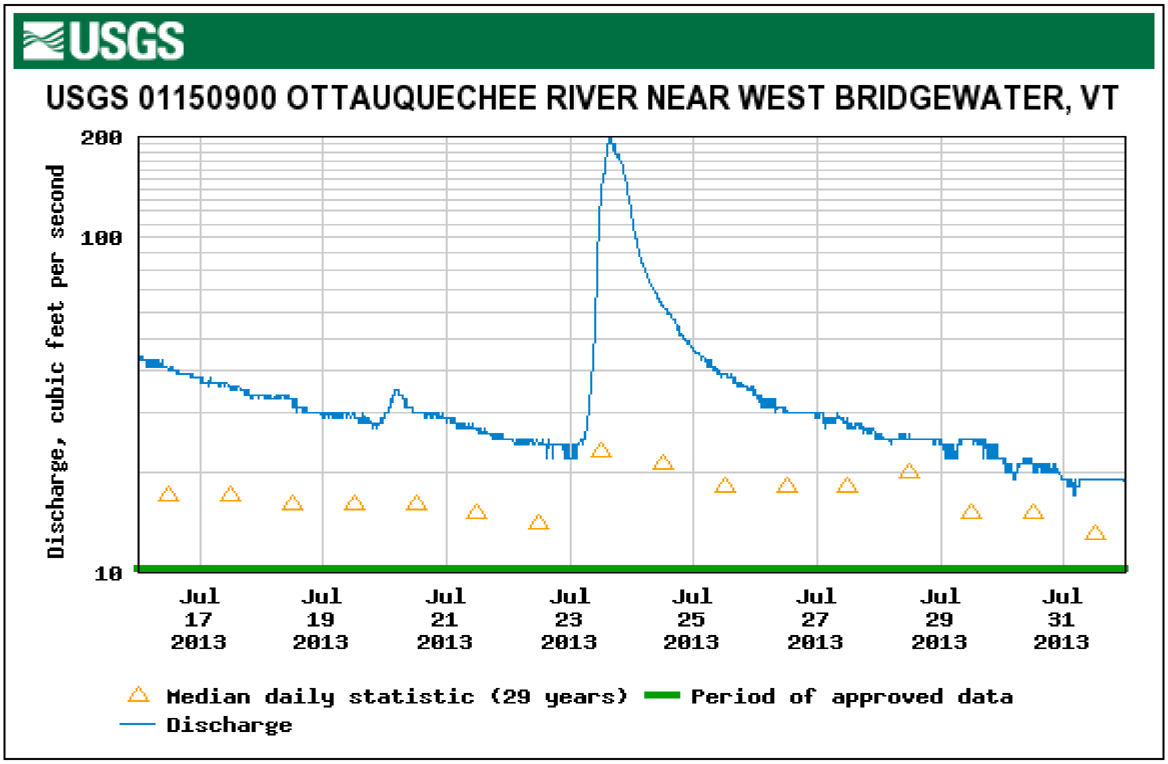
SECTION 11: USGS FLOW GAGE DATA

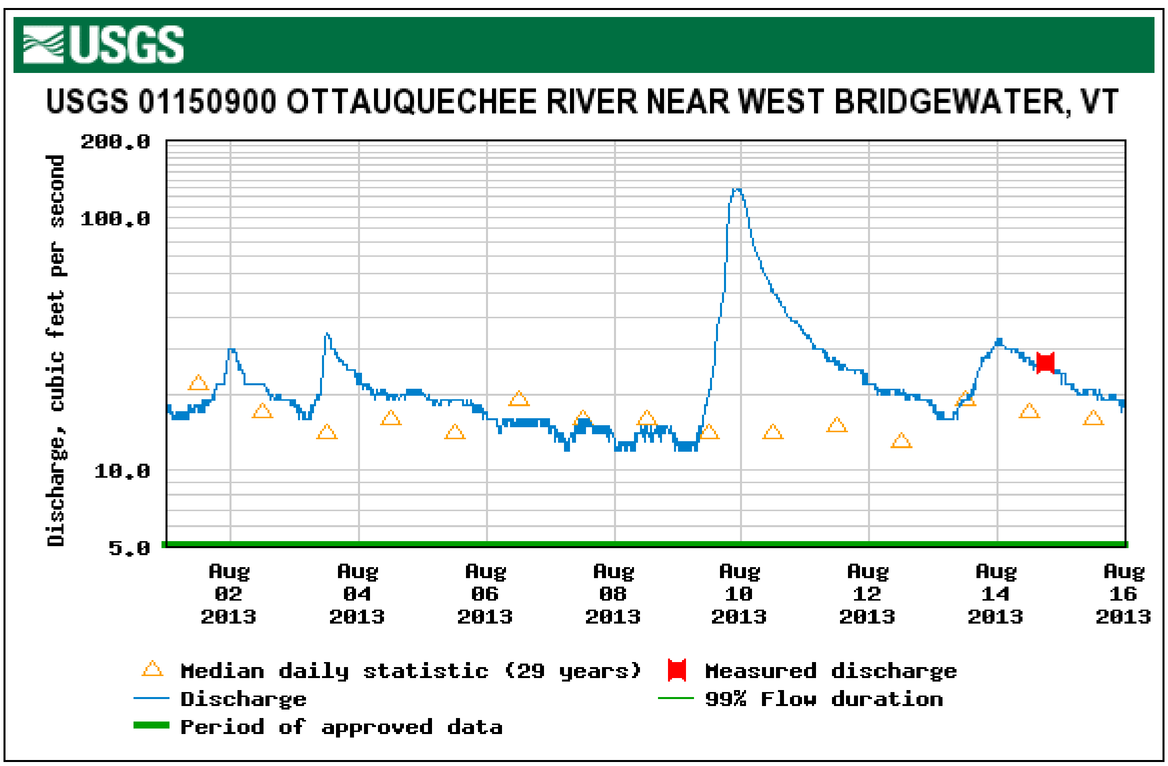
**2010 USGS flow gage data is not available. Flow gage data from 2011 is not included in this report as the data failed to achieve standards of statistical validity.*

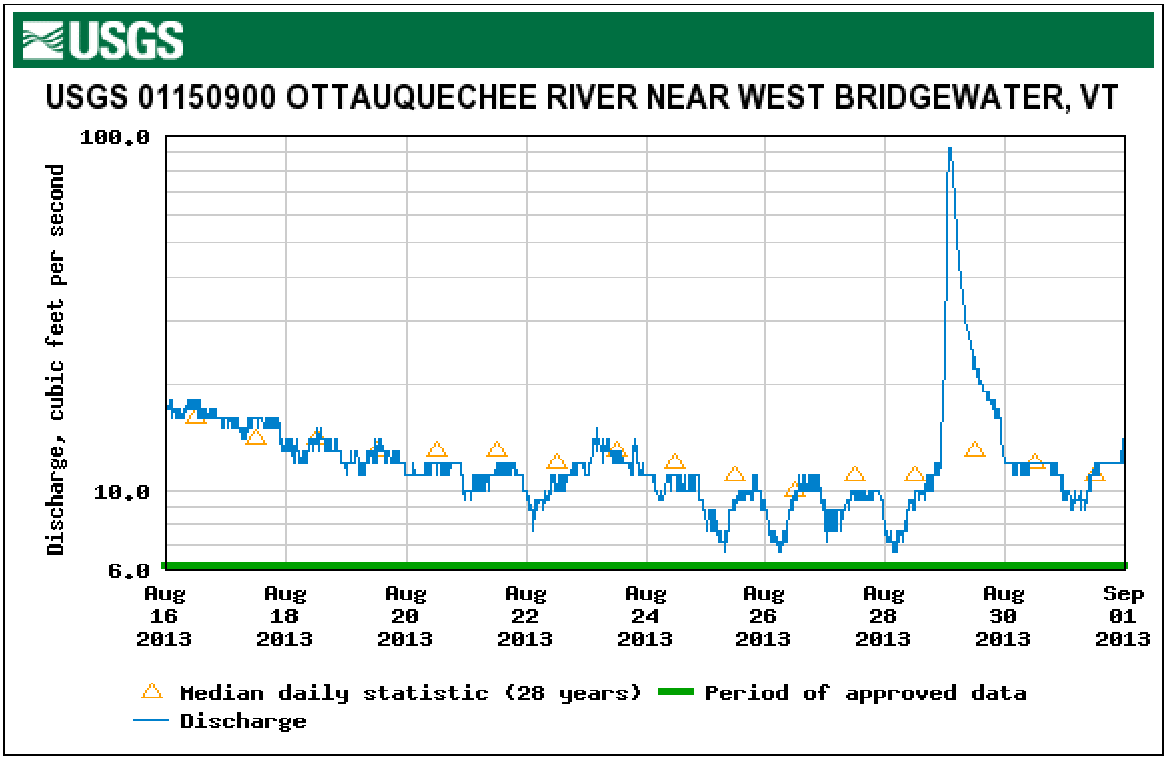
SECTION 11.1: 2013 USGS FLOW GAGE DATA – WEST BRIDGEWATER GAUGING STATION

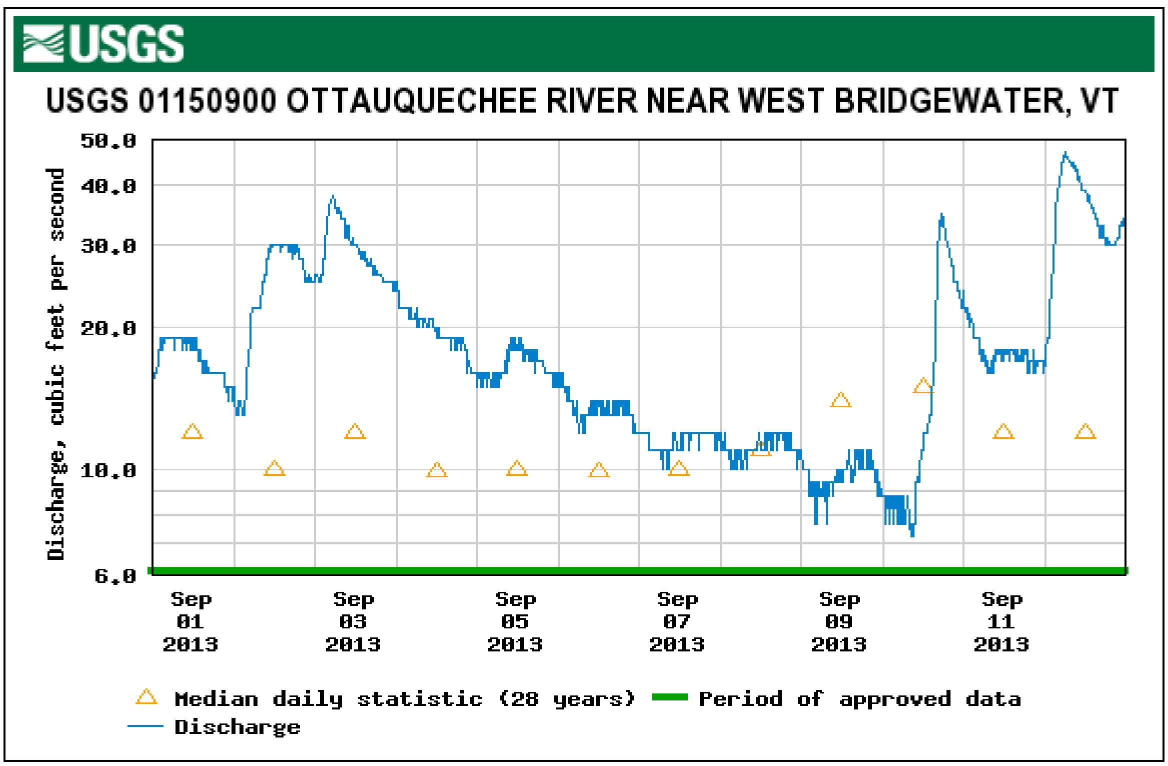




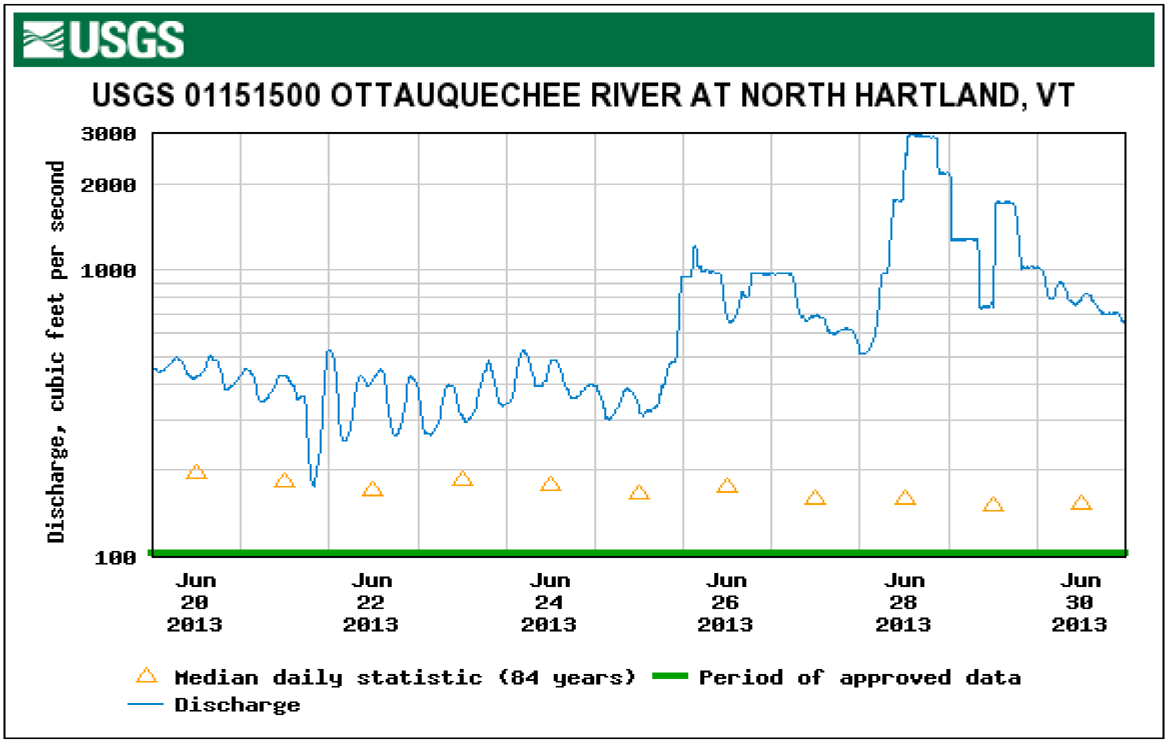

USGS
USGS 01150900 OTTAUQUECHEE RIVER NEAR WEST BRIDGEWATER, VT
Discharge, cubic feet per second
200
100
10
Jul 17 2013
Jul 19 2013
Jul 21 2013
Jul 23 2013
Jul 25 2013
Jul 27 2013
Jul 29 2013
Jul 31 2013
Median daily statistic (29 years)
Period of approved data
Discharge

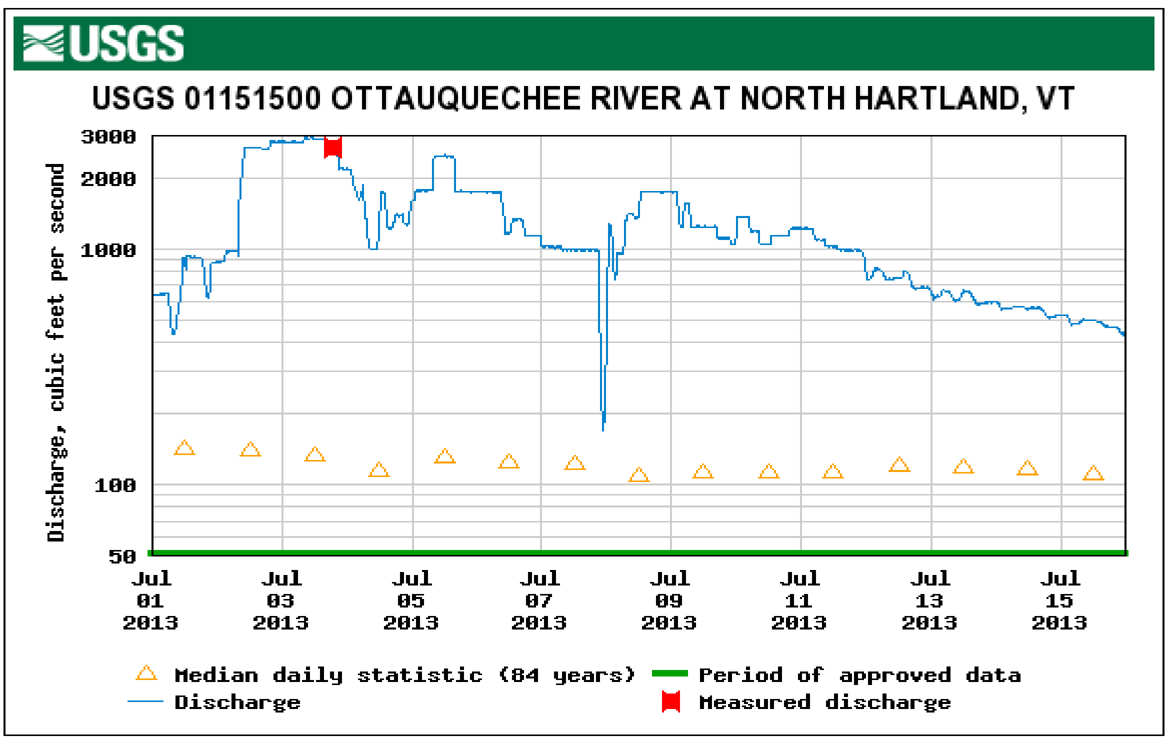

USGS
USGS 01150900 OTTAUQUECHEE RIVER NEAR WEST BRIDGEWATER, VT
Discharge, cubic feet per second
200.0
100.0
10.0
5.0
Aug 02 2013
Aug 04 2013
Aug 06 2013
Aug 08 2013
Aug 10 2013
Aug 12 2013
Aug 14 2013
Aug 16 2013
Median daily statistic (29 years)
Measured discharge
Discharge
99% Flow duration
Period of approved data

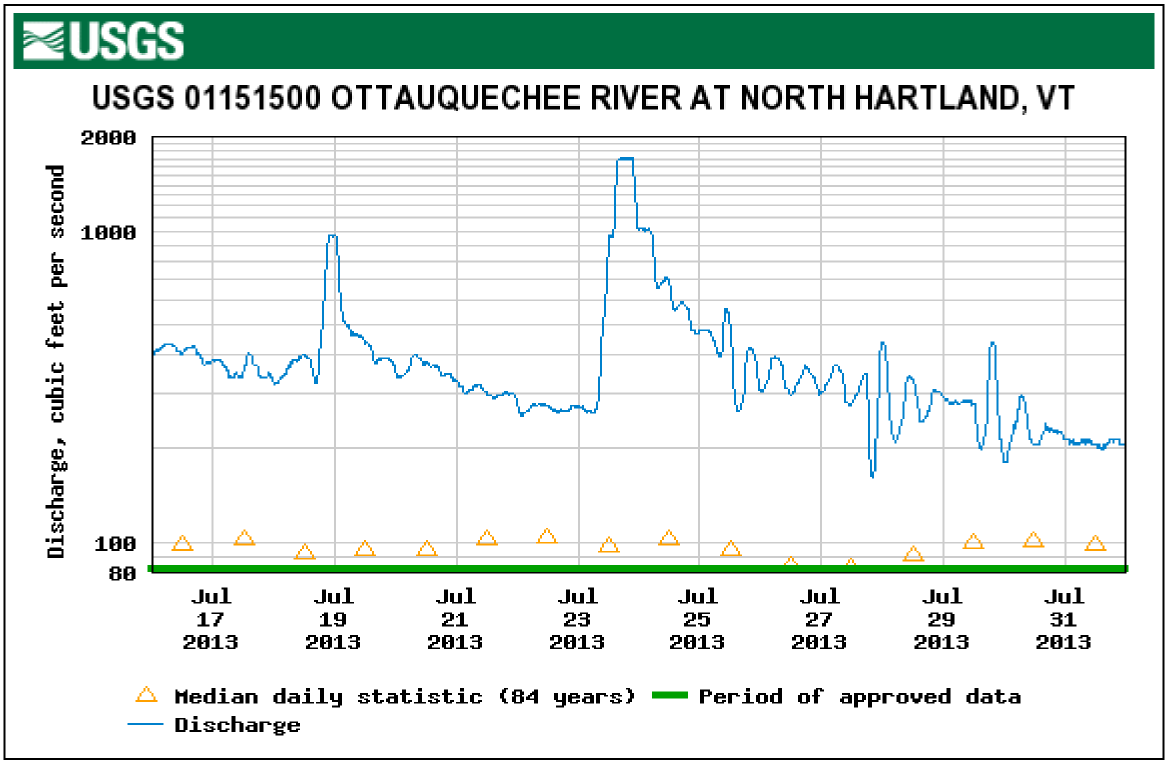

USGS
USGS 01150900 OTTAUQUECHEE RIVER NEAR WEST BRIDGEWATER, VT
Discharge, cubic feet per second
100.0
10.0
6.0
Aug 16 2013
Aug 18 2013
Aug 20 2013
Aug 22 2013
Aug 24 2013
Aug 26 2013
Aug 28 2013
Aug 30 2013
Sep 01 2013
Median daily statistic (28 years)
Period of approved data
Discharge

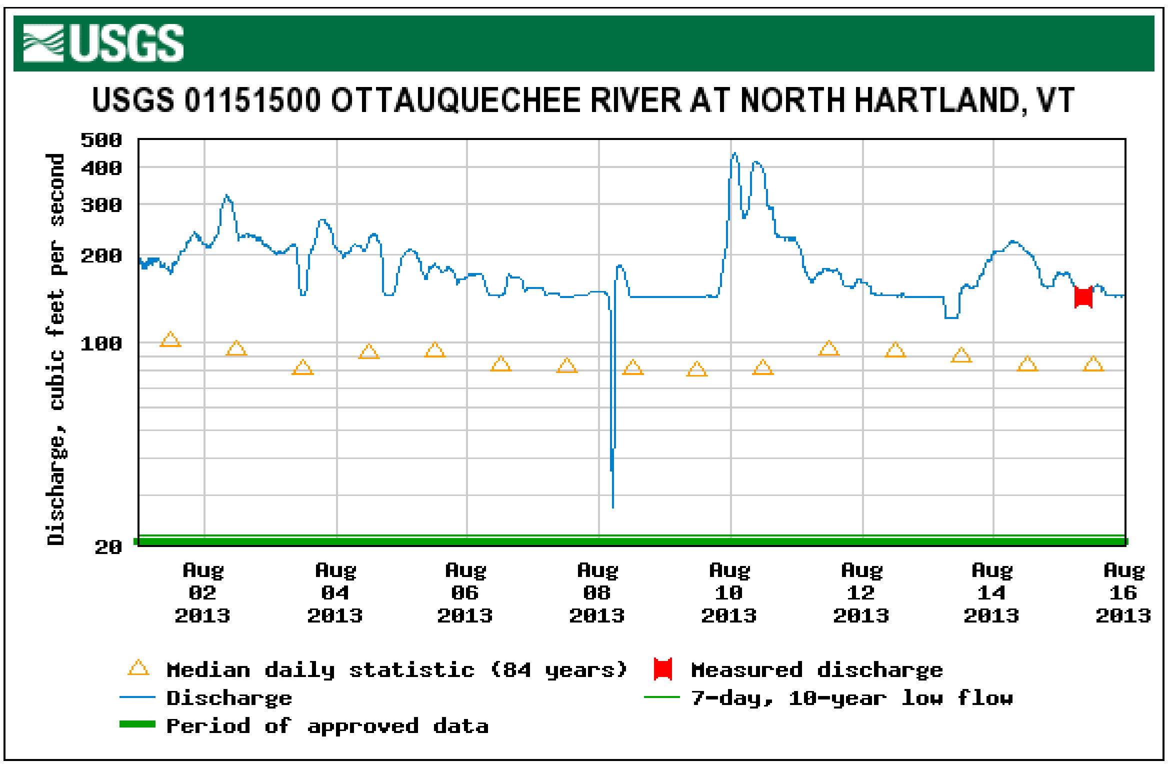

USGS
USGS 01150900 OTTAUQUECHEE RIVER NEAR WEST BRIDGEWATER, VT
Discharge, cubic feet per second
50.0
40.0
30.0
20.0
10.0
6.0
Sep 01 2013
Sep 03 2013
Sep 05 2013
Sep 07 2013
Sep 09 2013
Sep 11 2013
Median daily statistic (28 years)
Period of approved data
Discharge

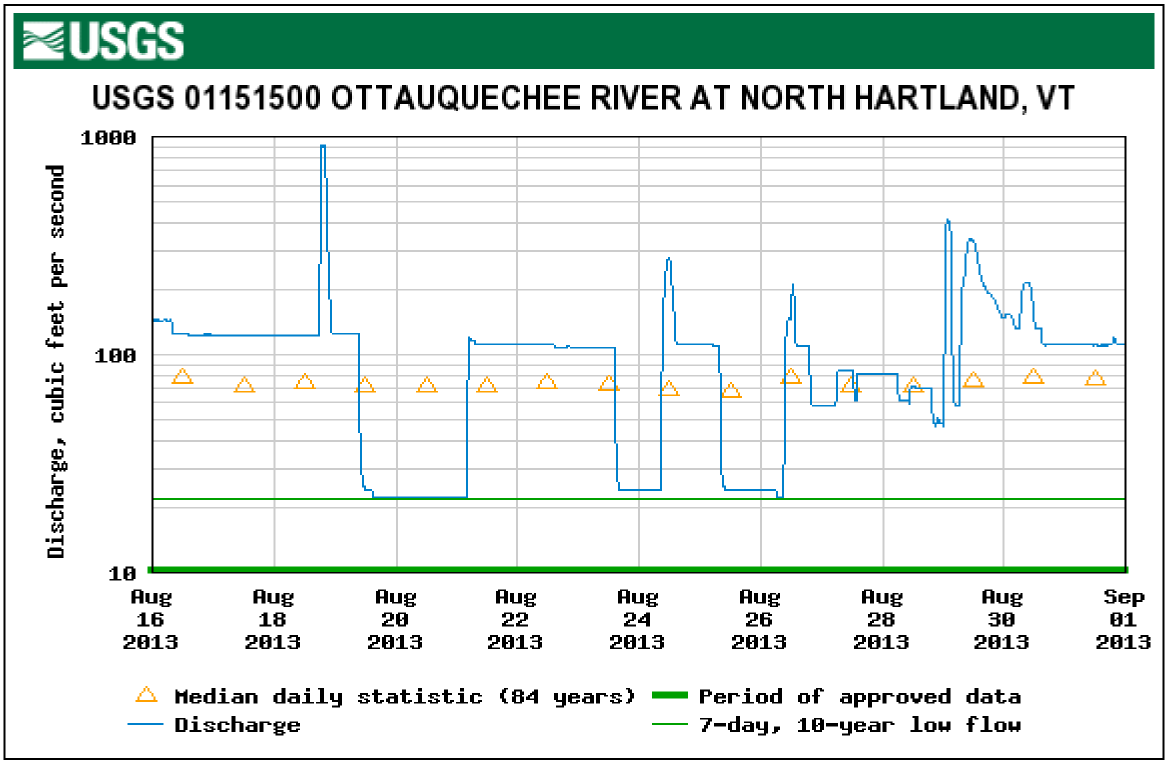
SECTION 11.2: 2013 USGS FLOW GAGE DATA – NORTH HARTLAND GAUGING STATION

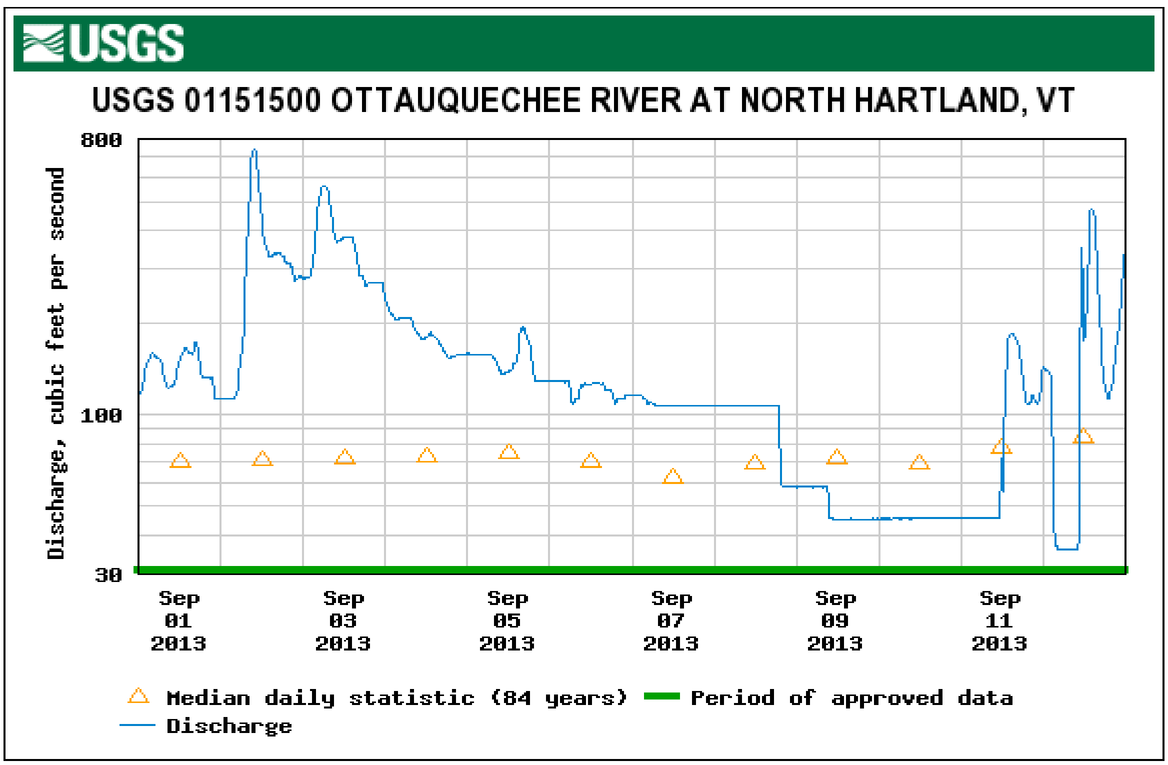




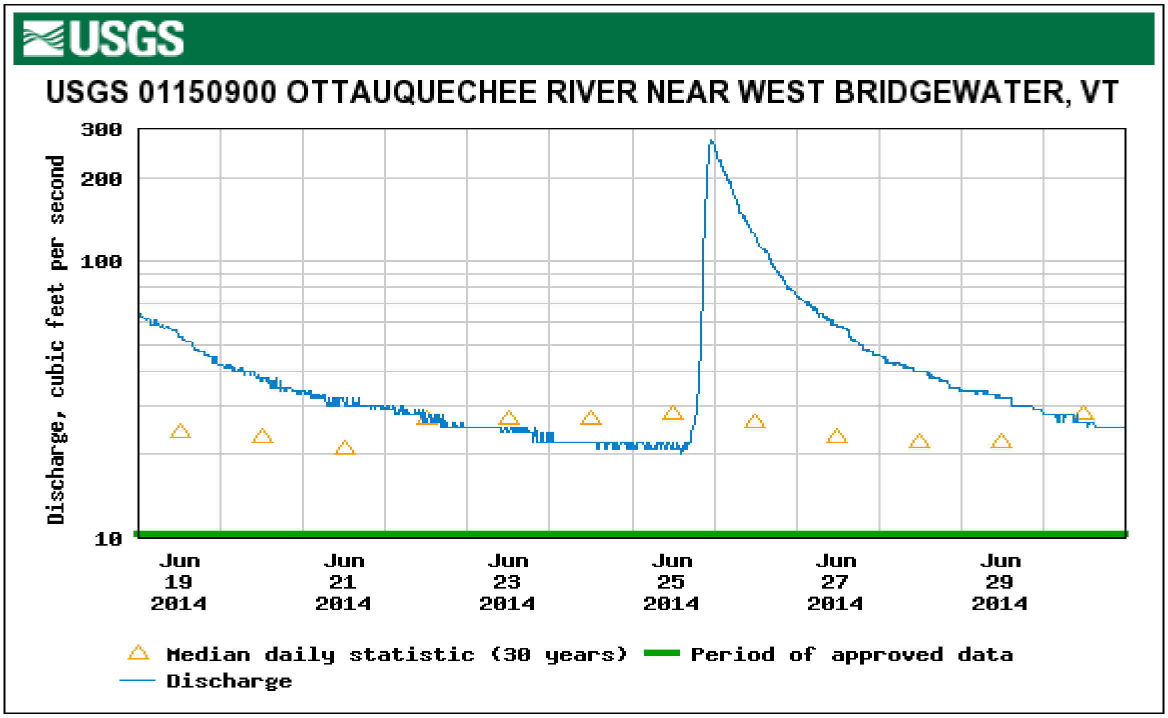

USGS
USGS 01151500 OTTAUQUECHEE RIVER AT NORTH HARTLAND, VT
Discharge, cubic feet per second
2000
1000
100
80
Jul 17 2013
Jul 19 2013
Jul 21 2013
Jul 23 2013
Jul 25 2013
Jul 27 2013
Jul 29 2013
Jul 31 2013
Median daily statistic (84 years)
Period of approved data
Discharge

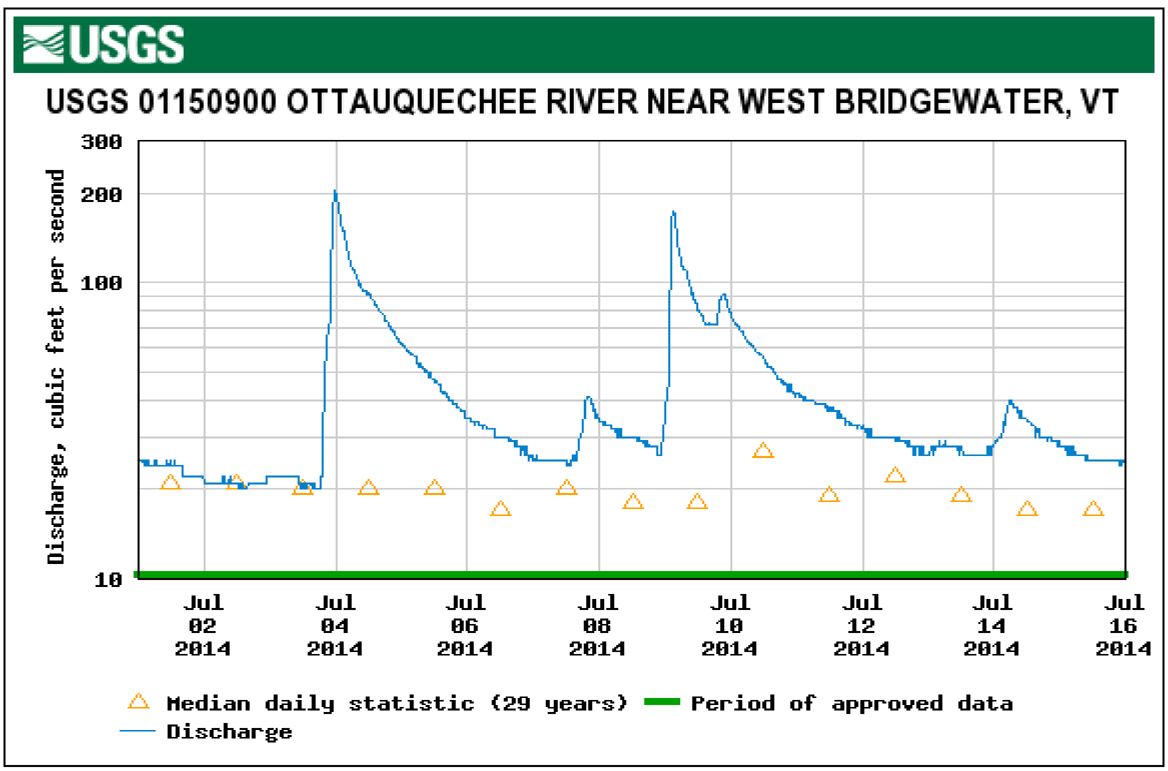

USGS
USGS 01151500 OTTAUQUECHEE RIVER AT NORTH HARTLAND, VT
Discharge, cubic feet per second
500
400
300
200
100
20
Aug 02 2013
Aug 04 2013
Aug 06 2013
Aug 08 2013
Aug 10 2013
Aug 12 2013
Aug 14 2013
Aug 16 2013
Median daily statistic (84 years)
Measured discharge
Discharge
7-day, 10-year low flow
Period of approved data

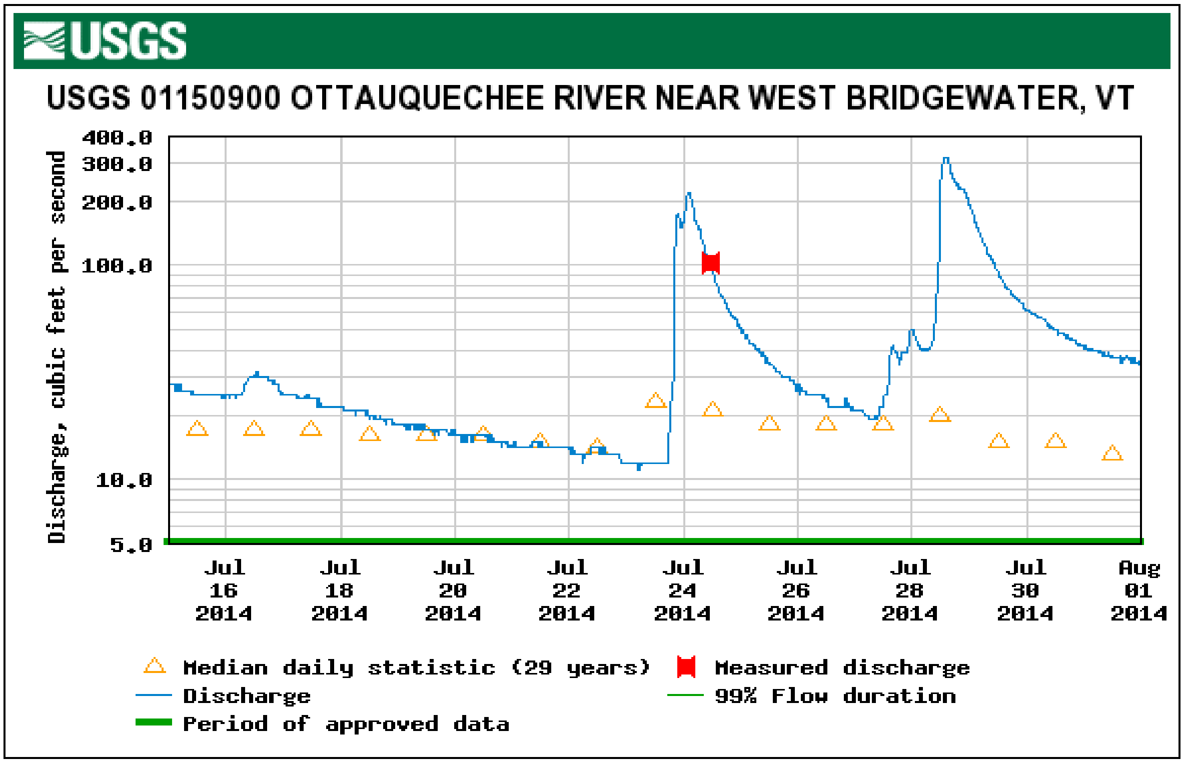

USGS
USGS 01151500 OTTAUQUECHEE RIVER AT NORTH HARTLAND, VT
Discharge, cubic feet per second
1000
100
10
Aug 16 2013
Aug 18 2013
Aug 20 2013
Aug 22 2013
Aug 24 2013
Aug 26 2013
Aug 28 2013
Aug 30 2013
Sep 01 2013
Median daily statistic (84 years)
Period of approved data
Discharge
7-day, 10-year low flow

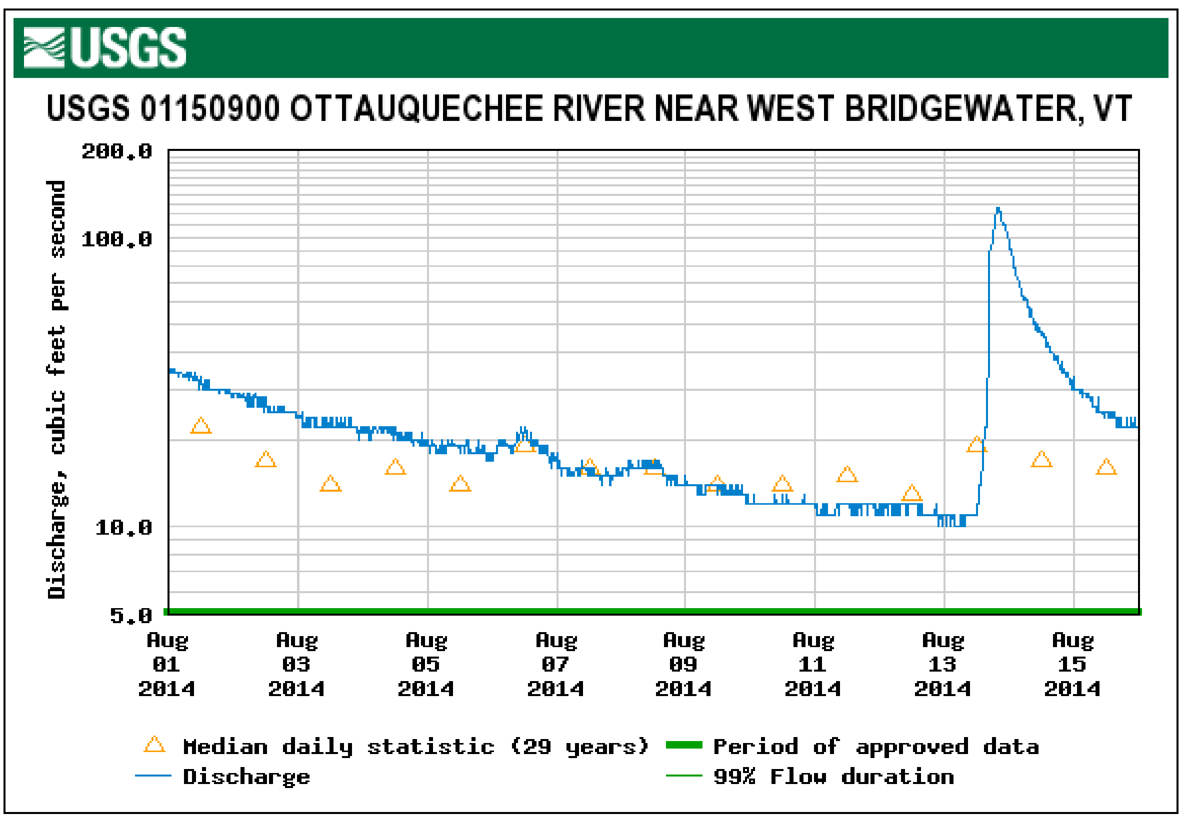

USGS
USGS 01151500 OTTAUQUECHEE RIVER AT NORTH HARTLAND, VT
Discharge, cubic feet per second
800
100
30
Sep 01 2013
Sep 03 2013
Sep 05 2013
Sep 07 2013
Sep 09 2013
Sep 11 2013
Median daily statistic (84 years)
Period of approved data
Discharge

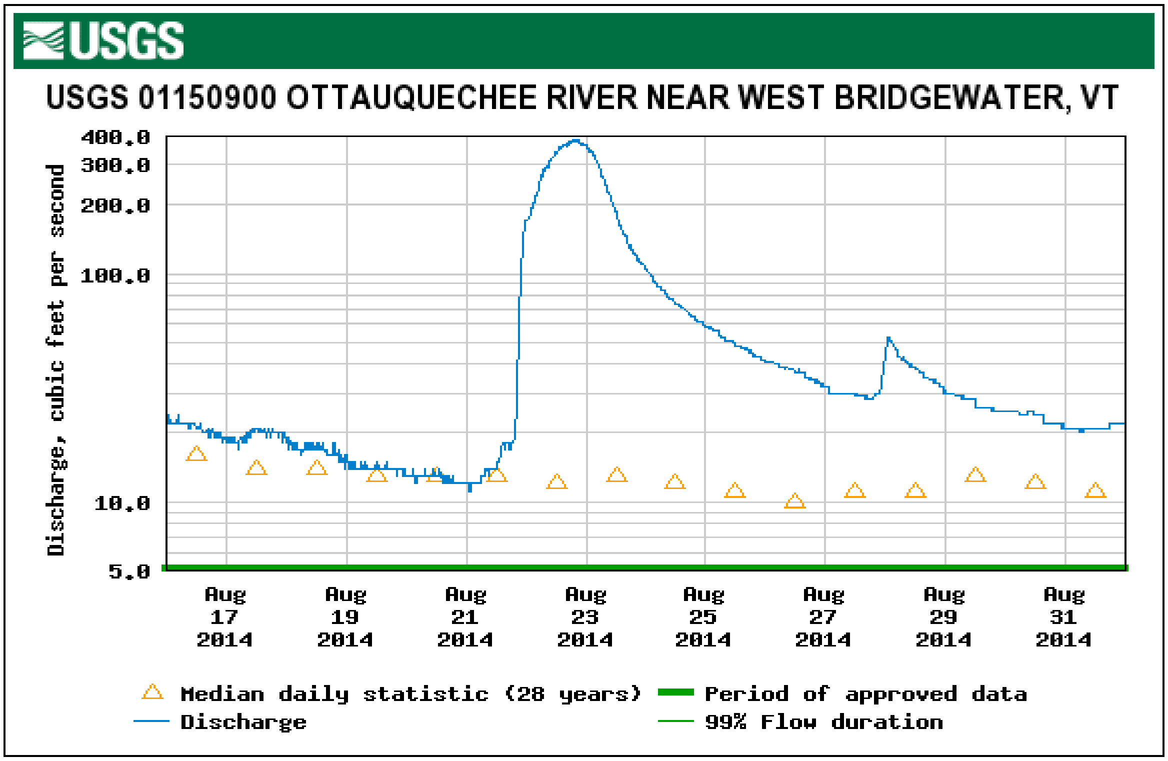
SECTION 11.3: 2014 USGS FLOW GAGE DATA – WEST BRIDGEWATER GAUGING STATION

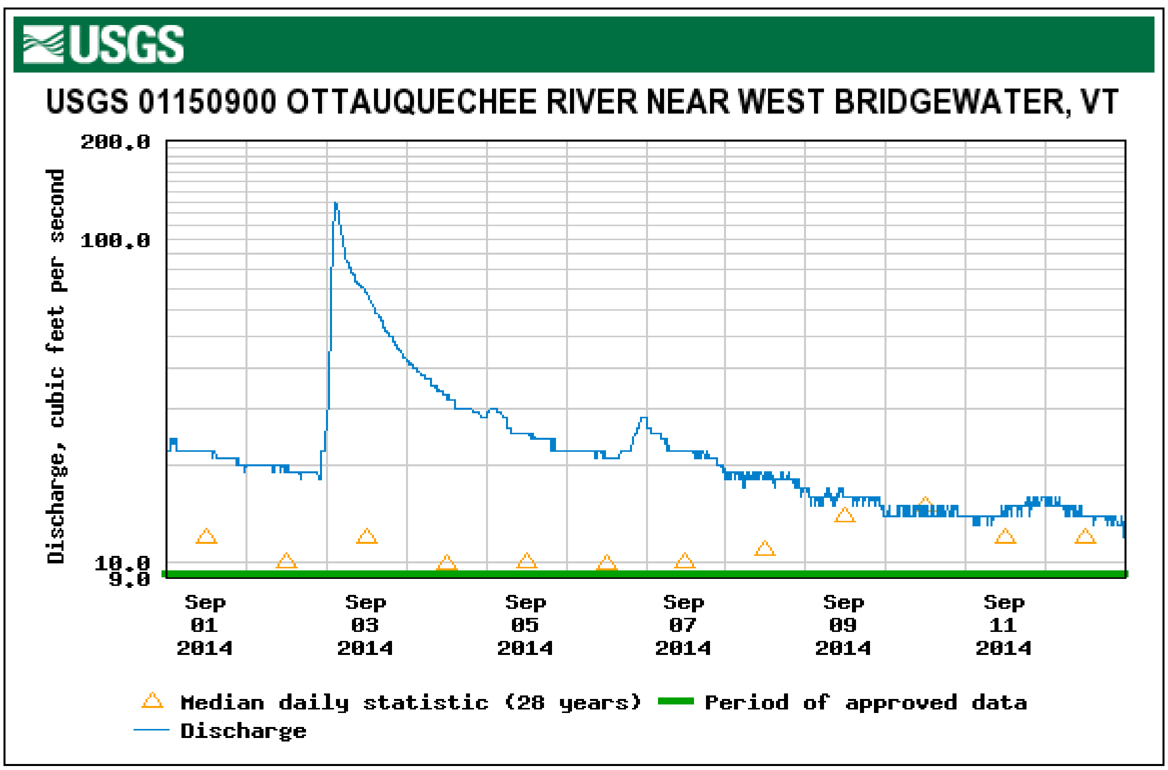




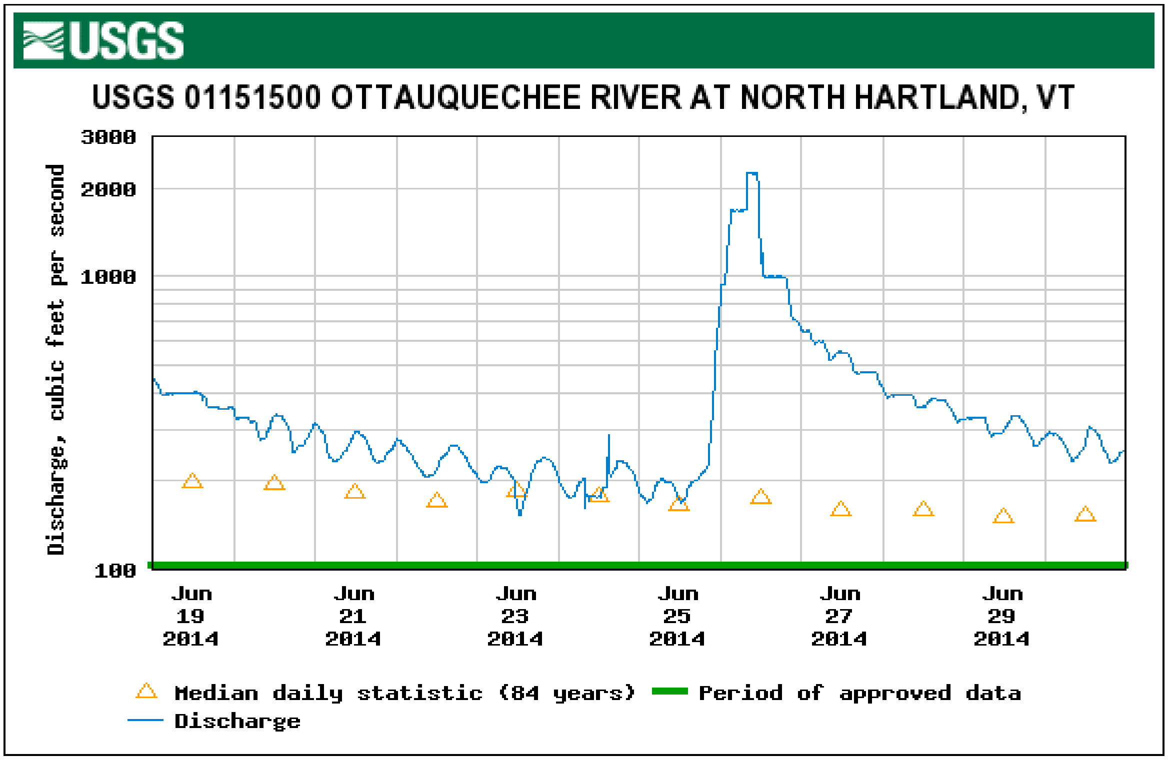

USGS
USGS 01150900 OTTAUQUECHEE RIVER NEAR WEST BRIDGEWATER, VT
Discharge, cubic feet per second
400.0
300.0
200.0
100.0
10.0
5.0
Jul 16 2014
Jul 18 2014
Jul 20 2014
Jul 22 2014
Jul 24 2014
Jul 26 2014
Jul 28 2014
Jul 30 2014
Aug 01 2014
Median daily statistic (29 years)
Measured discharge
Discharge
99% Flow duration
Period of approved data

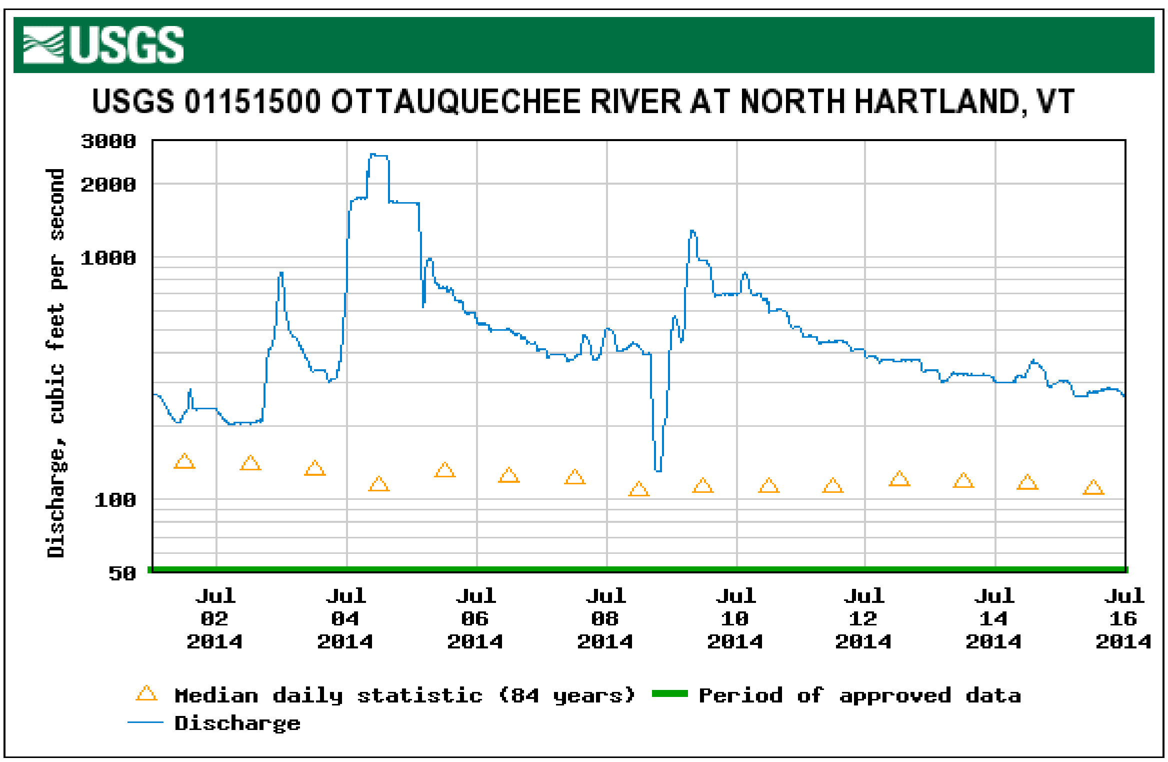

USGS
USGS 01150900 OTTAUQUECHEE RIVER NEAR WEST BRIDGEWATER, VT
Discharge, cubic feet per second
200.0
100.0
10.0
5.0
Aug 01 2014
Aug 03 2014
Aug 05 2014
Aug 07 2014
Aug 09 2014
Aug 11 2014
Aug 13 2014
Aug 15 2014
Median daily statistic (29 years)
Period of approved data
Discharge
99% Flow duration

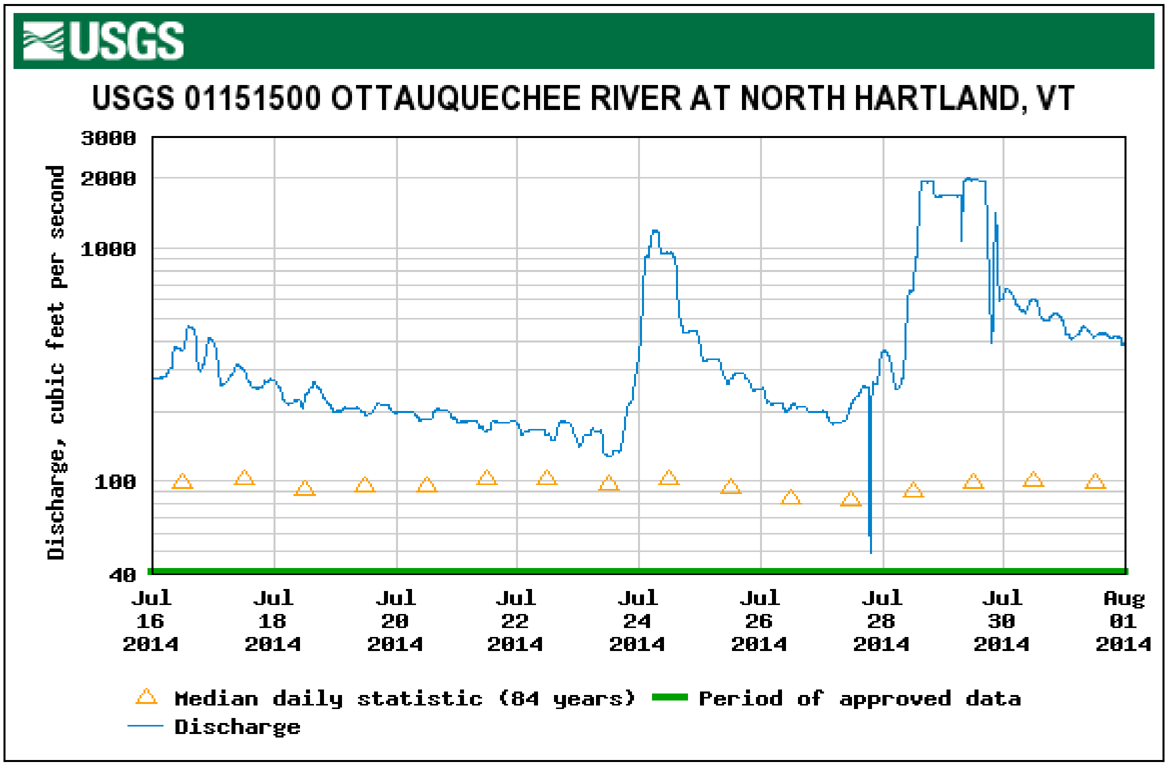

USGS
USGS 01150900 OTTAUQUECHEE RIVER NEAR WEST BRIDGEWATER, VT
Discharge, cubic feet per second
400.0
300.0
200.0
100.0
10.0
5.0
Aug 17 2014
Aug 19 2014
Aug 21 2014
Aug 23 2014
Aug 25 2014
Aug 27 2014
Aug 29 2014
Aug 31 2014
Median daily statistic (28 years)
Discharge
Period of approved data
99% Flow duration

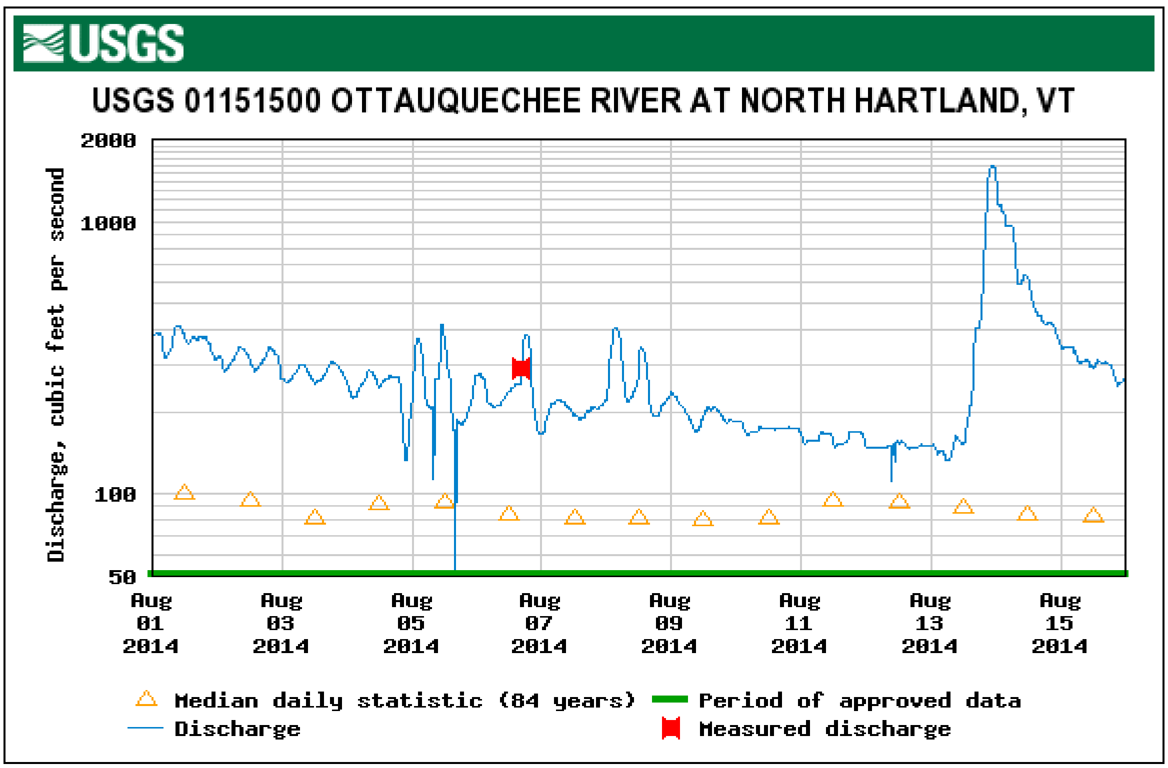

USGS
USGS 01150900 OTTAUQUECHEE RIVER NEAR WEST BRIDGEWATER, VT
Discharge, cubic feet per second
200.0
100.0
10.0
9.0
Sep 01 2014
Sep 03 2014
Sep 05 2014
Sep 07 2014
Sep 09 2014
Sep 11 2014
Median daily statistic (28 years)
Discharge
Period of approved data

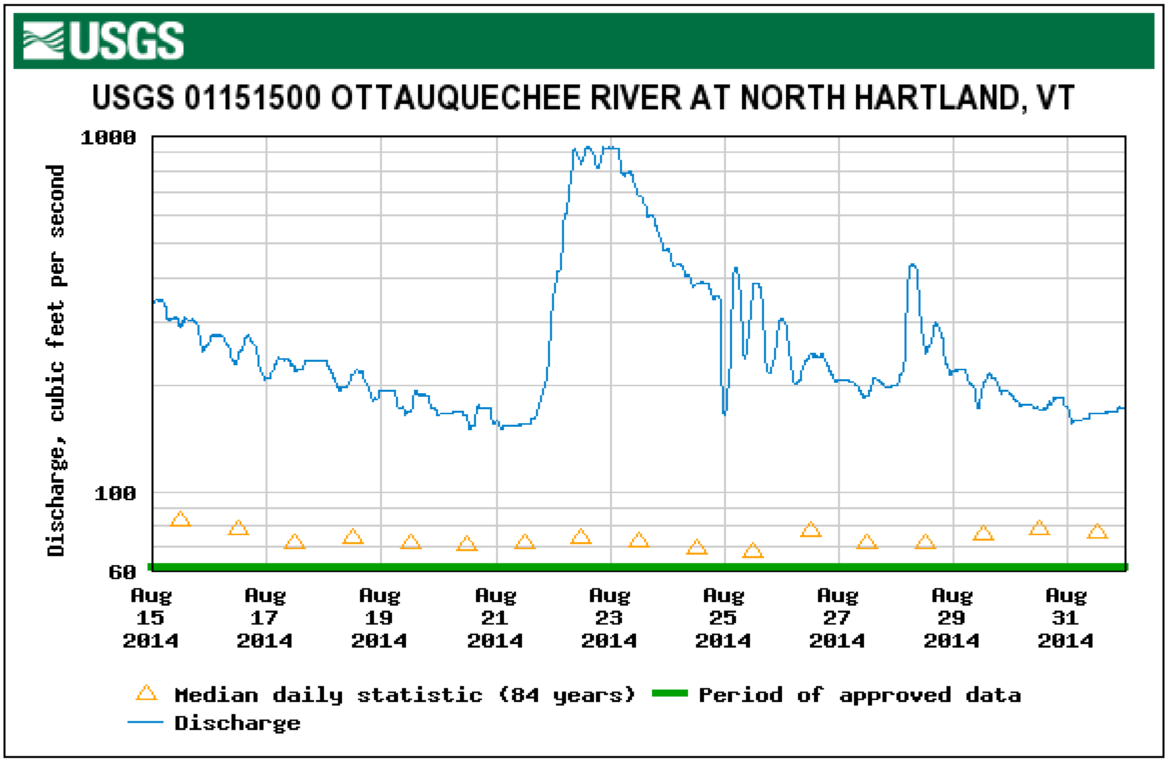
SECTION 11.4: 2014 USGS FLOW GAGE DATA – NORTH HARTLAND GAUGING STATION

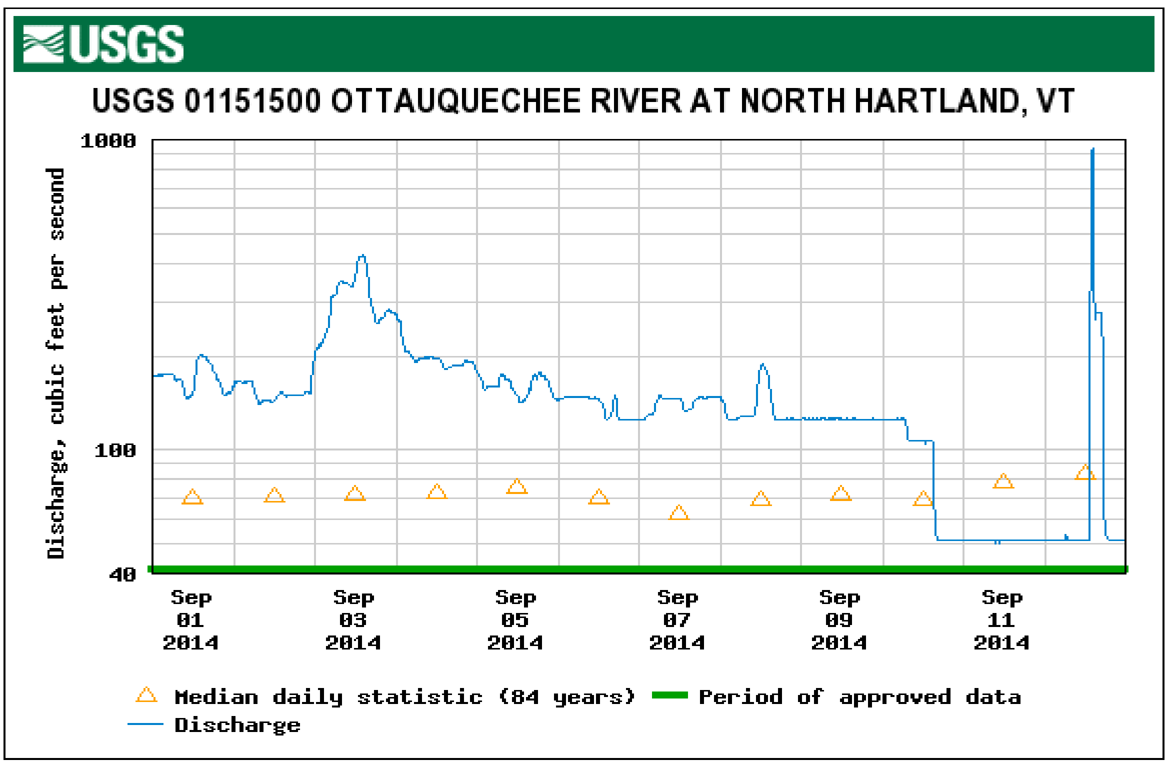




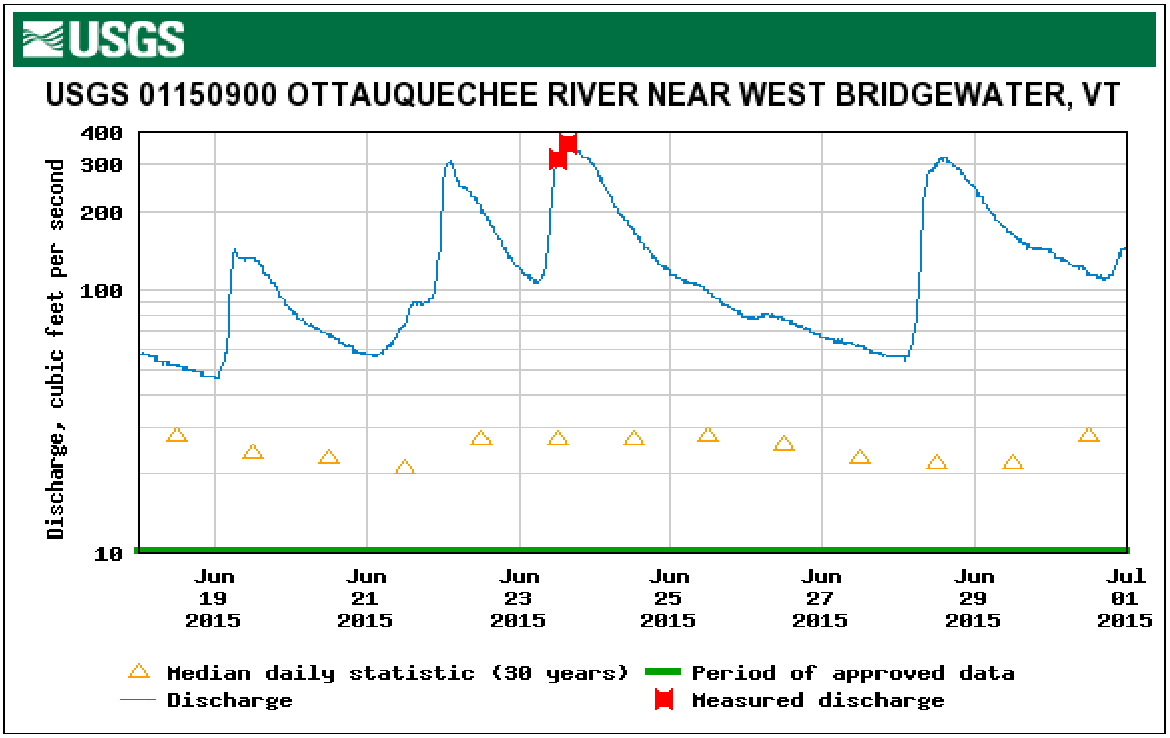

USGS
USGS 01151500 OTTAUQUECHEE RIVER AT NORTH HARTLAND, VT
Discharge, cubic feet per second
3000
2000
1000
100
40
Jul 16 2014
Jul 18 2014
Jul 20 2014
Jul 22 2014
Jul 24 2014
Jul 26 2014
Jul 28 2014
Jul 30 2014
Aug 01 2014
Median daily statistic (84 years)
Period of approved data
Discharge

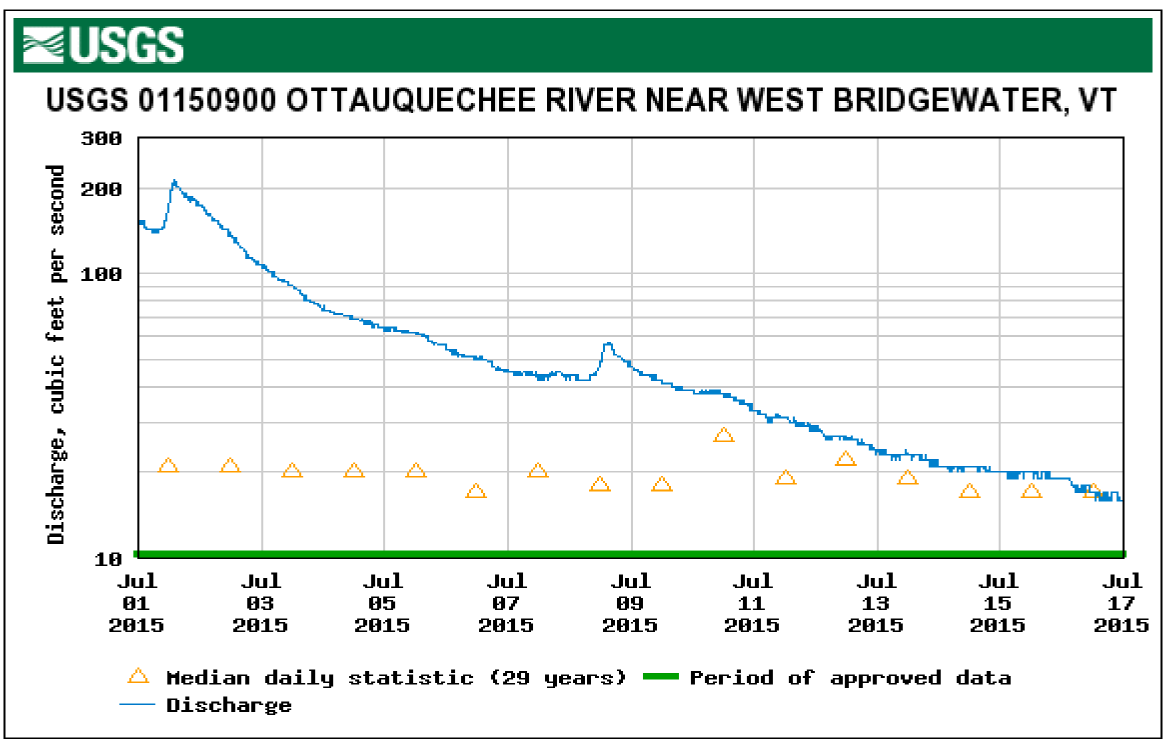

USGS
USGS 01151500 OTTAUQUECHEE RIVER AT NORTH HARTLAND, VT
Discharge, cubic feet per second
2000
1000
100
50
Aug 01 2014
Aug 03 2014
Aug 05 2014
Aug 07 2014
Aug 09 2014
Aug 11 2014
Aug 13 2014
Aug 15 2014
Median daily statistic (84 years)
Period of approved data
Discharge
Measured discharge

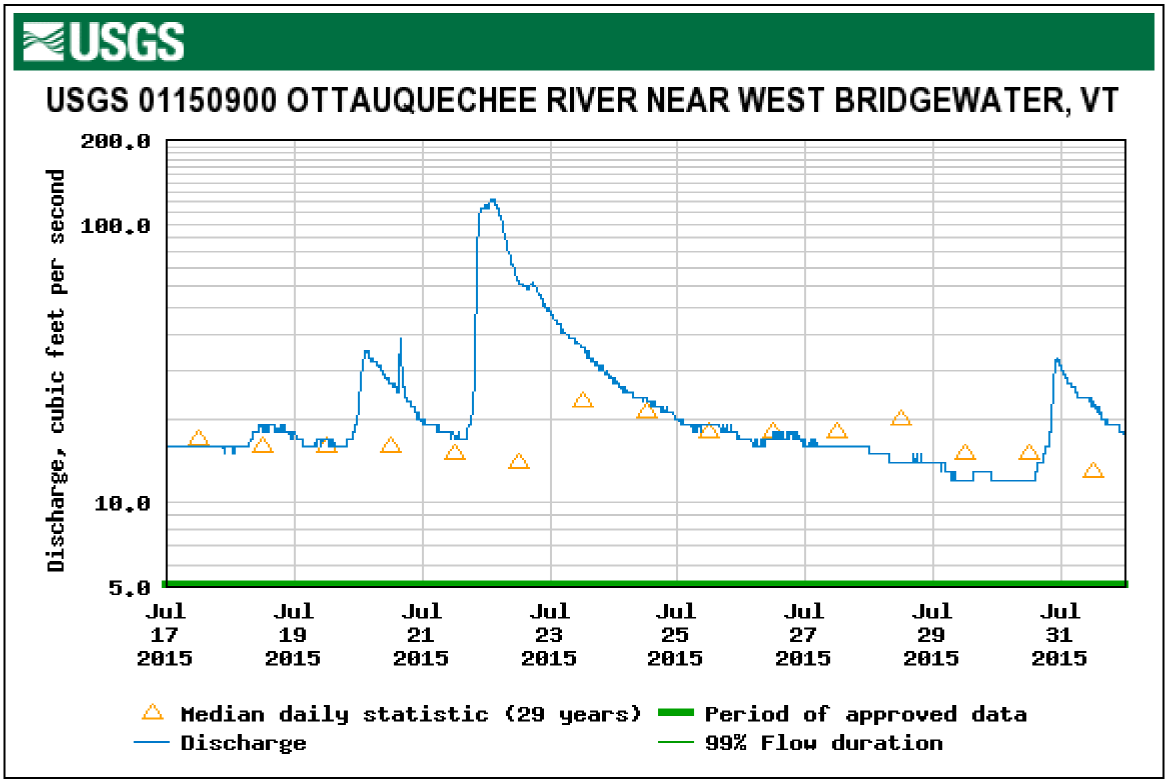

USGS
USGS 01151500 OTTAUQUECHEE RIVER AT NORTH HARTLAND, VT
Discharge, cubic feet per second
1000
100
60
Aug 15 2014
Aug 17 2014
Aug 19 2014
Aug 21 2014
Aug 23 2014
Aug 25 2014
Aug 27 2014
Aug 29 2014
Aug 31 2014
Median daily statistic (84 years)
Period of approved data
Discharge

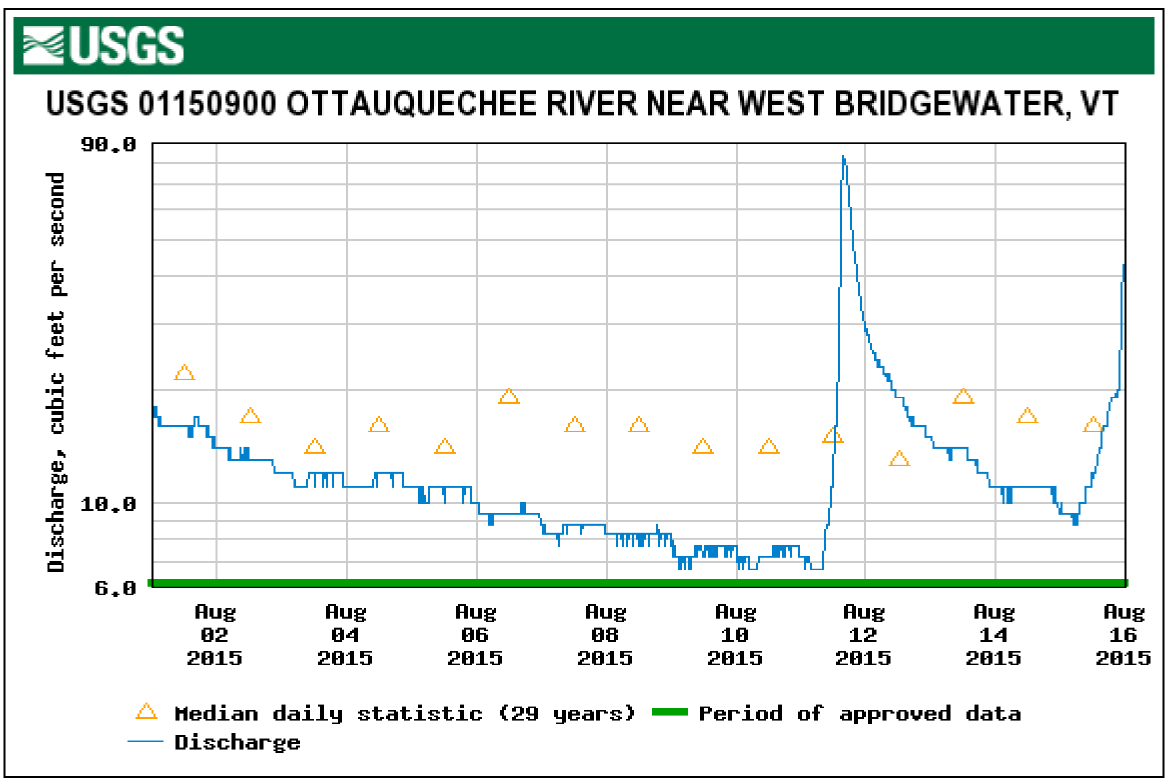

USGS
USGS 01151500 OTTAUQUECHEE RIVER AT NORTH HARTLAND, VT
Discharge, cubic feet per second
1000
100
40
Sep 01 2014
Sep 03 2014
Sep 05 2014
Sep 07 2014
Sep 09 2014
Sep 11 2014
Median daily statistic (84 years)
Period of approved data
Discharge

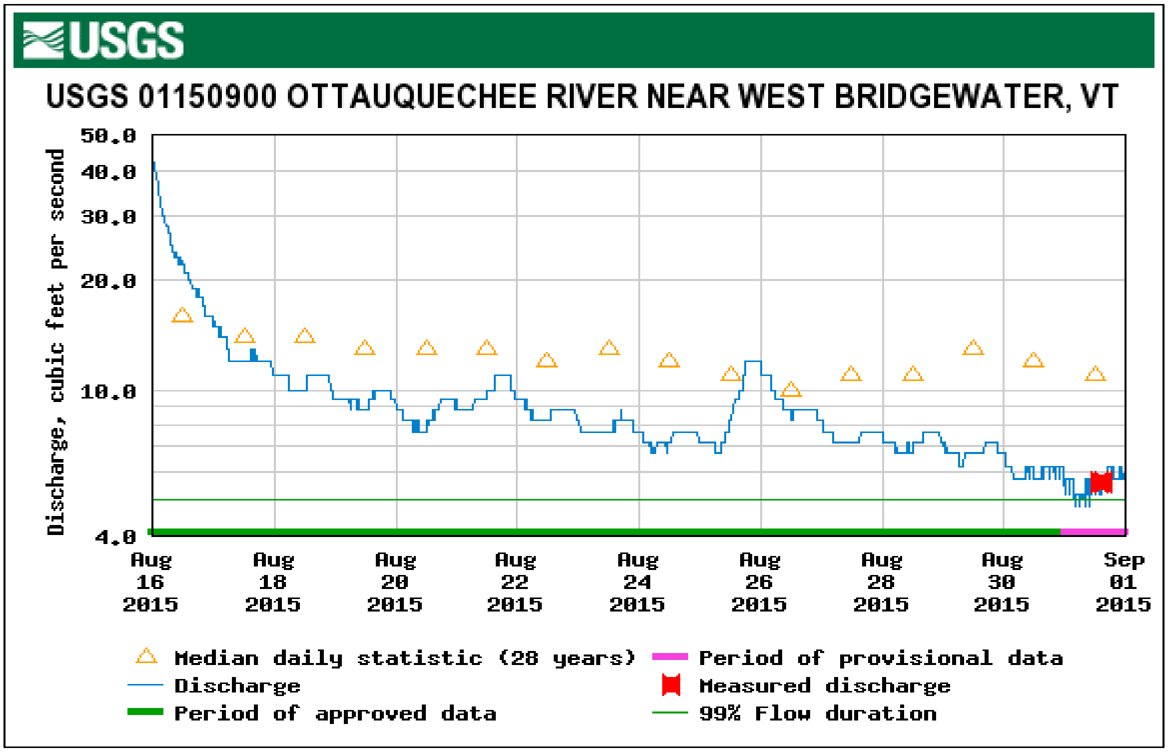
SECTION 11.5: 2015 USGS FLOW GAGE DATA – WEST BRIDGEWATER GAUGING STATION



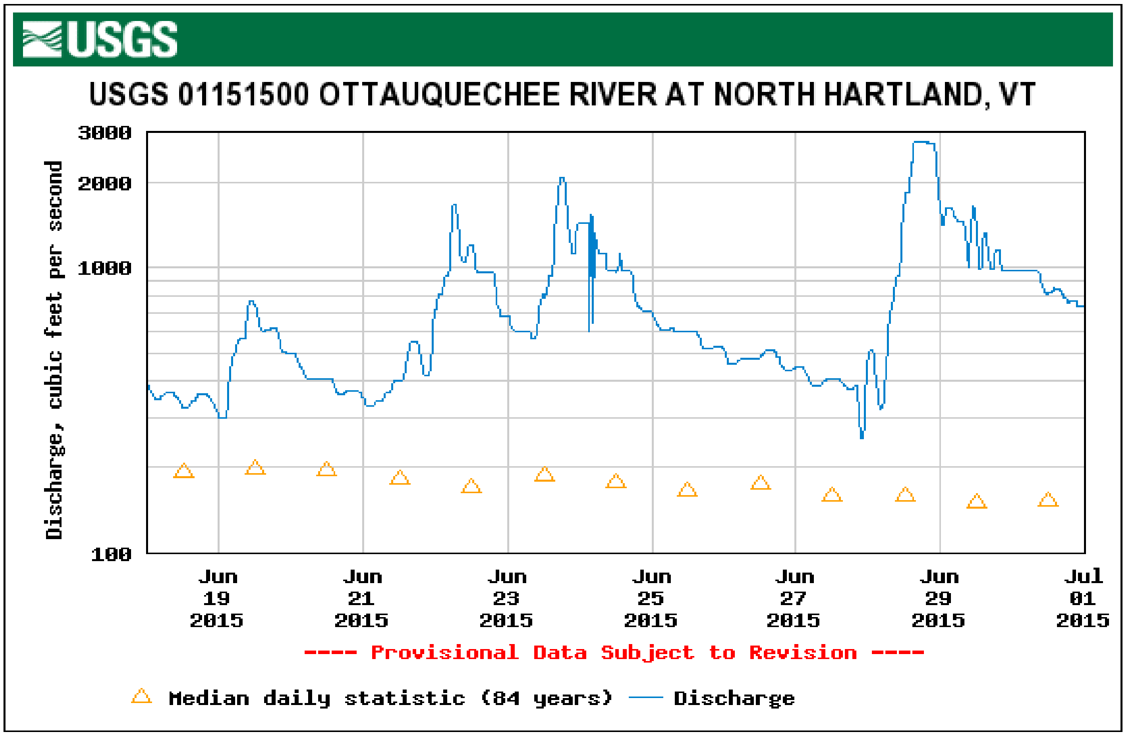


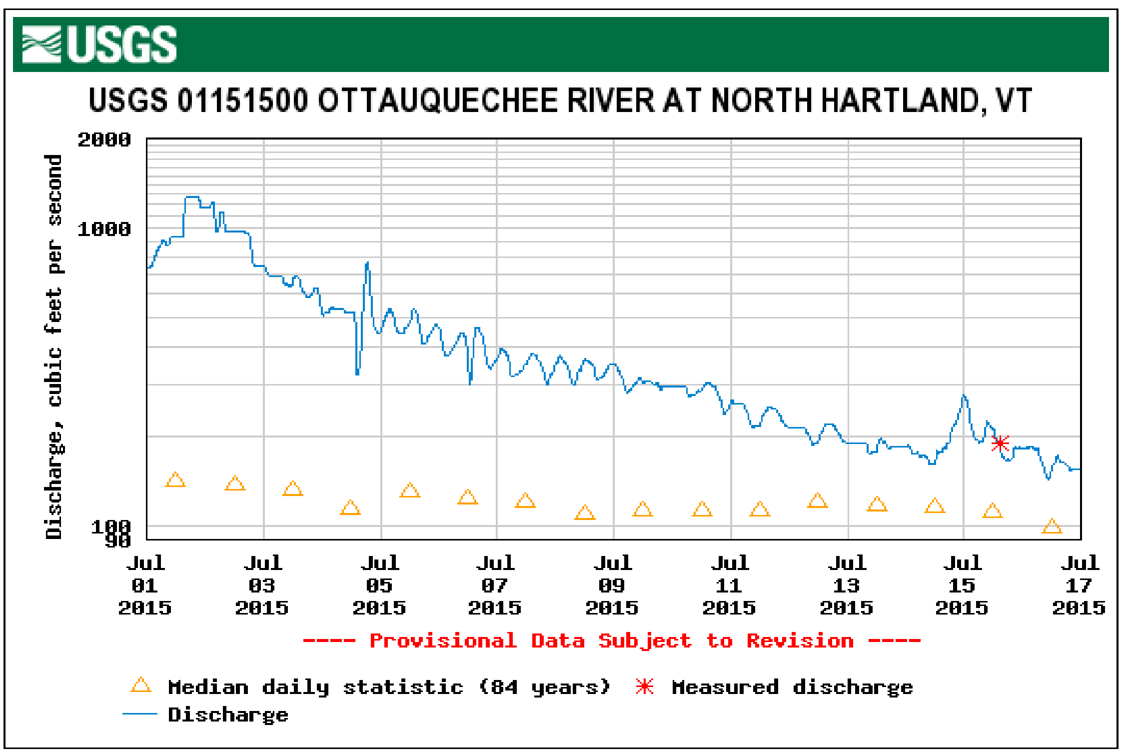

USGS
USGS 01150900 OTTAUQUECHEE RIVER NEAR WEST BRIDGEWATER, VT
200.0
100.0
10.0
5.0
Discharge, cubic feet per second
Jul 17 2015
Jul 19 2015
Jul 21 2015
Jul 23 2015
Jul 25 2015
Jul 27 2015
Jul 29 2015
Jul 31 2015
Median daily statistic (29 years)
Period of approved data
Discharge
99% Flow duration

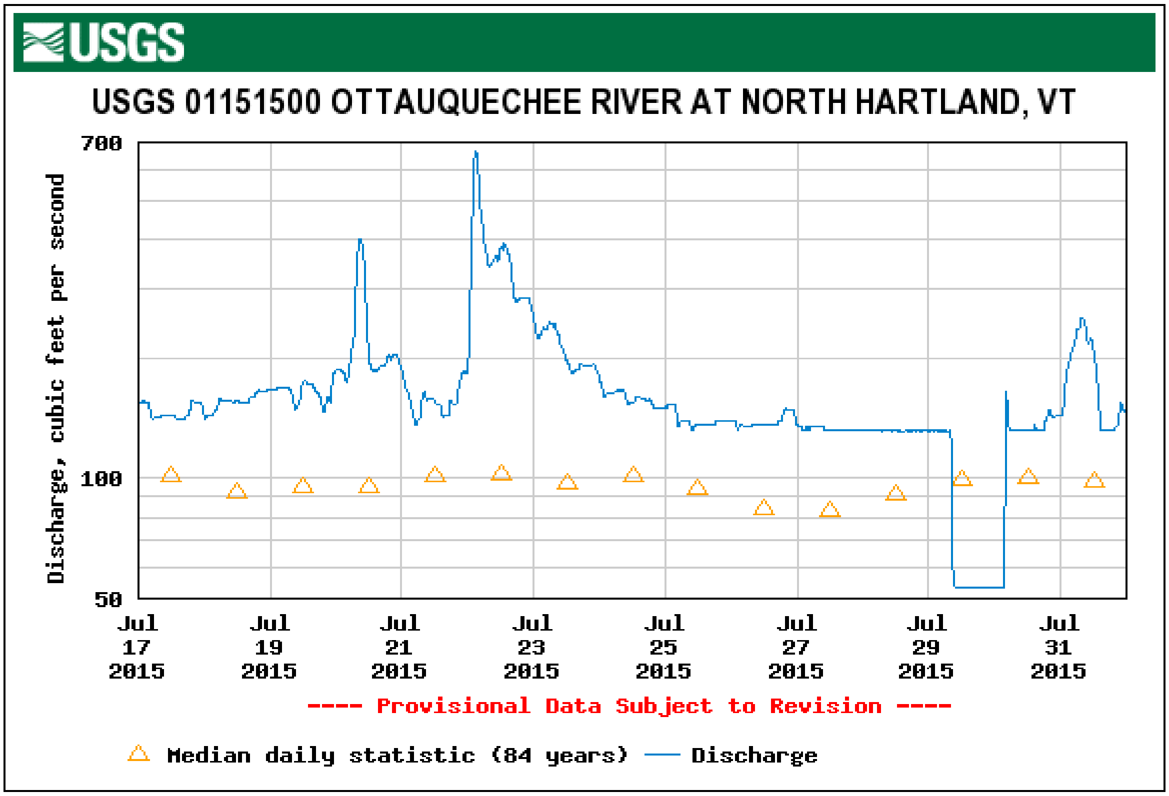

USGS
USGS 01150900 OTTAUQUECHEE RIVER NEAR WEST BRIDGEWATER, VT
90.0
10.0
6.0
Discharge, cubic feet per second
Aug 02 2015
Aug 04 2015
Aug 06 2015
Aug 08 2015
Aug 10 2015
Aug 12 2015
Aug 14 2015
Aug 16 2015
Median daily statistic (29 years)
Period of approved data
Discharge

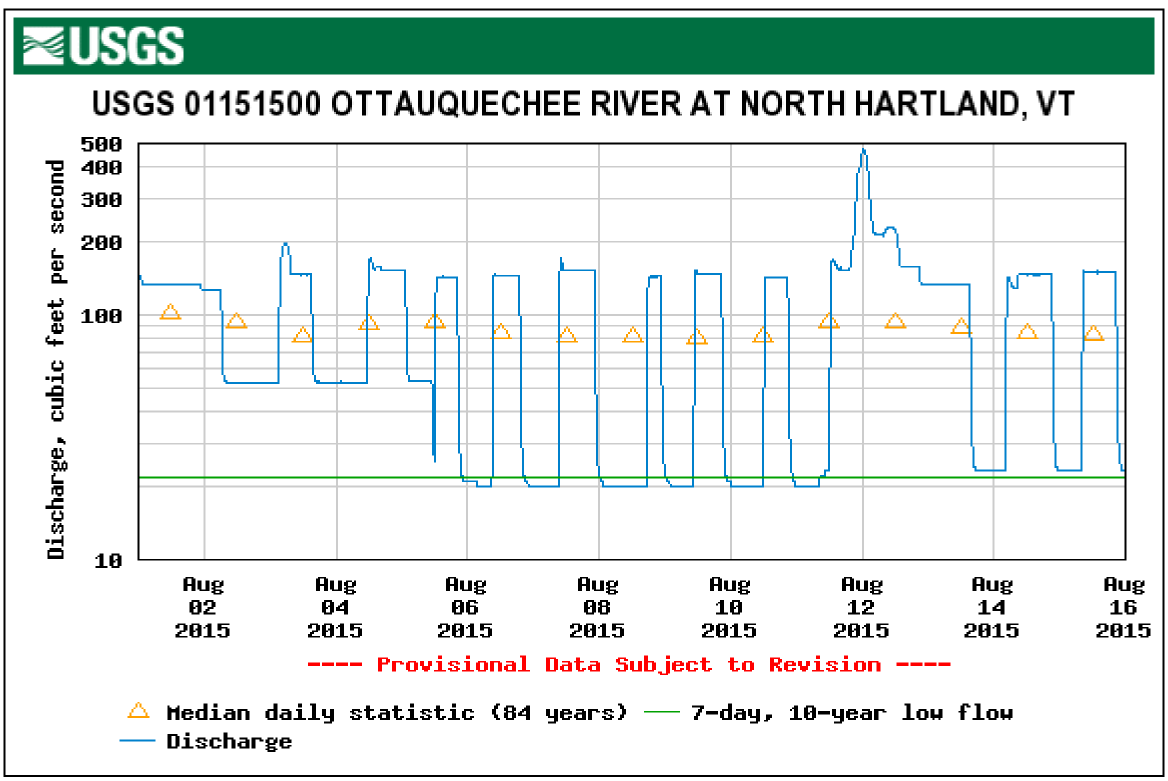

USGS
USGS 01150900 OTTAUQUECHEE RIVER NEAR WEST BRIDGEWATER, VT
Discharge, cubic feet per second
50.0
40.0
30.0
20.0
10.0
4.0
Aug 16 2015
Aug 18 2015
Aug 20 2015
Aug 22 2015
Aug 24 2015
Aug 26 2015
Aug 28 2015
Aug 30 2015
Sep 01 2015
Median daily statistic (28 years)
Discharge
Period of approved data
Period of provisional data
Measured discharge
99% Flow duration

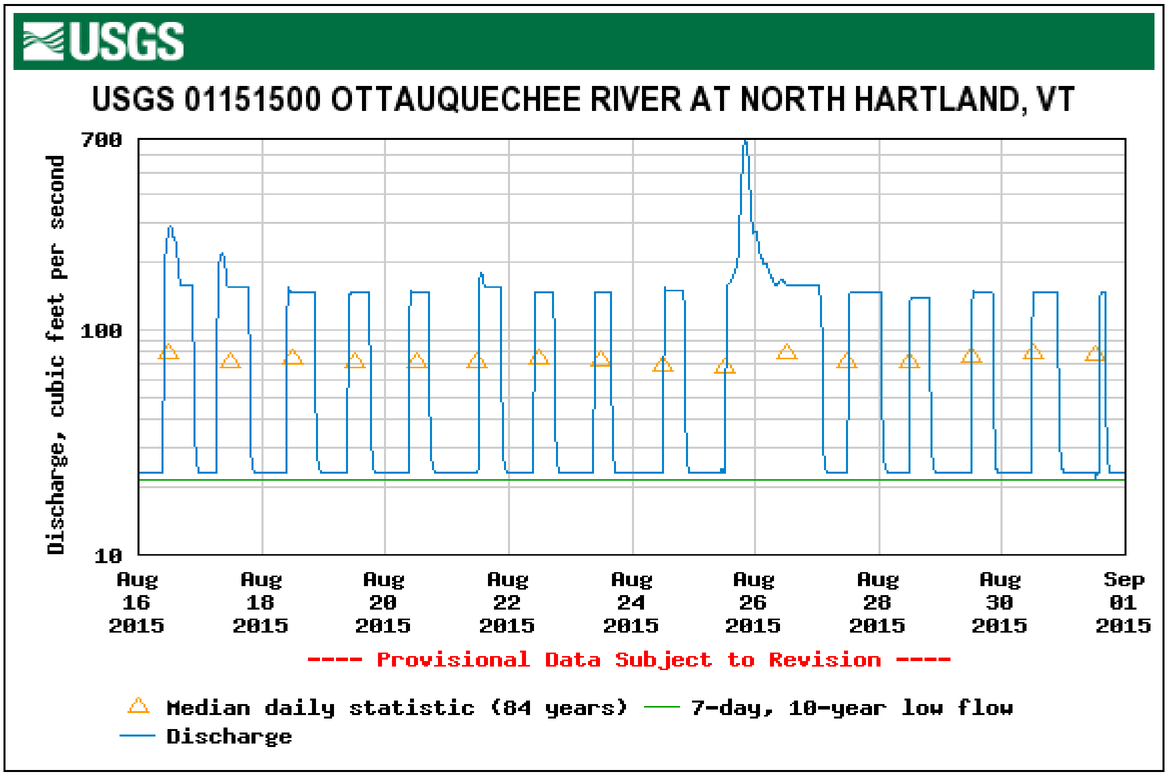
SECTION 11.6: 2015 USGS FLOW GAGE DATA – NORTH HARTLAND GAUGING STATION



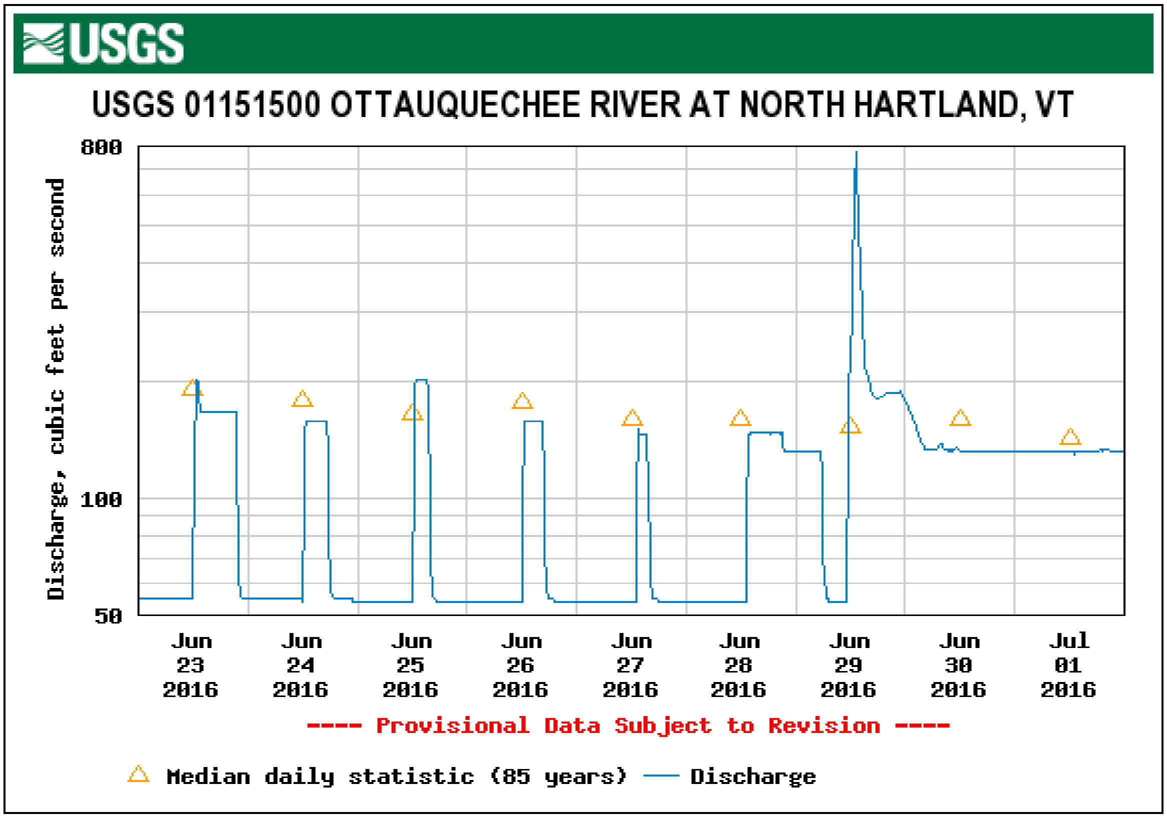


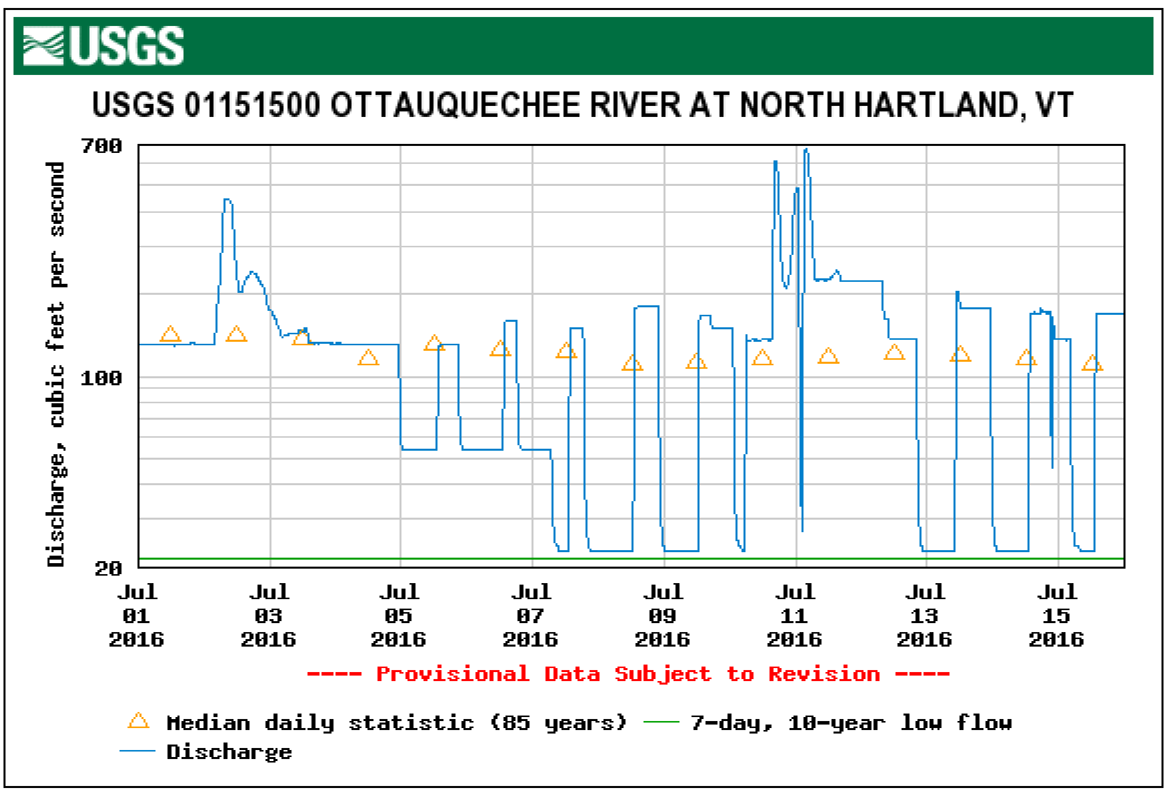

USGS
USGS 01151500 OTTAUQUECHEE RIVER AT NORTH HARTLAND, VT
Discharge, cubic feet per second
700
100
50
Jul 17 2015
Jul 19 2015
Jul 21 2015
Jul 23 2015
Jul 25 2015
Jul 27 2015
Jul 29 2015
Jul 31 2015
---- Provisional Data Subject to Revision ----
Median daily statistic (84 years)
Discharge

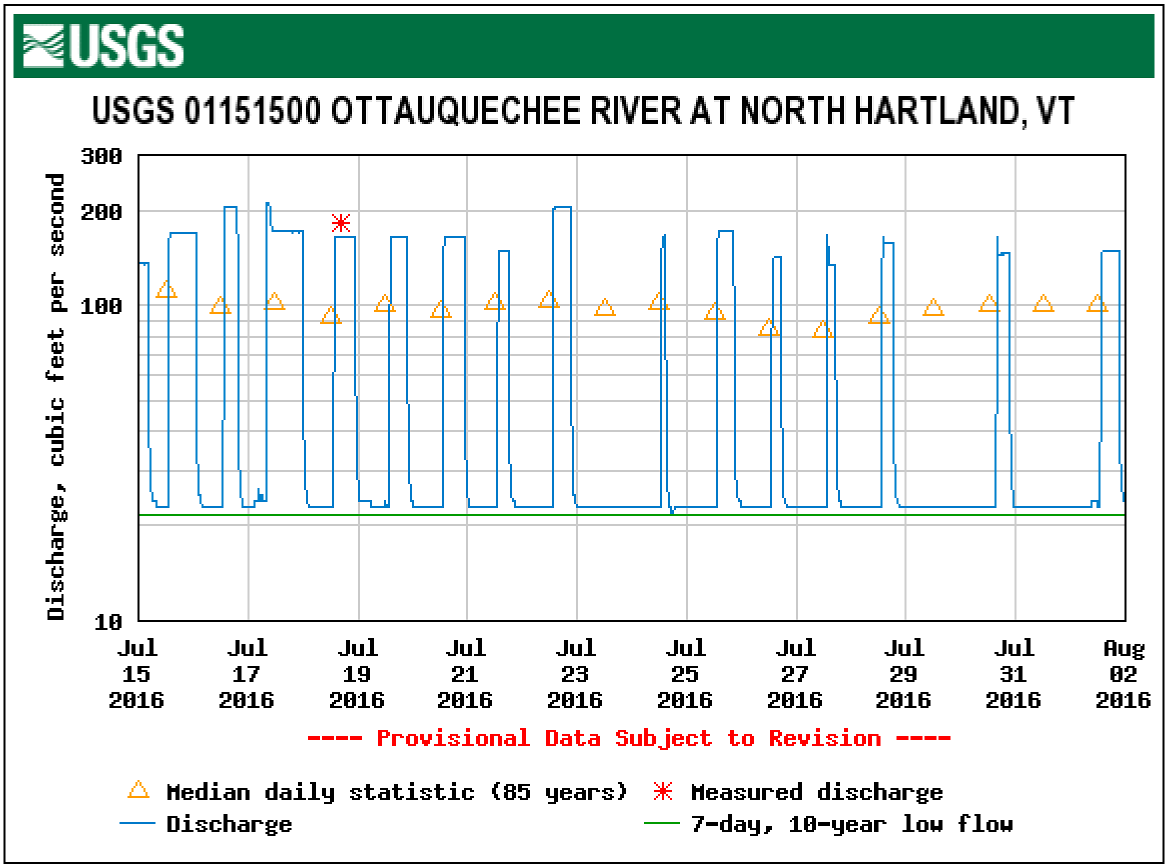

USGS
USGS 01151500 OTTAUQUECHEE RIVER AT NORTH HARTLAND, VT
Discharge, cubic feet per second
500
400
300
200
100
10
Aug 02 2015
Aug 04 2015
Aug 06 2015
Aug 08 2015
Aug 10 2015
Aug 12 2015
Aug 14 2015
Aug 16 2015
---- Provisional Data Subject to Revision ----
Median daily statistic (84 years)
7-day, 10-year low flow
Discharge

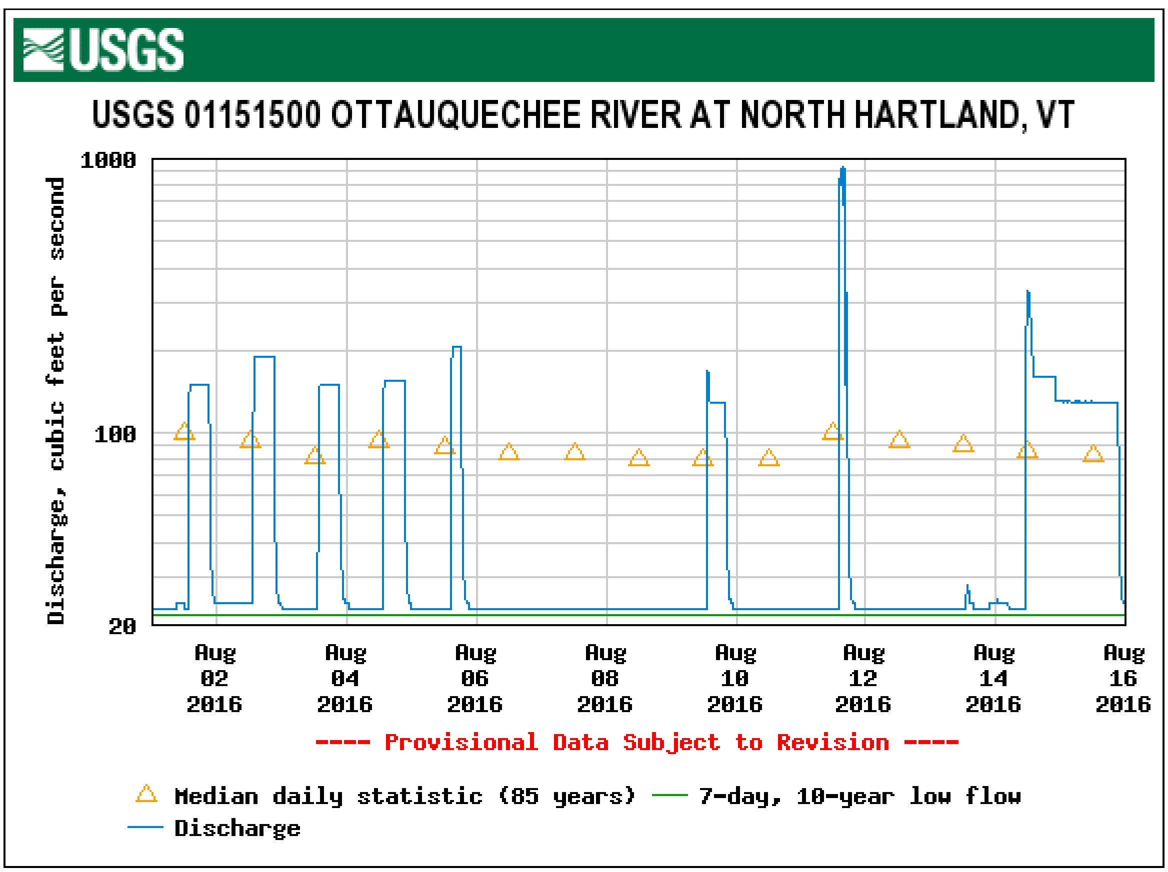

USGS
USGS 01151500 OTTAUQUECHEE RIVER AT NORTH HARTLAND, VT
Discharge, cubic feet per second
700
100
10
Aug 16 2015
Aug 18 2015
Aug 20 2015
Aug 22 2015
Aug 24 2015
Aug 26 2015
Aug 28 2015
Aug 30 2015
Sep 01 2015
---- Provisional Data Subject to Revision ----
Median daily statistic (84 years)
7-day, 10-year low flow
Discharge

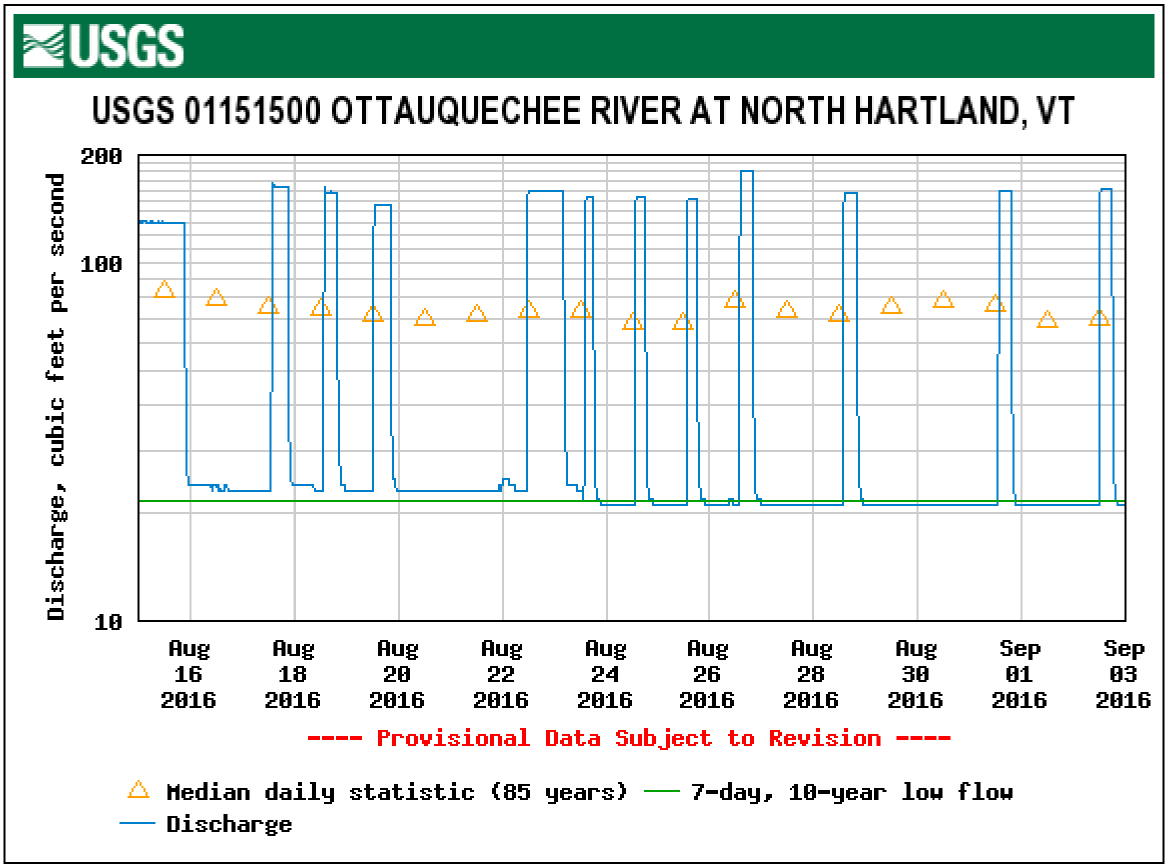
SECTION 11.7: 2016 USGS FLOW GAGE DATA – NORTH HARTLAND GAUGING STATION



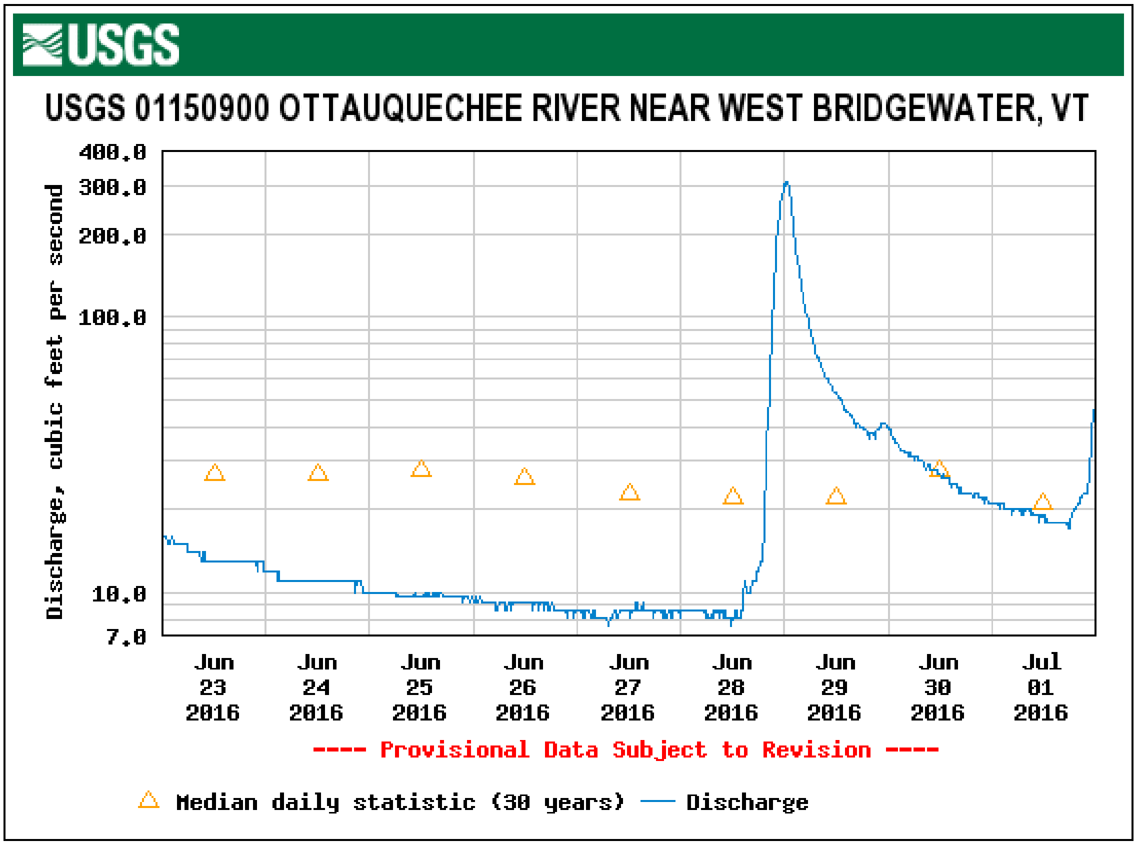


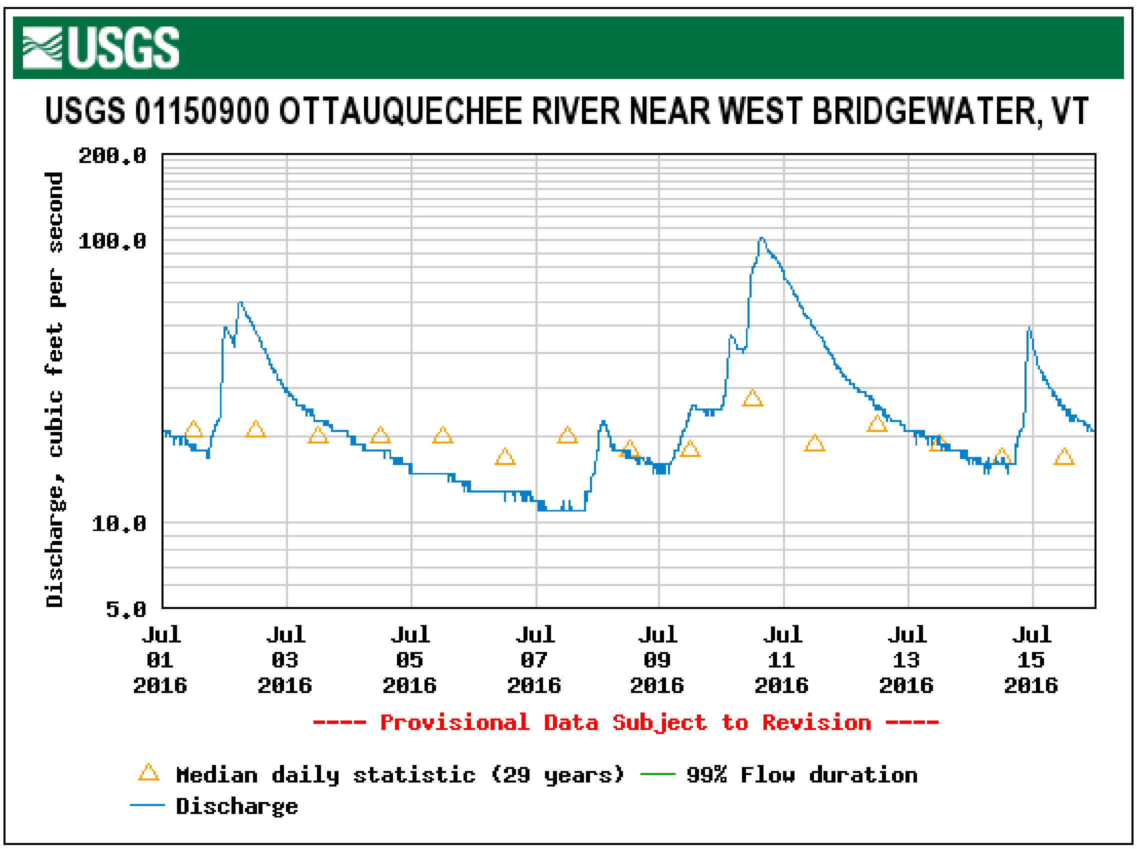

USGS
USGS 01151500 OTTAUQUECHEE RIVER AT NORTH HARTLAND, VT
Discharge, cubic feet per second
300
200
100
10
Jul 15 2016
Jul 17 2016
Jul 19 2016
Jul 21 2016
Jul 23 2016
Jul 25 2016
Jul 27 2016
Jul 29 2016
Jul 31 2016
Aug 02 2016
---- Provisional Data Subject to Revision ----
Median daily statistic (85 years)
Measured discharge
Discharge
7-day, 10-year low flow

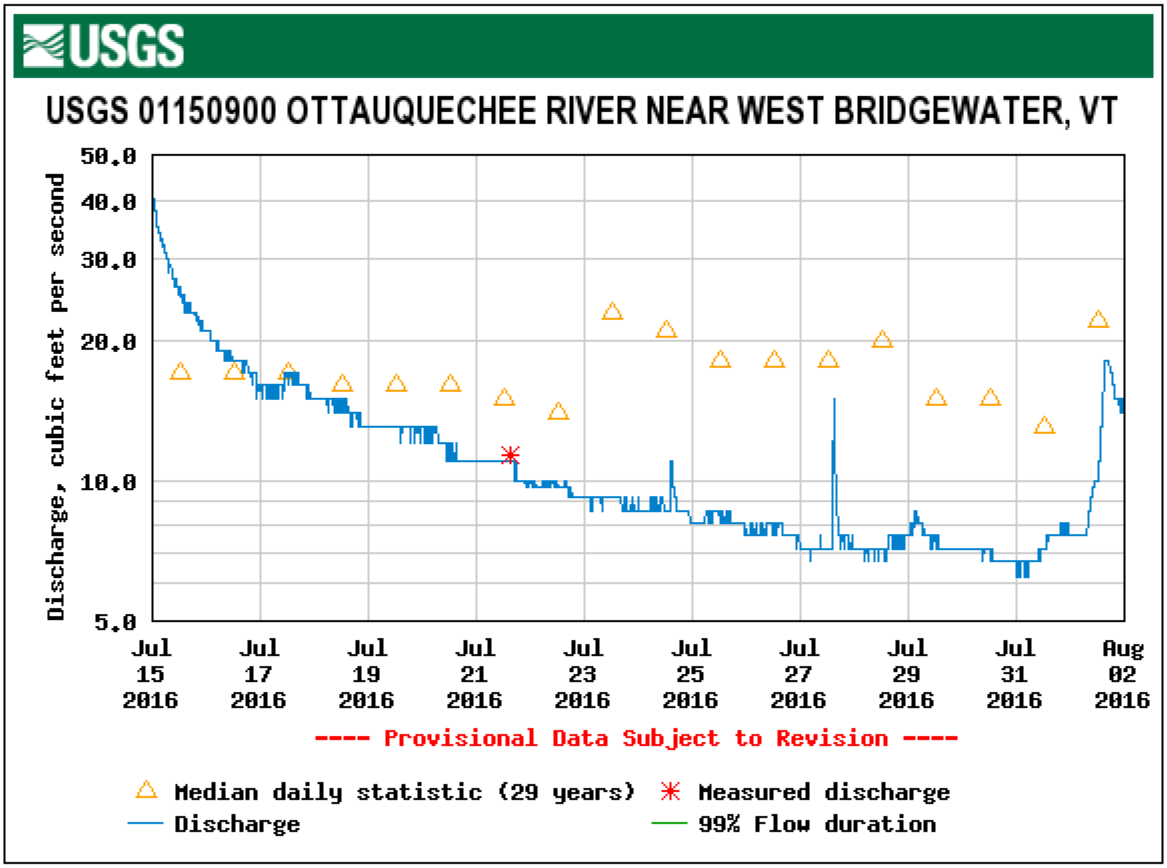

USGS
USGS 01151500 OTTAUQUECHEE RIVER AT NORTH HARTLAND, VT
Discharge, cubic feet per second
1000
100
20
Aug 02 2016
Aug 04 2016
Aug 06 2016
Aug 08 2016
Aug 10 2016
Aug 12 2016
Aug 14 2016
Aug 16 2016
---- Provisional Data Subject to Revision ----
Median daily statistic (85 years)
7-day, 10-year low flow
Discharge

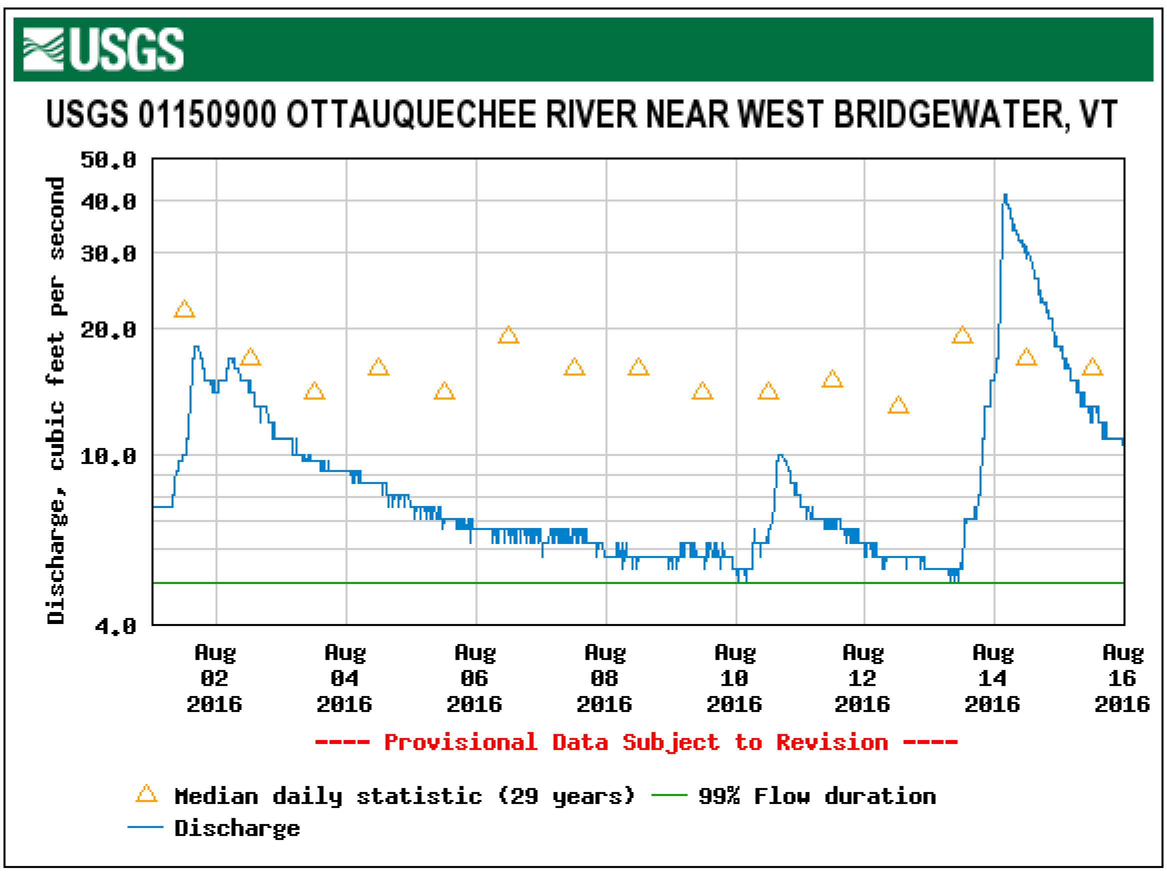

USGS
USGS 01151500 OTTAUQUECHEE RIVER AT NORTH HARTLAND, VT
Discharge, cubic feet per second
200
100
10
Aug 16 2016
Aug 18 2016
Aug 20 2016
Aug 22 2016
Aug 24 2016
Aug 26 2016
Aug 28 2016
Aug 30 2016
Sep 01 2016
Sep 03 2016
---- Provisional Data Subject to Revision ----
Median daily statistic (85 years)
7-day, 10-year low flow
Discharge

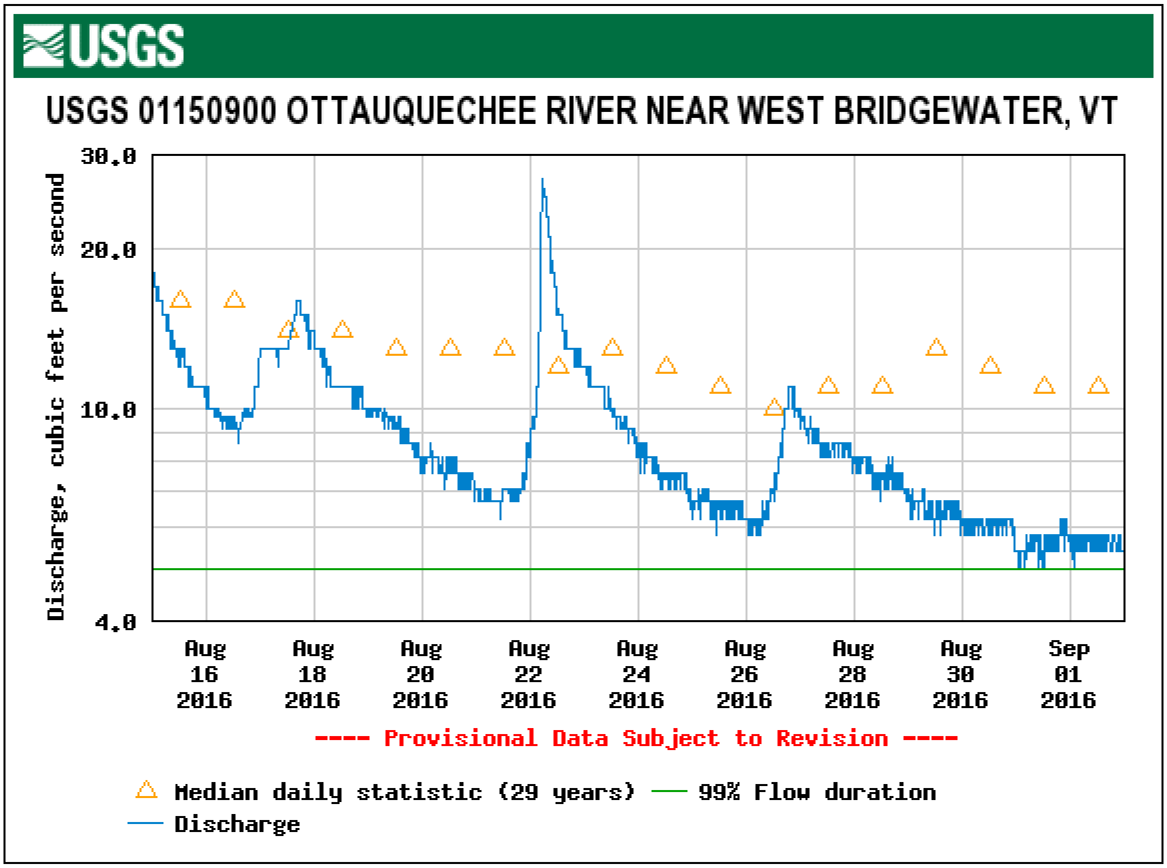
SECTION 11.8: 2016 USGS FLOW GAGE DATA – WEST BRIDGEWATER GAUGING STATION



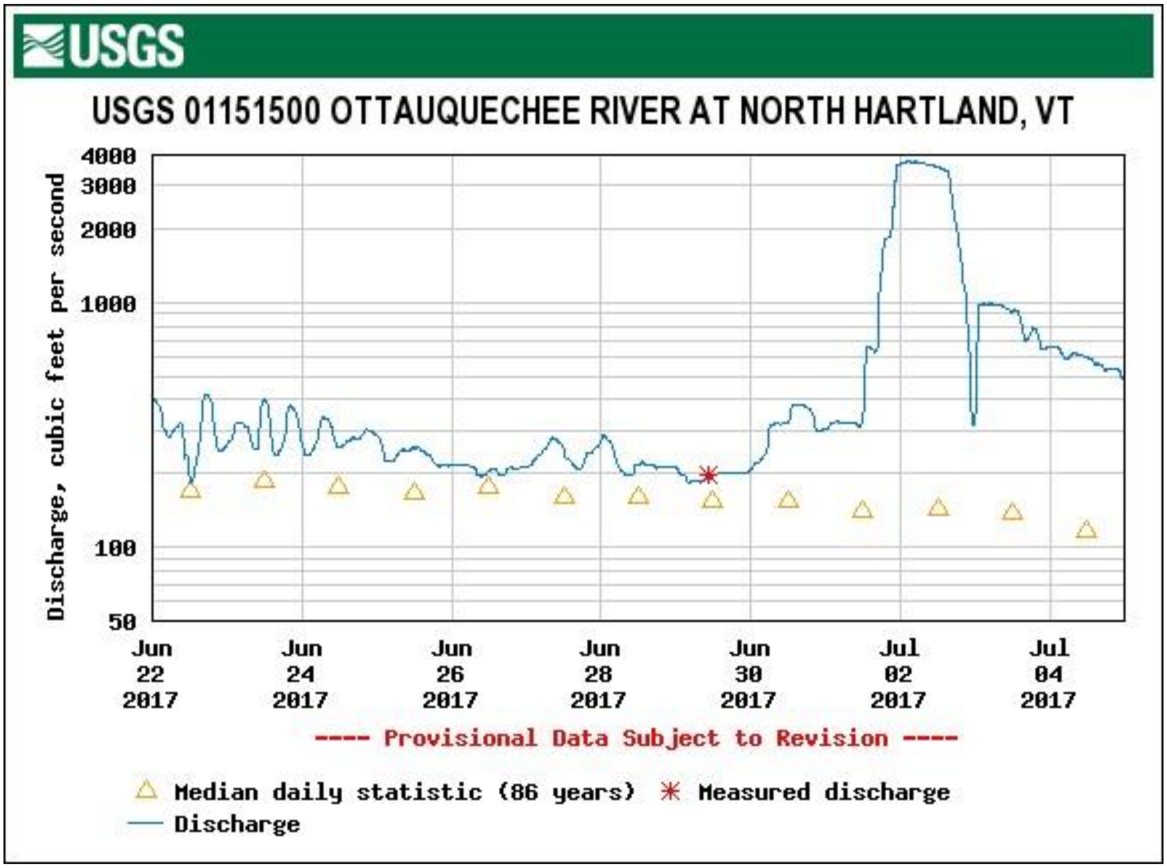


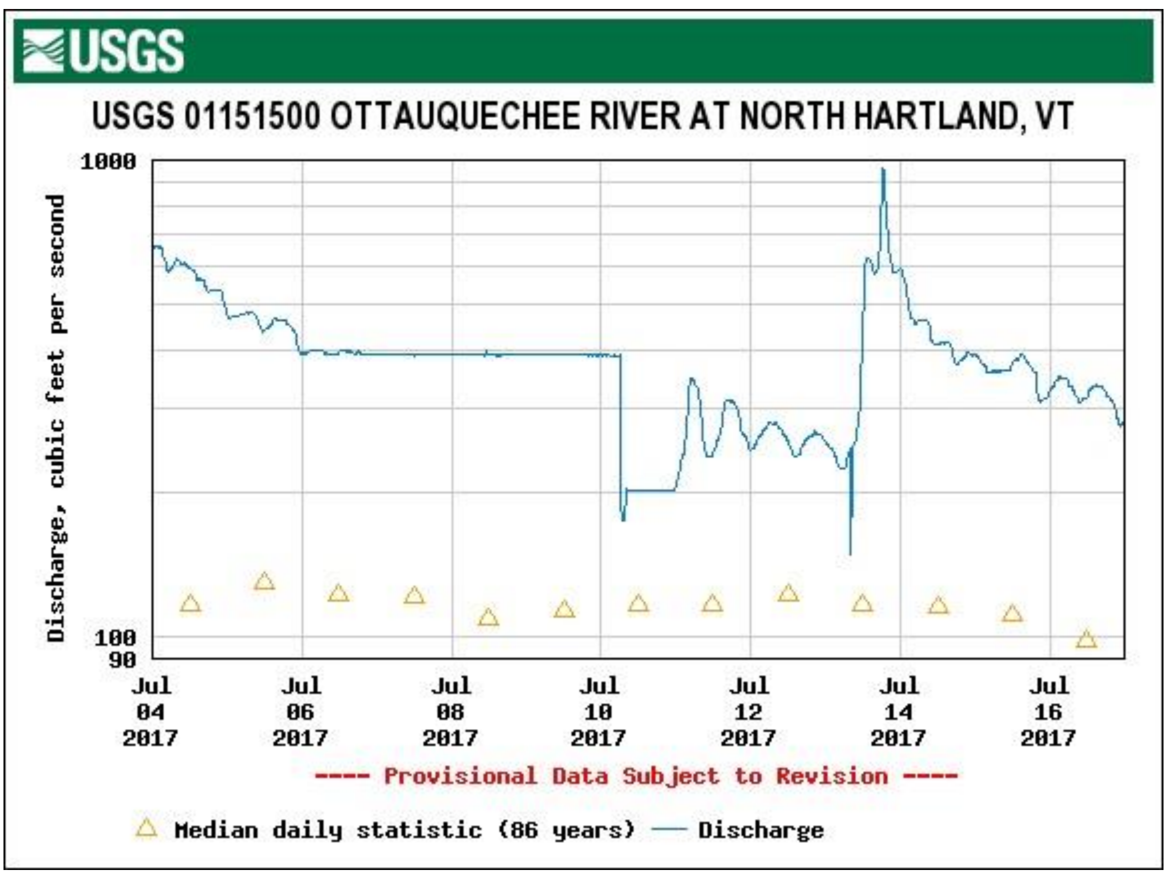

USGS
USGS 01150900 OTTAUQUECHEE RIVER NEAR WEST BRIDGEWATER, VT
Discharge, cubic feet per second
50.0
40.0
30.0
20.0
10.0
5.0
Jul 15 2016
Jul 17 2016
Jul 19 2016
Jul 21 2016
Jul 23 2016
Jul 25 2016
Jul 27 2016
Jul 29 2016
Jul 31 2016
Aug 02 2016
---- Provisional Data Subject to Revision ----
Median daily statistic (29 years)
Measured discharge
Discharge
99% Flow duration

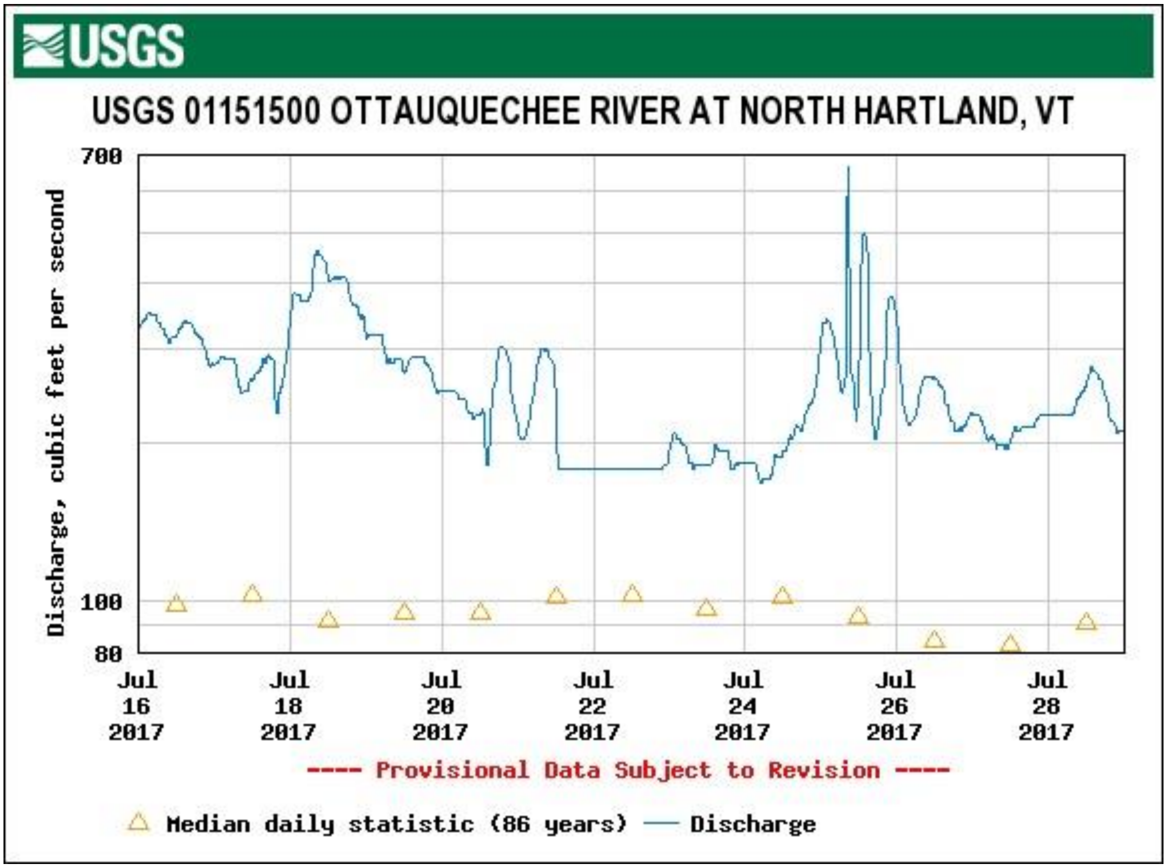

USGS
USGS 01150900 OTTAUQUECHEE RIVER NEAR WEST BRIDGEWATER, VT
Discharge, cubic feet per second
50.0
40.0
30.0
20.0
10.0
4.0
Aug 02 2016
Aug 04 2016
Aug 06 2016
Aug 08 2016
Aug 10 2016
Aug 12 2016
Aug 14 2016
Aug 16 2016
---- Provisional Data Subject to Revision ----
Median daily statistic (29 years)
99% Flow duration
Discharge

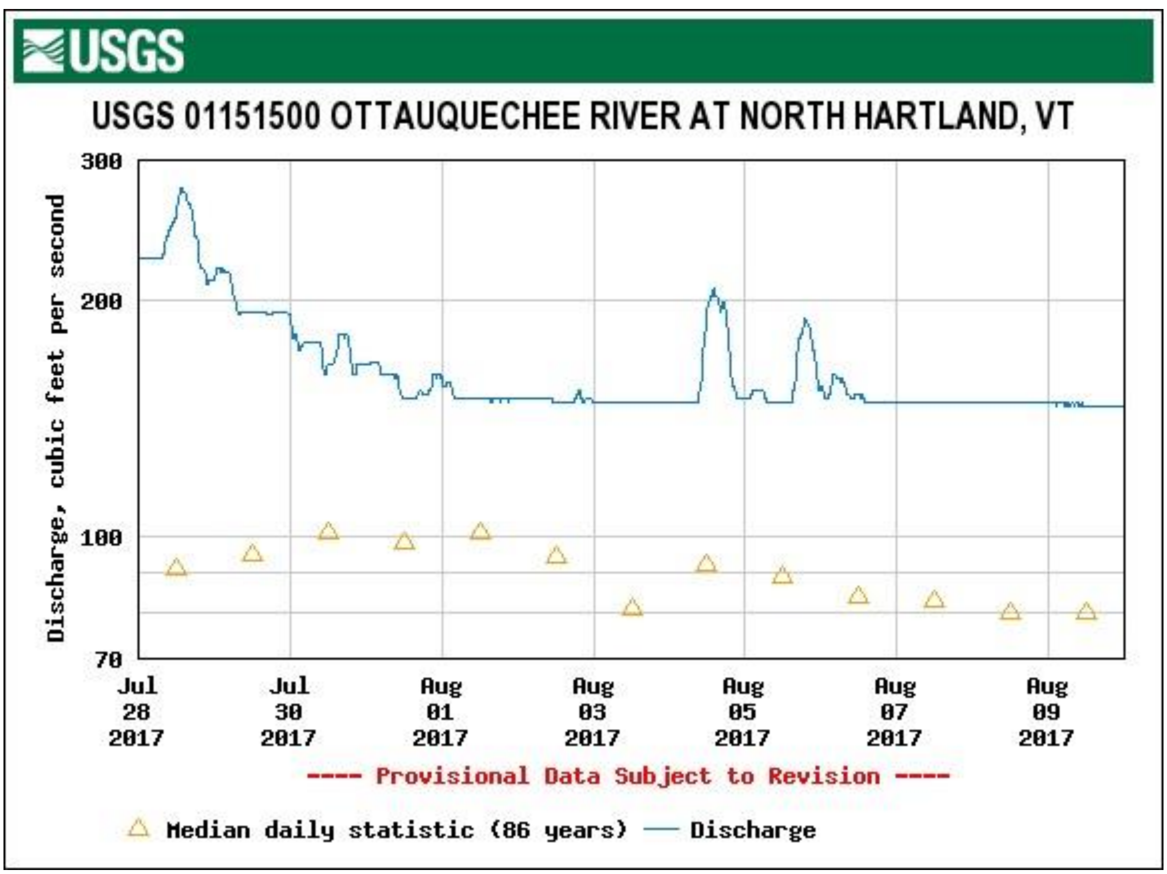

USGS
USGS 01150900 OTTAUQUECHEE RIVER NEAR WEST BRIDGEWATER, VT
Discharge, cubic feet per second
30.0
20.0
10.0
4.0
Aug 16 2016
Aug 18 2016
Aug 20 2016
Aug 22 2016
Aug 24 2016
Aug 26 2016
Aug 28 2016
Aug 30 2016
Sep 01 2016
---- Provisional Data Subject to Revision ----
Median daily statistic (29 years)
99% Flow duration
Discharge

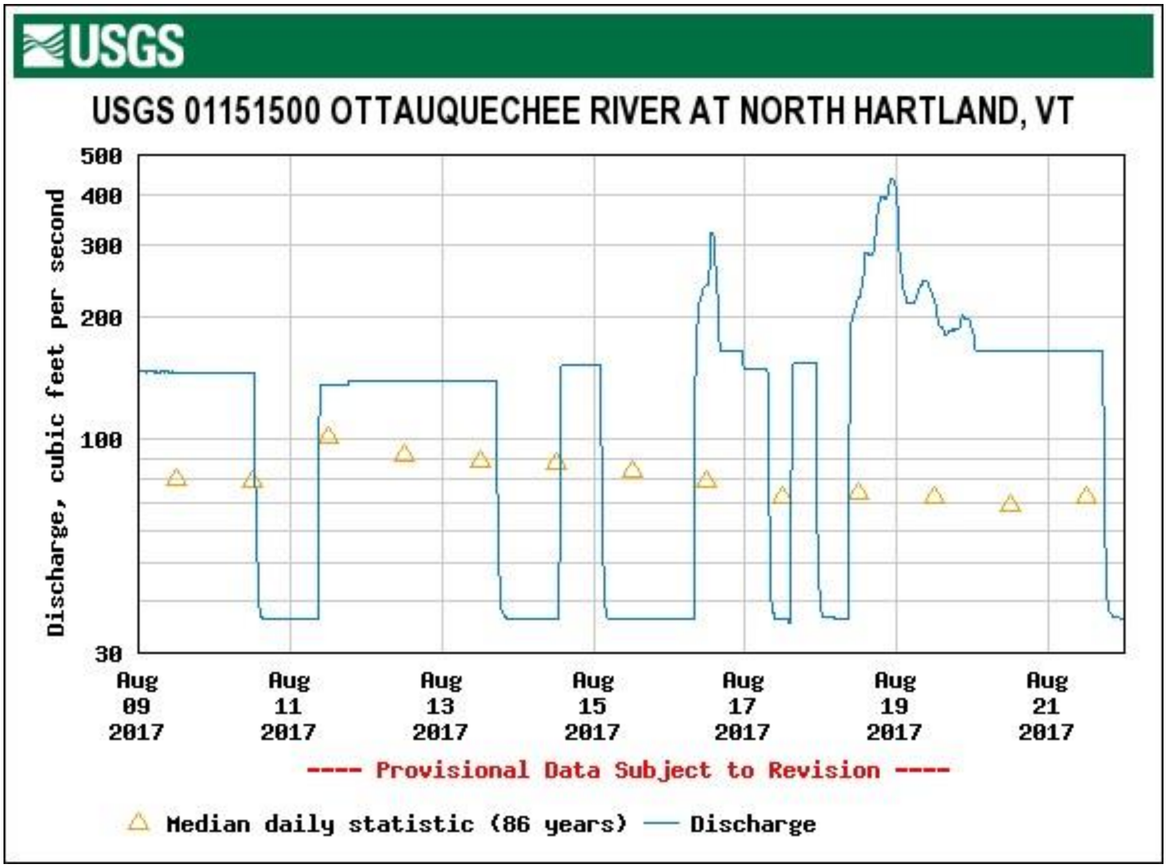
SECTION 11.9: 2017 USGS FLOW GAGE DATA – NORTH HARTLAND GAUGING STATION

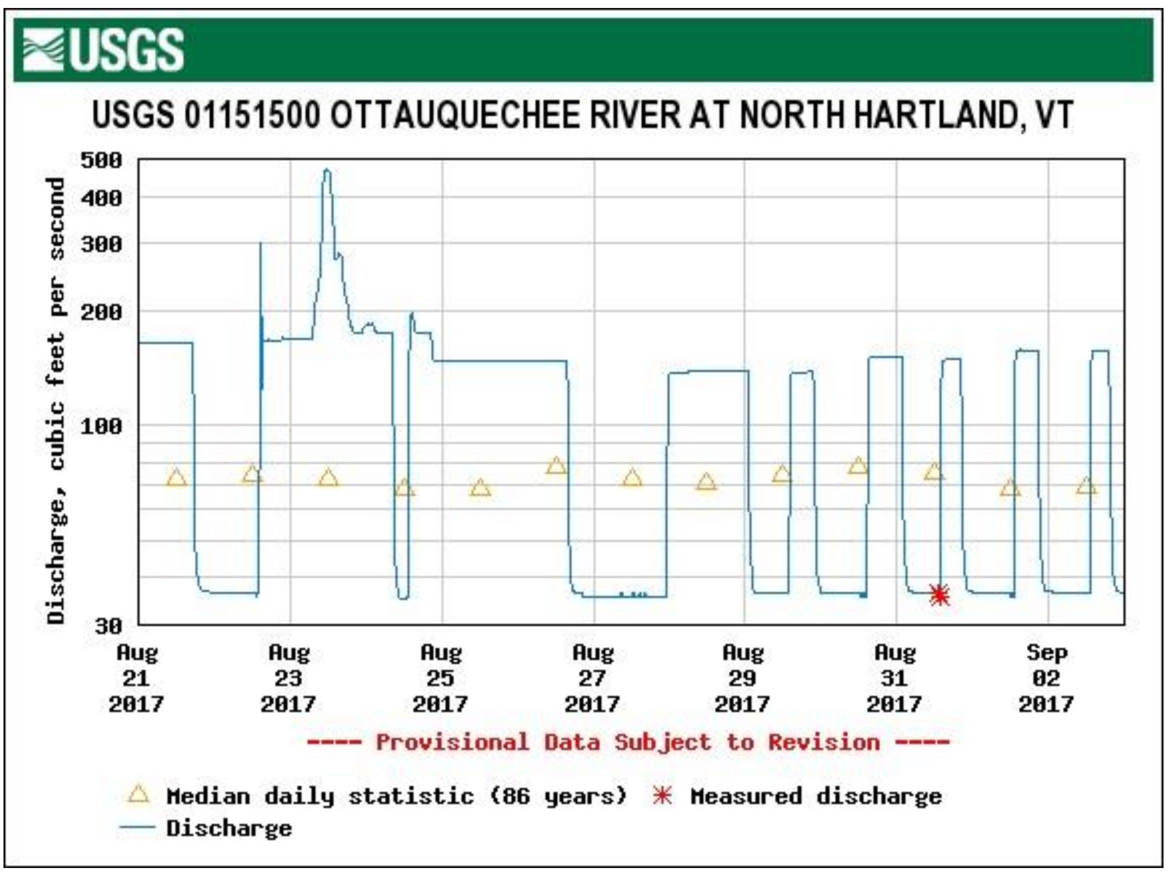




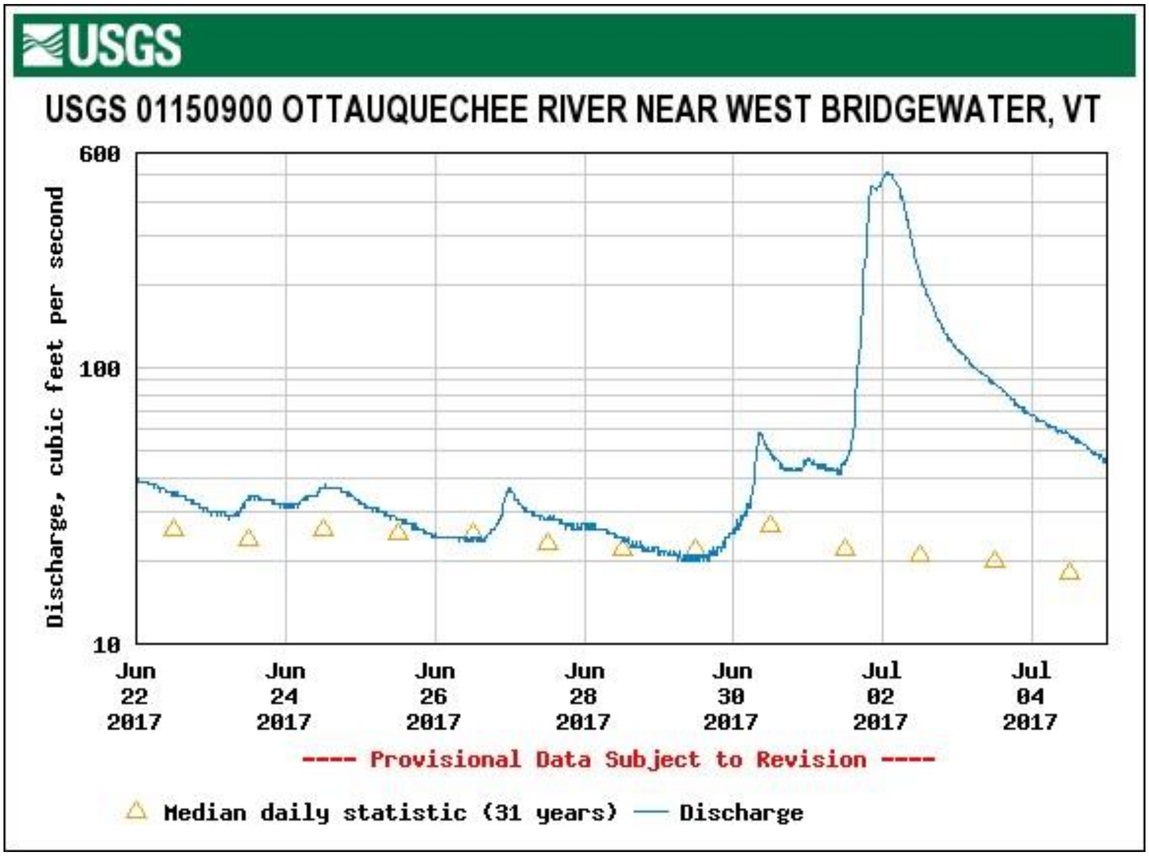

USGS
USGS 01151500 OTTAUQUECHEE RIVER AT NORTH HARTLAND, VT
Discharge, cubic feet per second
700
100
80
Jul 16 2017
Jul 18 2017
Jul 20 2017
Jul 22 2017
Jul 24 2017
Jul 26 2017
Jul 28 2017
---- Provisional Data Subject to Revision ----
Median daily statistic (86 years)
Discharge

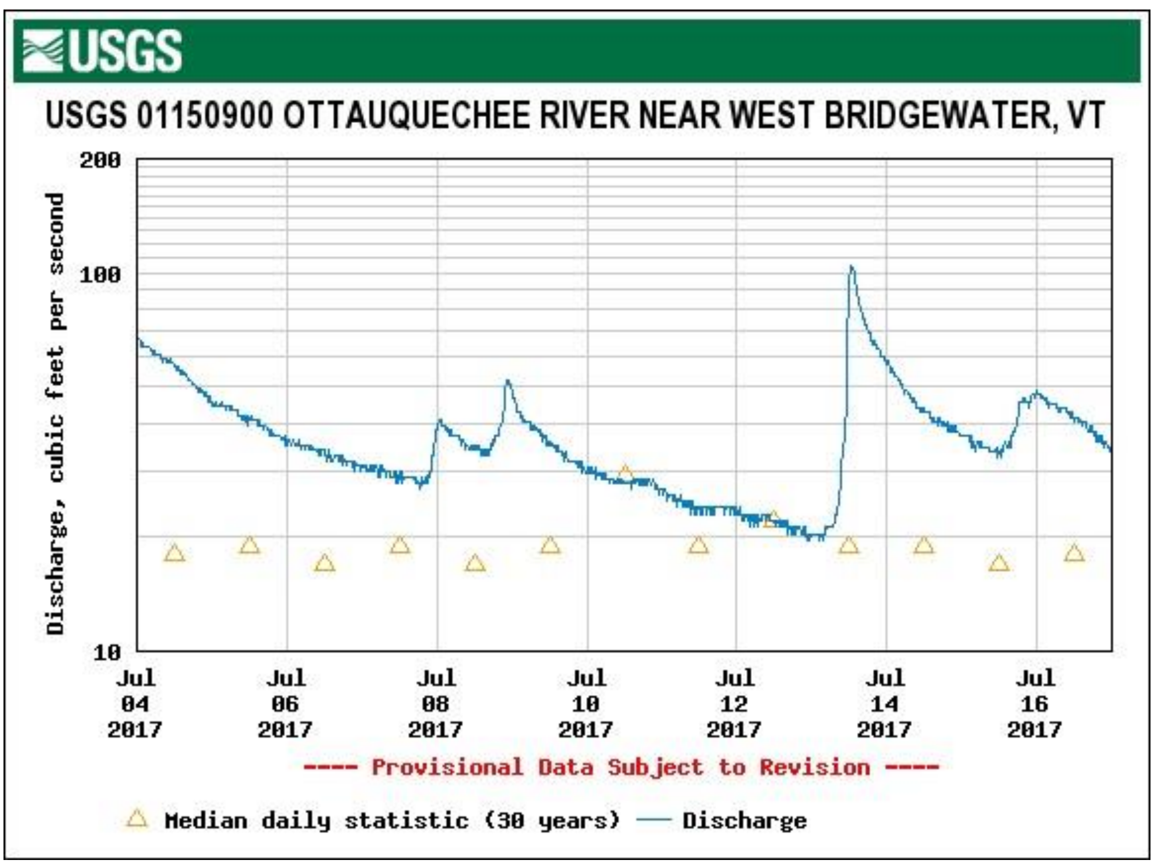

USGS
USGS 01151500 OTTAUQUECHEE RIVER AT NORTH HARTLAND, VT
Discharge, cubic feet per second
300
200
100
70
Jul 28 2017
Jul 30 2017
Aug 01 2017
Aug 03 2017
Aug 05 2017
Aug 07 2017
Aug 09 2017
---- Provisional Data Subject to Revision ----
Median daily statistic (86 years)
Discharge

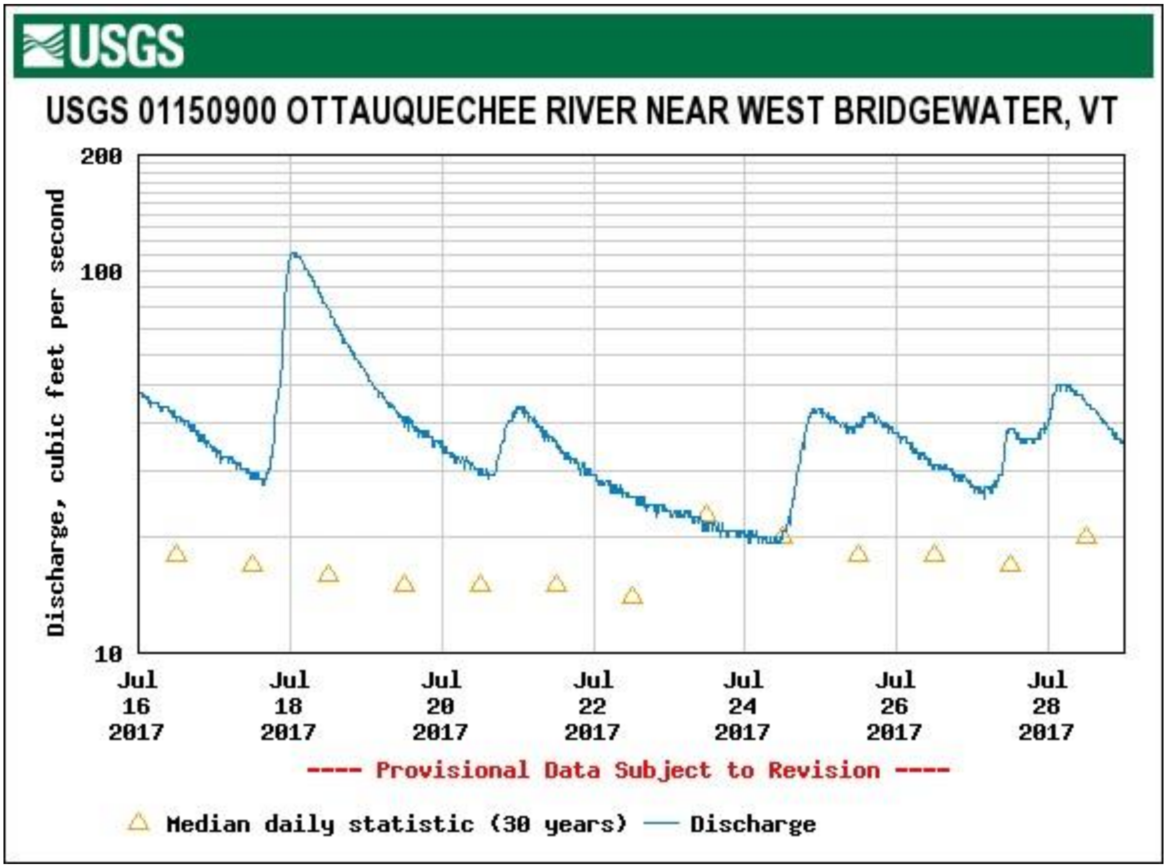

USGS
USGS 01151500 OTTAUQUECHEE RIVER AT NORTH HARTLAND, VT
Discharge, cubic feet per second
500
400
300
200
100
30
Aug 09 2017
Aug 11 2017
Aug 13 2017
Aug 15 2017
Aug 17 2017
Aug 19 2017
Aug 21 2017
---- Provisional Data Subject to Revision ----
Median daily statistic (86 years)
Discharge

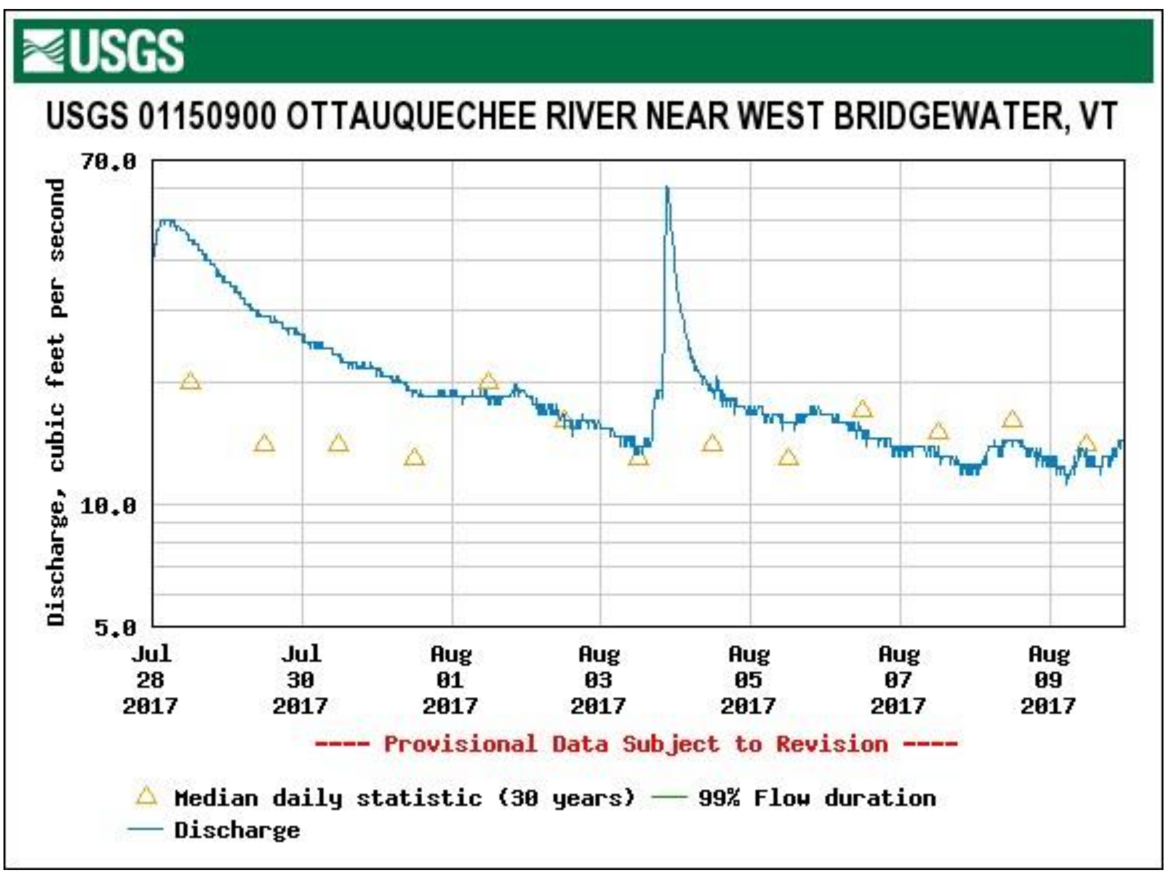

USGS
USGS 01151500 OTTAUQUECHEE RIVER AT NORTH HARTLAND, VT
Discharge, cubic feet per second
500
400
300
200
100
30
Aug 21 2017
Aug 23 2017
Aug 25 2017
Aug 27 2017
Aug 29 2017
Aug 31 2017
Sep 02 2017
---- Provisional Data Subject to Revision ----
Median daily statistic (86 years)
Measured discharge
Discharge

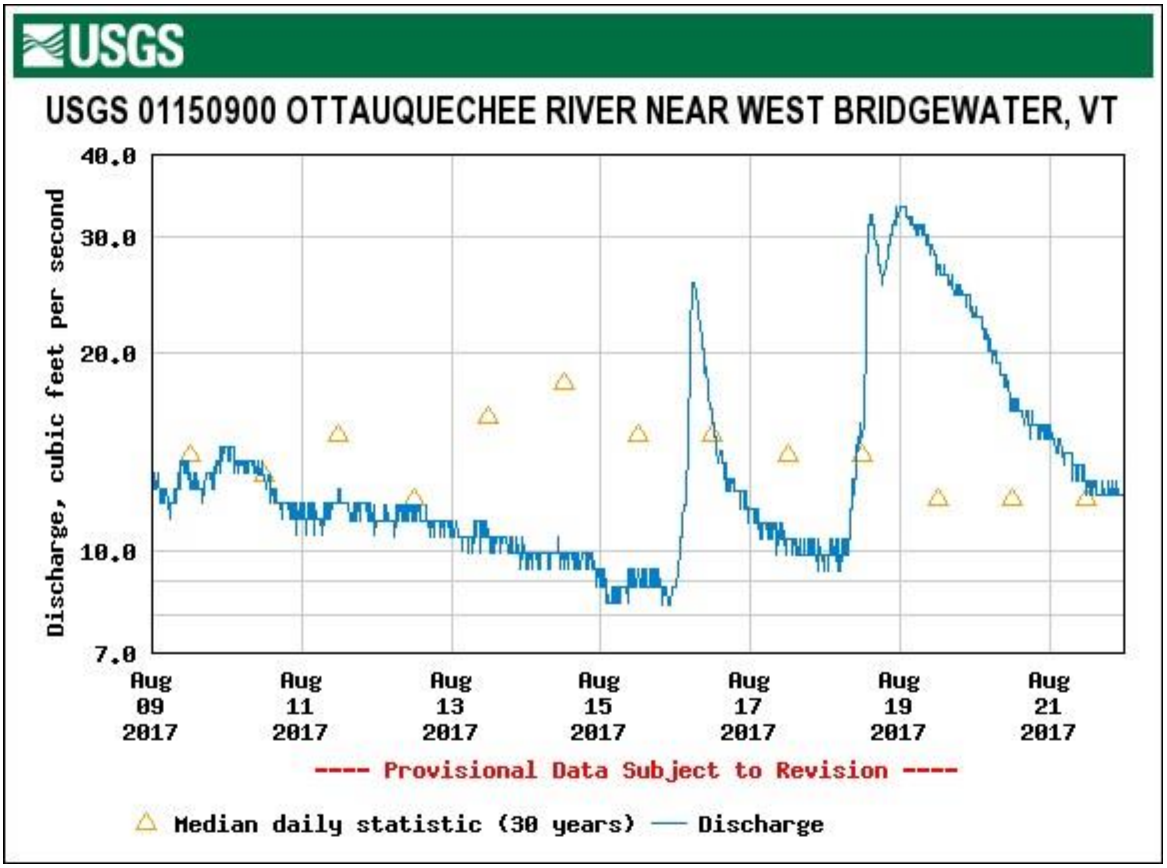
SECTION 11.10: 2017 USGS FLOW GAGE DATA – WEST BRIDGEWATER GAUGING STATION

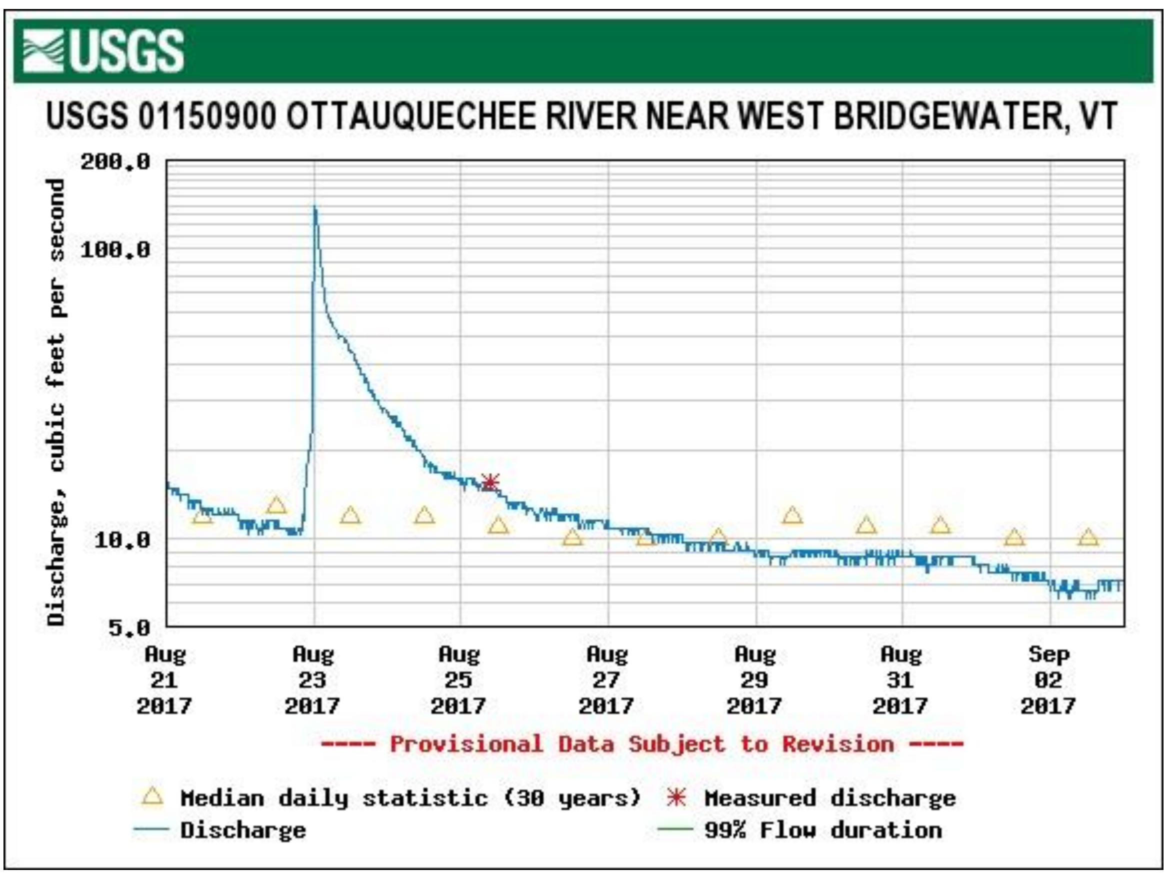





USGS
USGS 01150900 OTTAUQUECHEE RIVER NEAR WEST BRIDGEWATER, VT
200
100
10
Discharge, cubic feet per second
Jul 16 2017
Jul 18 2017
Jul 20 2017
Jul 22 2017
Jul 24 2017
Jul 26 2017
Jul 28 2017
---- Provisional Data Subject to Revision ----
Median daily statistic (30 years)
Discharge


USGS
USGS 01150900 OTTAUQUECHEE RIVER NEAR WEST BRIDGEWATER, VT
70.0
10.0
5.0
Discharge, cubic feet per second
Jul 28 2017
Jul 30 2017
Aug 01 2017
Aug 03 2017
Aug 05 2017
Aug 07 2017
Aug 09 2017
---- Provisional Data Subject to Revision ----
Median daily statistic (30 years)
99% Flow duration
Discharge


USGS
USGS 01150900 OTTAUQUECHEE RIVER NEAR WEST BRIDGEWATER, VT
Discharge, cubic feet per second
40.0
30.0
20.0
10.0
7.0
Aug 09 2017
Aug 11 2017
Aug 13 2017
Aug 15 2017
Aug 17 2017
Aug 19 2017
Aug 21 2017
---- Provisional Data Subject to Revision ----
Median daily statistic (30 years)
Discharge


USGS
USGS 01150900 OTTAUQUECHEE RIVER NEAR WEST BRIDGEWATER, VT
Discharge, cubic feet per second
200.0
100.0
10.0
5.0
Aug 21 2017
Aug 23 2017
Aug 25 2017
Aug 27 2017
Aug 29 2017
Aug 31 2017
Sep 02 2017
---- Provisional Data Subject to Revision ----
Median daily statistic (30 years)
Measured discharge
Discharge
99% Flow duration

SECTION 12: ANNUAL GEOMETRIC MEAN BY SITE

SECTION 12.1: TOTAL PHOSPHORUS ANNUAL GEOMETRIC MEAN BY SITE

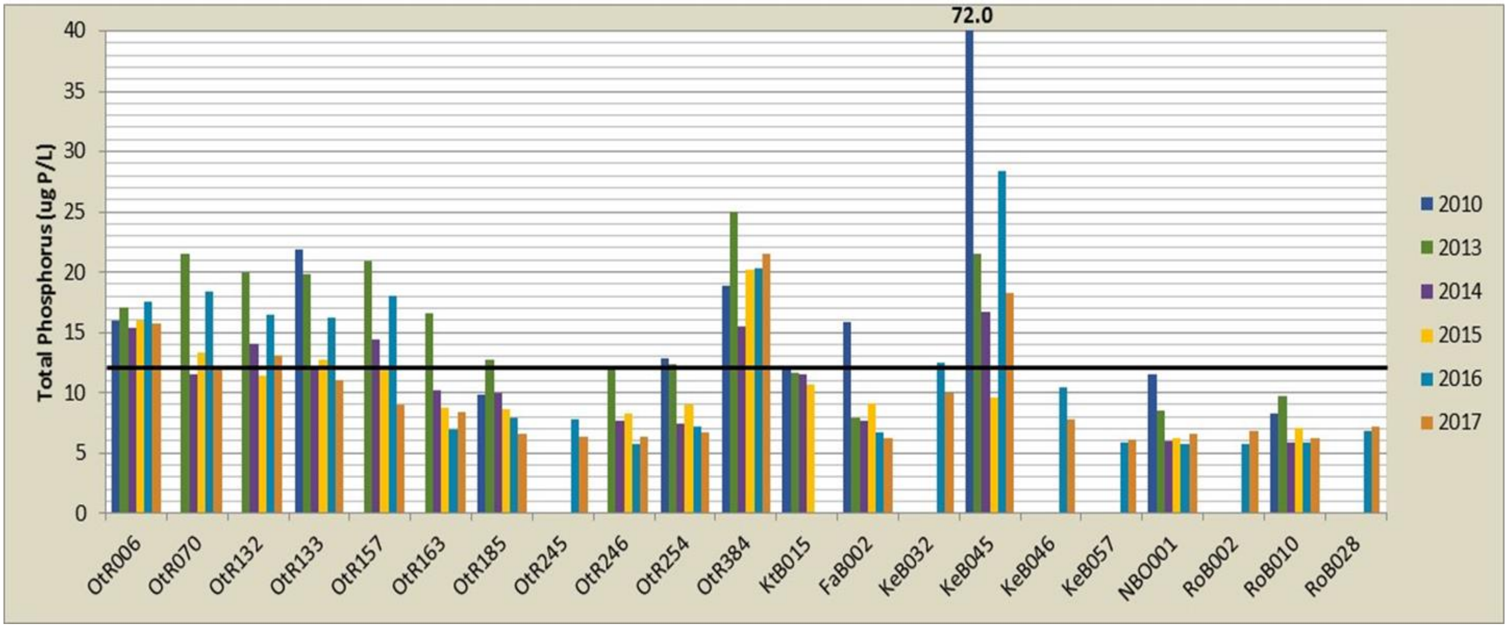


Figure 12a: Total Phosphorus Annual Geometric Mean by Site

42.11% of data points exceed state standards (12 ug/l) dating back to 2010 with respect to Total Phosphorus concentrations based upon annual geometric mean values. Sites OtR006 and OtR384 have exceeded standards each year they've been monitored to date, indicating chronic phosphorus impairment at these sites. While site KeB045 did not exceed standards in 2015, it has exhibited TP impairment every other year, often at very high levels (note the extremely high concentration in 2010 of 72.0 ug/l). Of the sites which have been monitored at least four years, only OtR246, NBO001, and RoB010 have never exceeded state standards. With the exception of site KeB045, TP concentrations are generally significantly higher within the Main Stem Ottauquechee River relative to tributaries. Total Phosphorus concentrations within the Ottauquechee Watershed do not appear to exhibit any significant increasing or decreasing long-term trends at any sites.

SECTION 12.2: CHLORIDE ANNUAL GEOMETRIC MEAN BY SITE

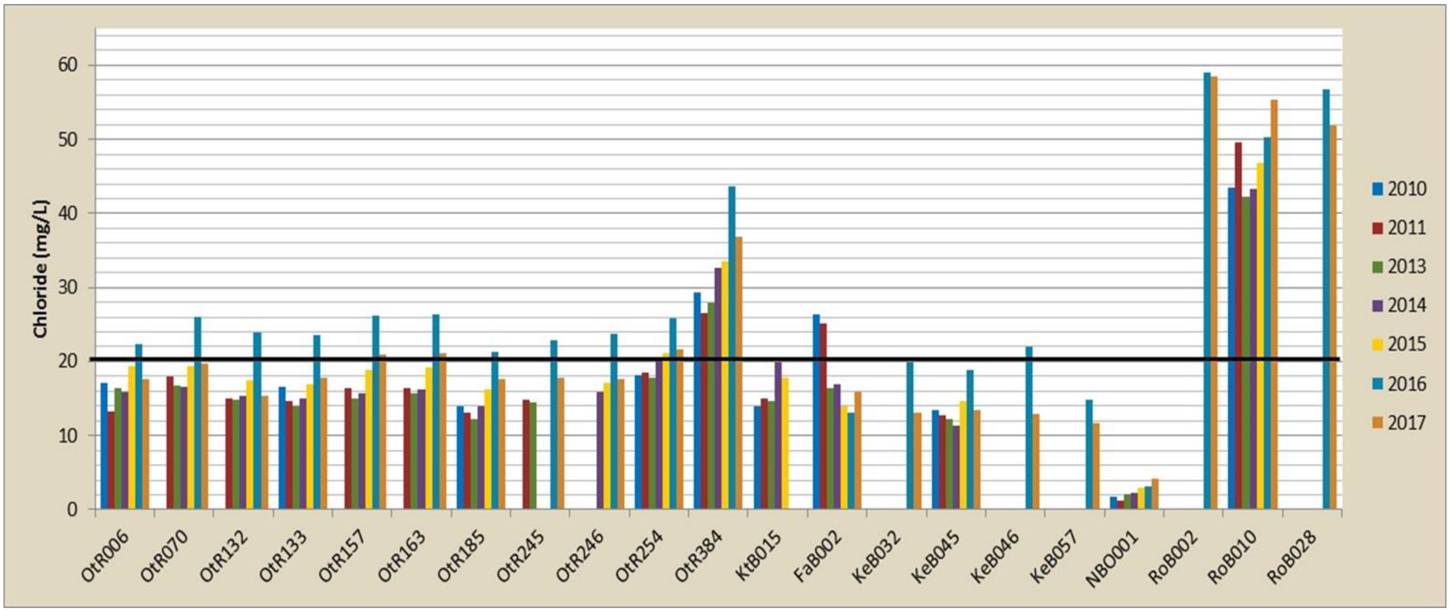


Figure 12b: Chloride Annual Geometric Mean by Site

32.73% of the above mean values exceed current state standards regarding chloride concentrations (20 mg/l). Among sites which have been monitored for at least four seasons, sites OtR384 and RoB010 exceeded standards each year based upon the geometric mean value of all data collected during a given season. Chloride concentrations in Roaring Brook (RoB002, RoB010, & RoB028) are extremely high relative to other sites. This is likely attributable to road salting around the Killington Ski Resort to accommodate safe vehicle travel during icy conditions. Given the relatively mild climate during the winter of 2015-2016, it seems anomalous that chloride concentrations are shown to be higher during the 2016 monitoring season relative to any other year from 2010-2017. One potential explanation could be that given the lack of extremely cold conditions, ice treatment was effective for a larger portion of the winter season, thus more salt was utilized in road treatment as opposed to sand (salt becomes ineffective for ice treatment at about 10-15 degrees Fahrenheit). Excluding sites OtR384 and OtR254, 2016 marks the first season any Main Stem Ottauquechee site predominately exceeded state chloride standards (every main stem site predominately exceeded standards during the 2016 monitoring season). This trend did not continue into the 2017 monitoring season.

SECTION 12.3: TOTAL NITROGEN ANNUAL GEOMETRIC MEAN BY SITE

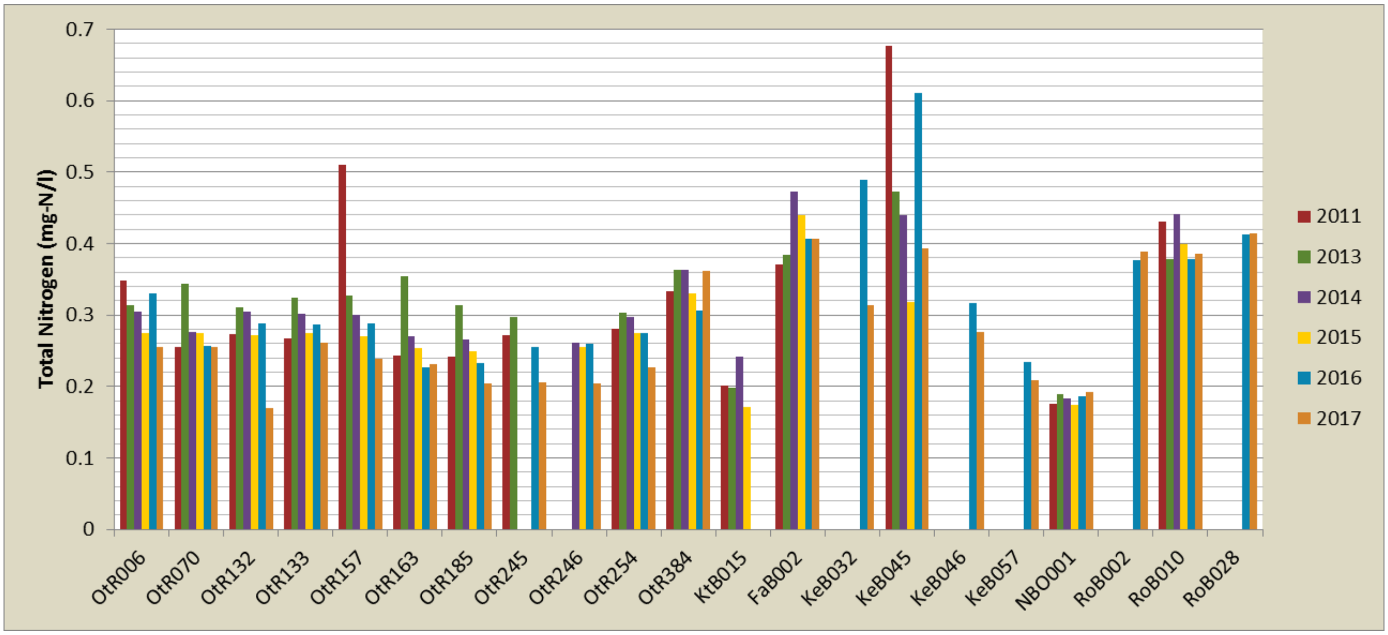


Figure 12c: Total Nitrogen Geometric Mean by Site

100% of the above geometric mean values are well within compliance with current Vermont water quality standards regarding nitrogen (5 mg/l). Total nitrogen concentrations are shown to be the highest at site KeB045 on Kedron Brook and are shown to be the lowest at site NBO001 on the North Branch Ottauquechee River. There does not appear to be any discernible increasing or decreasing long-term trends in total nitrogen concentrations at any site nor are there any mean values which so much as exceed 1 mg/l.

SECTION 12.4: TURBIDITY ANNUAL GEOMETRIC MEAN BY SITE

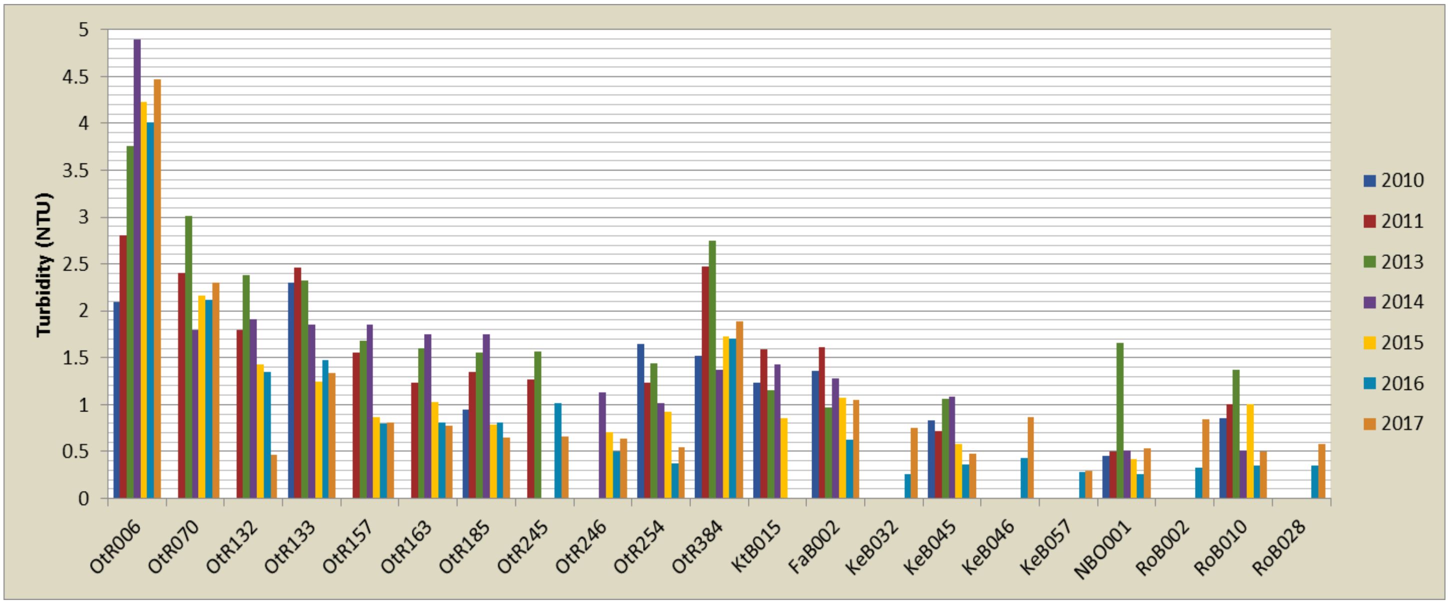


Figure 12d: Turbidity Geometric Mean by Site

100% of the above geometric mean values are well within compliance with current Vermont water quality standards regarding turbidity (10 NTU). Site OtR006 is shown to be by far the most turbid site, likely due to the increased mixing that occurs while in close proximity to the confluence of the Connecticut River. Site NBO001 is shown to be the least turbid site (with 2013 being an exception to that rule). No discernible increasing or decreasing long-term trends are observable from 2010-2017.

SECTION 12.5: E. COLI ANNUAL GEOMETRIC MEAN BY SITE

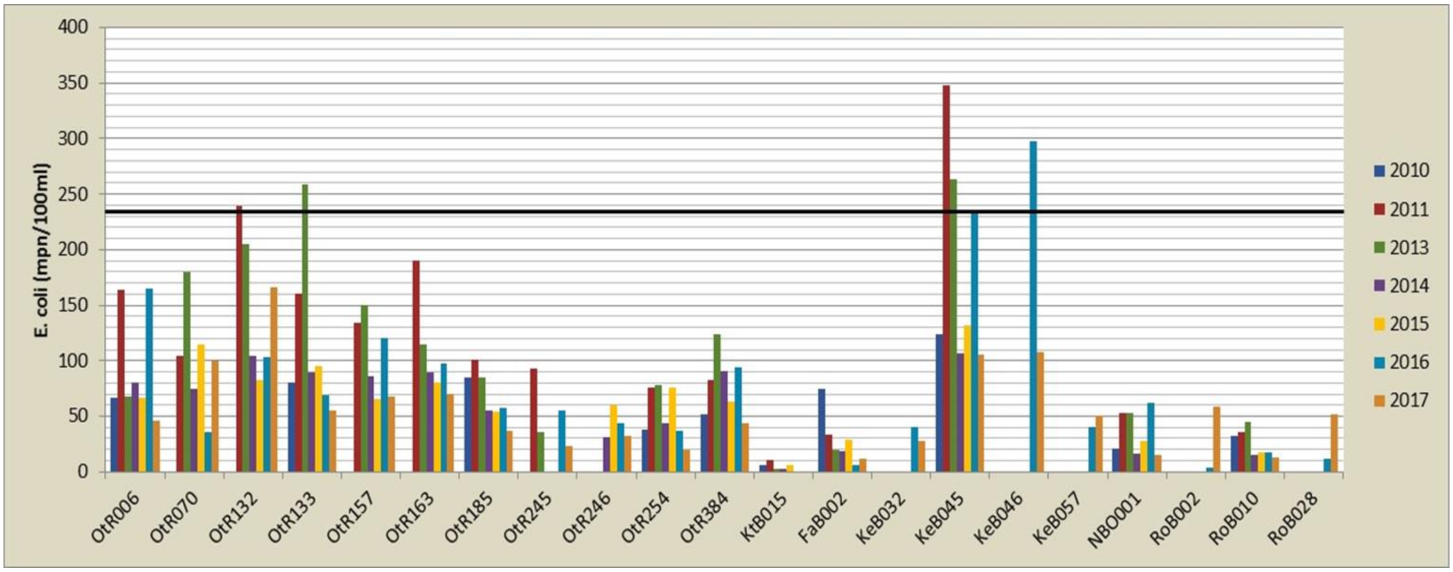


Figure 12e: *E. coli* Annual Geometric Mean by Site

Nearly all of the above geometric mean values are in compliance with current state standards for swimming suitability as only 5 mean values exceed those standards (235 MPN/100 mL sample). Of sites which have been monitored for at least four seasons, site KeB045 on Kedron Brook generally exhibits the highest *E. coli* bacteria concentrations, while site KTB015 on Kent Brook exhibits the lowest concentrations. With the exception of two sites on Kedron Brook, *E. coli* concentrations appear to be generally higher among Main Stem Ottauquechee River sites in relation to tributary sites. There does not appear to be any discernible increasing or declining long-term trends in terms of *E. coli* bacteria concentrations at any sites.

SECTION 13: MONITORING & PARAMETER HISTORY

Site ID	Parameter				
	TP	TN	Cl-	E. coli	TURB
OtR006	XXXXXX		X		
OtR070	XXXX		X		
OtR132	XXXX		X	X	
OtR133	XXXX		X	X	
OtR157	XXXX		XX		
OtR163	X		XX		
OtR185	X		X		
OtR245			X		
OtR246			X		
OtR254	XX		XXXX		
OtR384	XXXXXX		XXXXXXX		
KtB015					
FaB002	X		XX		
KeB032			X		
KeB045	XXXXX			XX	
KeB046			X	X	
KeB057					
NBO001					
RoB002			XX		
RoB010			XXXXXXX		
RoB028			XX		

**This table depicts the number of sampling seasons any particular site and parameter exceeded state standards (based upon geometric mean)*

**Before drawing conclusions based upon this table, please note the variability in the number of sampling seasons each site has been monitored (refer to table below).*

YEARS PROJECT SITES WERE MONITORED							
	2010	2011	2013	2014	2015	2016	2017
OtR006	X	X	X	X	X	X	X
OtR070		X	X	X	X	X	X
OtR132		X	X	X	X	X	X
OtR133	X	X	X	X	X	X	X
OtR157		X	X	X	X	X	X
OtR163		X	X	X	X	X	X
OtR185	X	X	X	X	X	X	X
OtR245		X	X			X	X
OtR246				X	X	X	X
OtR254	X	X	X	X	X	X	X
OtR384	X	X	X	X	X	X	X
KtB015	X	X	X	X	X		
FaB002	X	X	X	X	X	X	X
KeB032						X	X
KeB045	X	X	X	X	X	X	X
KeB046						X	X
KeB057						X	X
NBO001	X	X	X	X	X	X	X
RoB002						X	X
RoB010	X	X	X	X	X	X	X
RoB028						X	X

**Bolded site ID's indicate those sites have been monitored all 7 years of active ORG WQM*

SECTION 14: REFERENCES

Brian Oram, PG. *water-research.net*. 2014. 17 February 2016.

Government of British Columbia - Environmental Protection Division. *Ambient Water Quality Guidelines for Chloride*. 24 April 2003. 17 February 2016.

Kentucky Water Watch. *Chloride and Water Quality*. n.d. 17 February 2016.

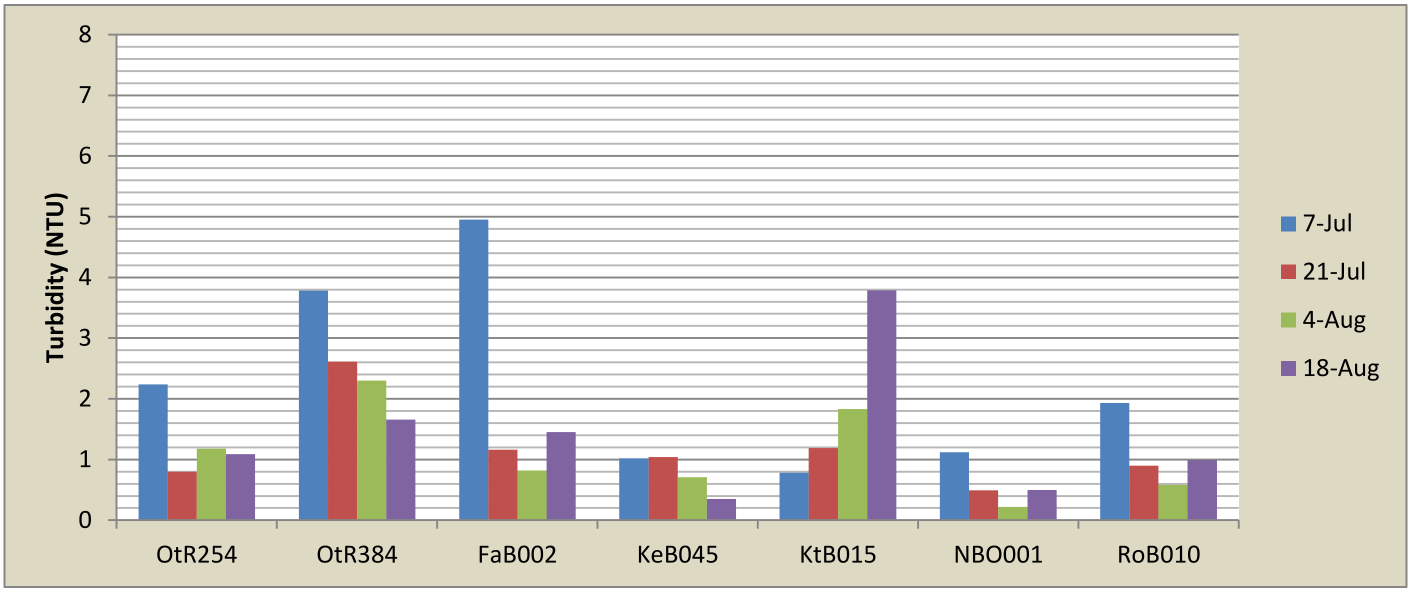
New Hampshire Department of Environmental Services. *Environmental Fact Sheet*. n.d. 17 February 2016.

U.S. Geological Survey. *The USGS Water Science School*. 2 December 2015. 17 February 2016. *The USGS Water Science School*. 27 July 2015. 17 February 2016.

APPENDIX A – SUMMARY OF 2011 DATA

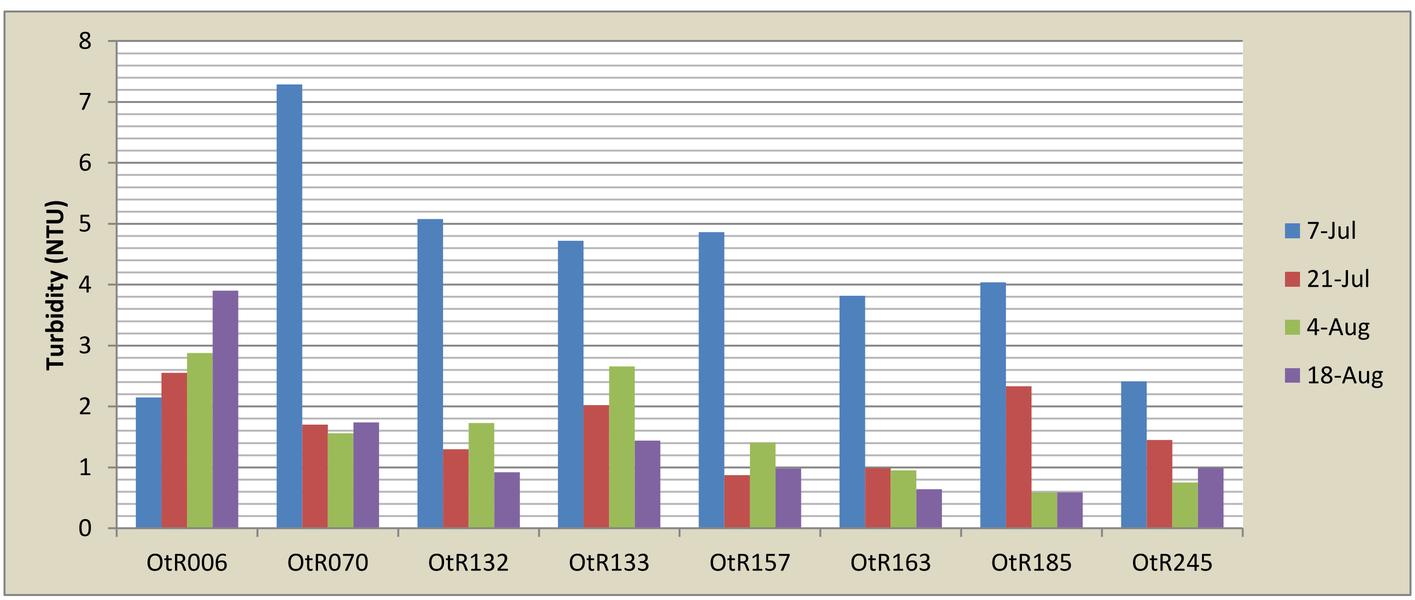
**The results included in Appendix A should not be interpreted as statistically valid data. The minimum number of sample collection dates conducted throughout the course of a season for any given parameter to hold statistical validity is 5, as prescribed by the QAPP (Appendix C of this report). As the 2011 sampling season was interrupted by Tropical Storm Irene, ORG was only able to sample on four of the seven intended monitoring dates. This data is simply included as a reference.*

2011 TURBIDITY DATA:



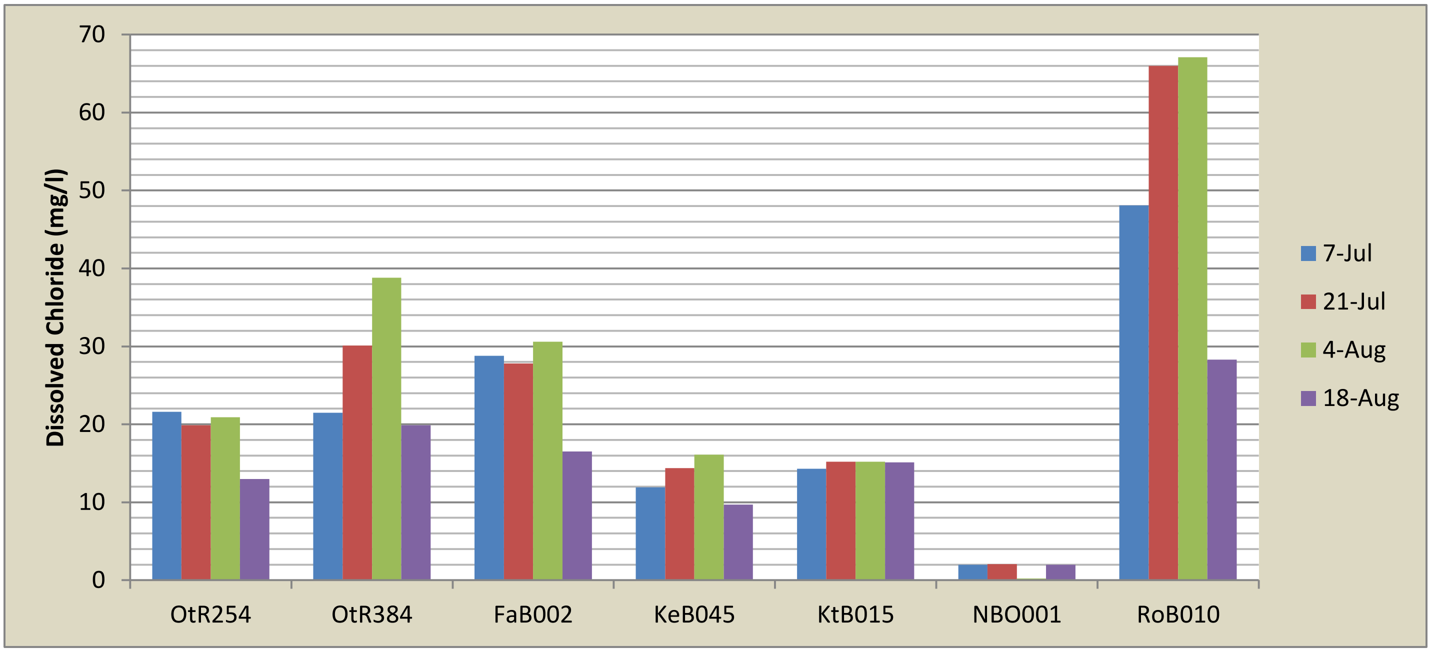
2011 Turbidity Data (above Bridgewater WWTF)

Each turbidity data point collected during the 2011 monitoring season fell well within current Vermont state standards (10 NTU). The site which appears to have been the least turbid during the 2011 season is NBO001. Conversely, sites OtR384 and OtR006 appear to have been the most turbid. Sites OtR006 and KtB015 show very distinct increasing trends throughout the season and OtR384, despite being one of the more turbid site overall, exhibits a very distinct downward trend throughout the season. With those exceptions, no significant trends appear to take place throughout the 2011 monitoring season.



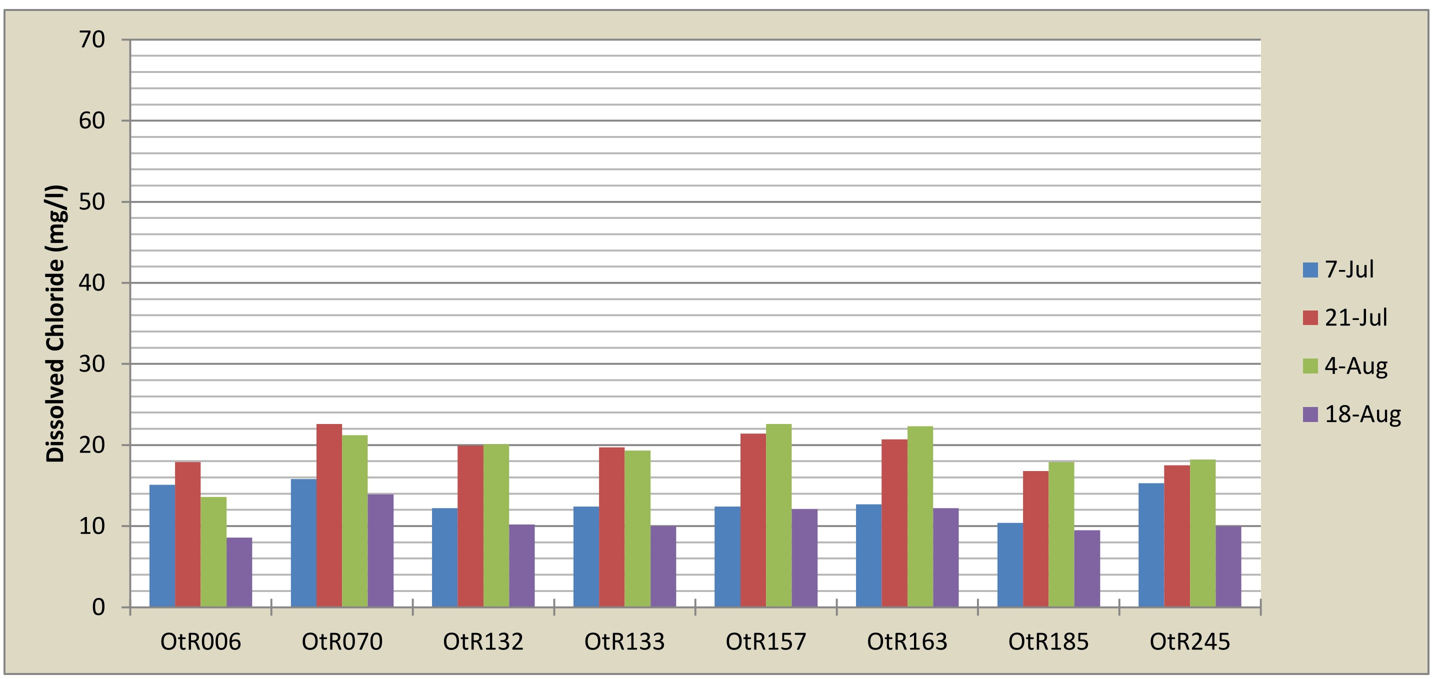
2011 Turbidity Data (below Bridgewater WWTF)

2011 CHLORIDE DATA



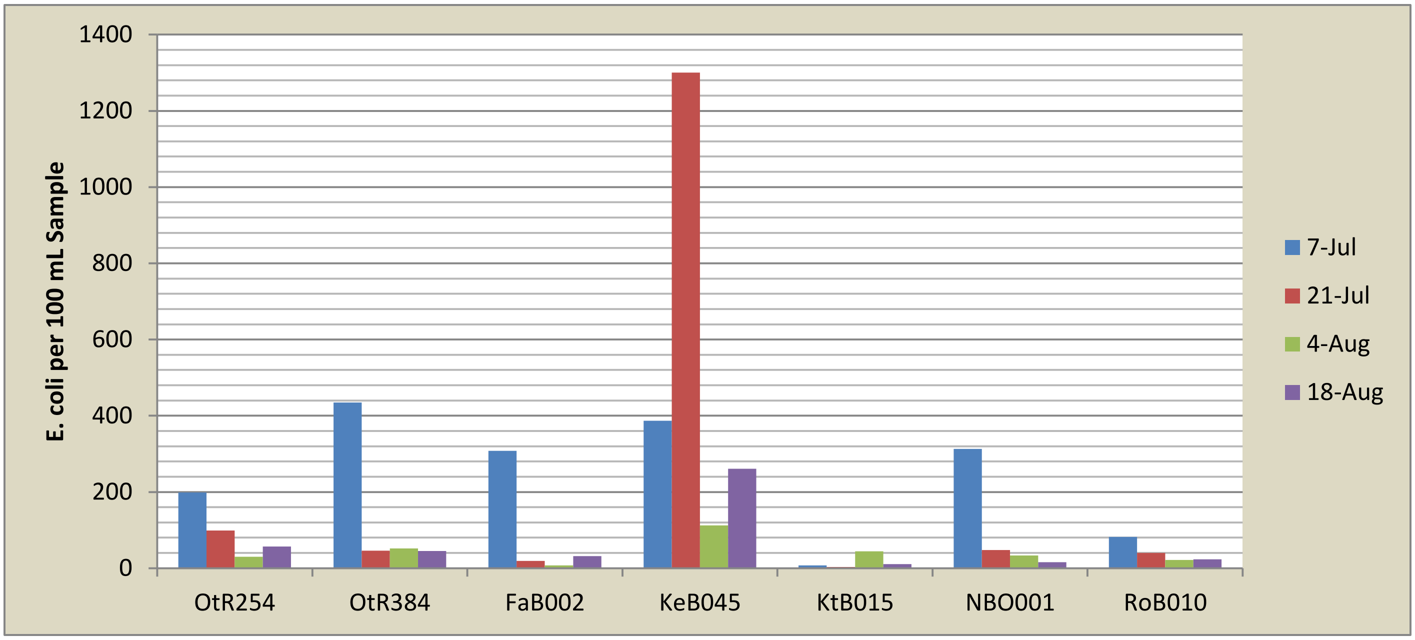
2011 Chloride Data (above Bridgewater WWTF)

The majority of chloride data points collected during the 2011 monitoring season were in compliance with current Vermont state standards (20 mg/L) as only roughly 31.6% of data points exceeded those standards. Site RoB010 on Roaring Brook in Killington exhibited by far the highest concentrations of chloride during the 2011 season, likely due to road salting to accommodate safe vehicle access to the Killington Ski Resort. By and large, chloride concentrations were significantly lower at all sites which fall below the waste water treatment facility in Bridgewater. The lowest and most stable chloride concentrations in 2011 are shown to be at site NBO001 on the North Branch Ottauquechee River, by a significant margin.



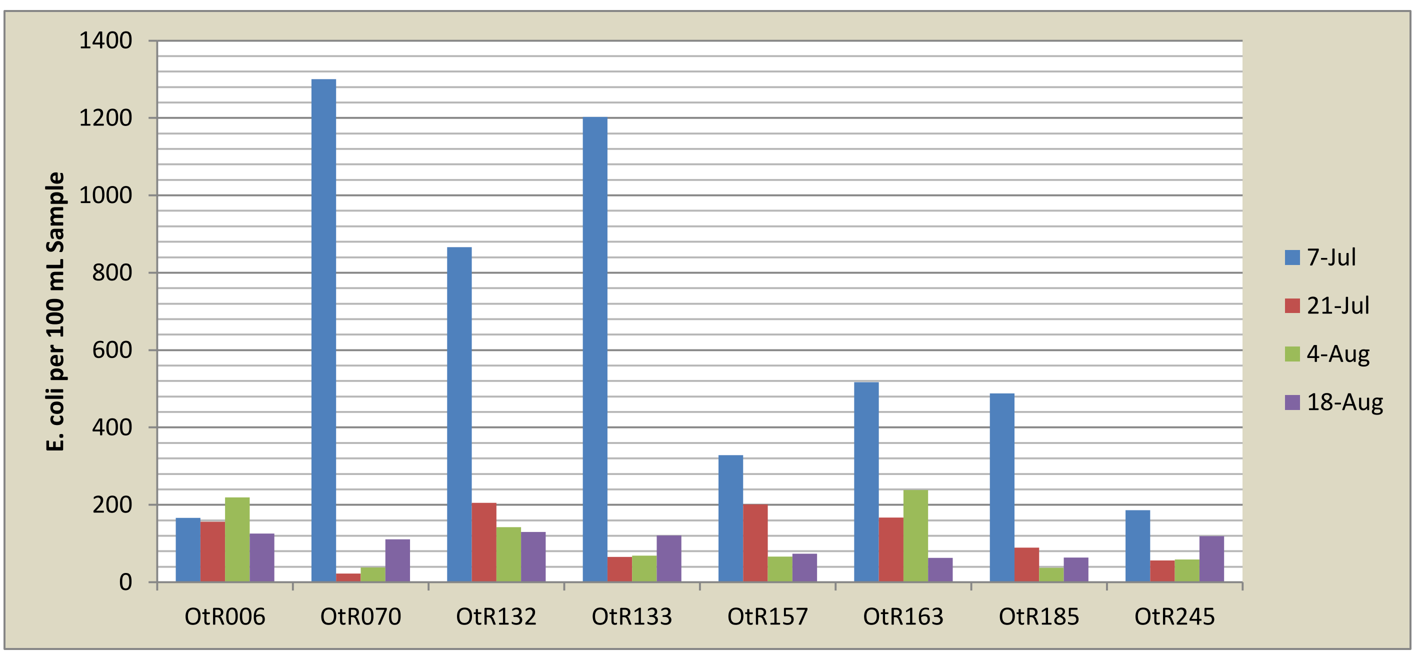
2011 Chloride Data (below Bridgewater WTFF)

2011 E. COLI DATA:



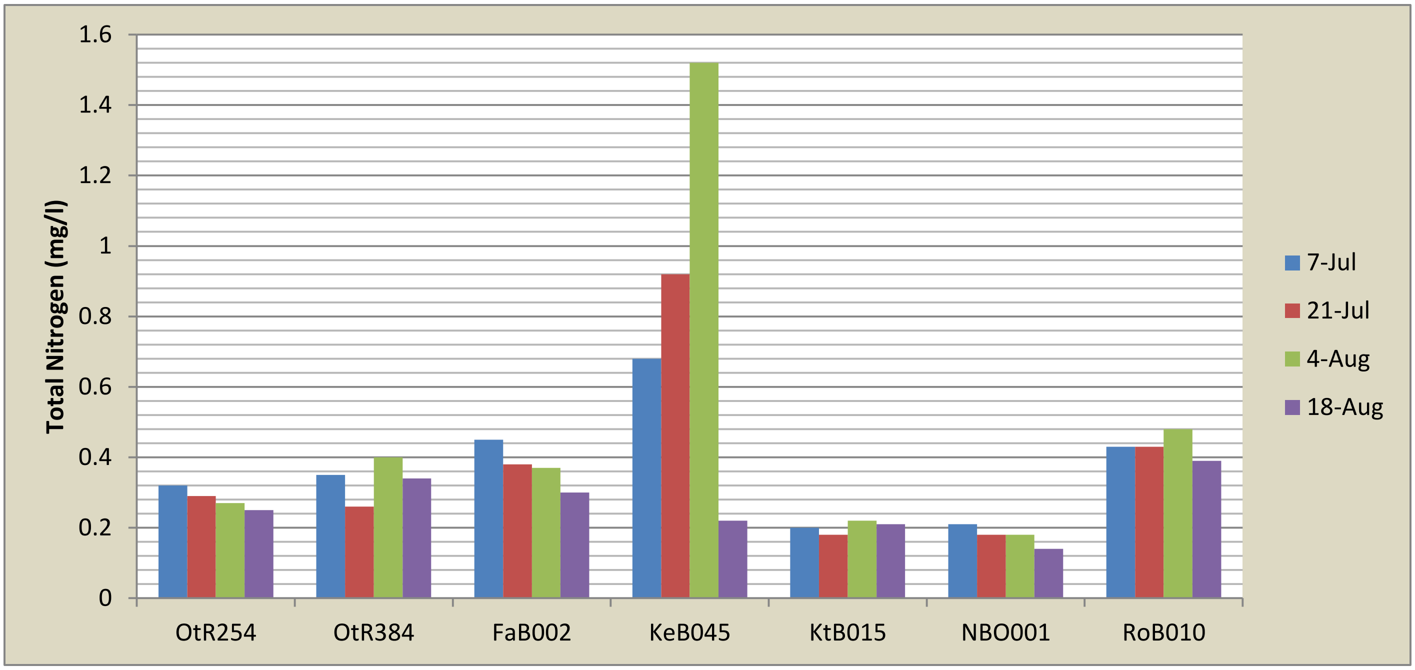
2011 E. coli Data (above Bridgewater WWTF)

The majority of *E. coli* data points collected during the 2011 monitoring season were in compliance with current Vermont state standards for swimming suitability (235 per 100 mL sample) as only 20% of data points exceeded those standards. The highest *E. coli* concentrations during the 2011 monitoring season can be found at site KeB045 on Kedron Brook, as 3 of the 4 data points available at that site exceed state standards. The lowest *E. coli* concentrations can be found at site KtB015 (outlet of Kent Pond), followed by RoB010 on Roaring Brook and NBO001 on the North Branch Ottauquechee River. A significant spike is observable on July 7 at nearly all sites. No significant increasing or descending trends seem to be present throughout the season.



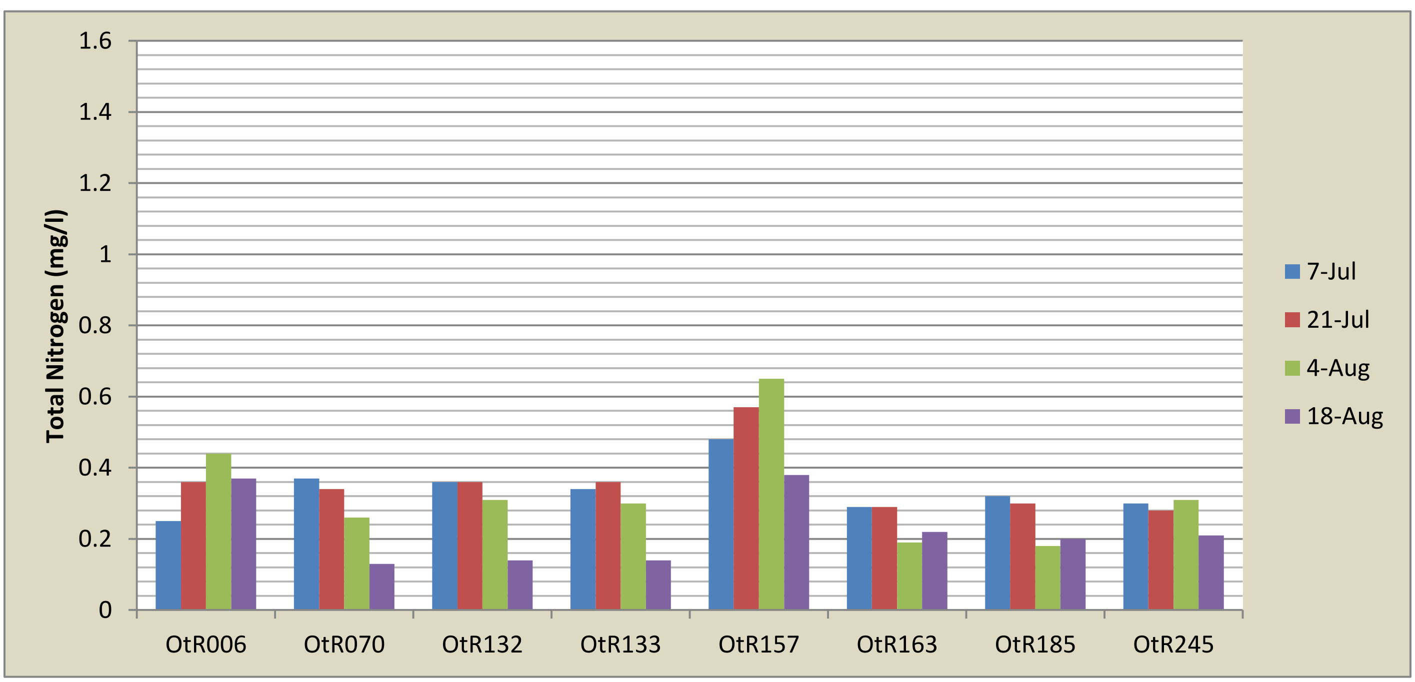
2011 E. coli Data (below Bridgewater WWTF)

2011 TOTAL NITROGEN DATA:



2011 E. coli Data (above Bridgewater WWTF)

All of the total nitrogen data points collected throughout the 2011 monitoring season were well within compliance with current Vermont state standards (5 mg/L). By far the highest concentrations of total nitrogen can be found at site KeB045 on Kedron Brook, while the lowest concentrations by a modest margin can be found at sites KtB015 at the outlet of Kent Pond and site NBO001 on the North Branch Ottauquechee River. Sites OtR070, OtR254, and FaB002 all exhibit distinct declining trends throughout the season. With those exceptions, no significant trends seem to be present.



2011 E. coli Data (below Bridgewater WWTF)

APPENDIX B – 2017 OTTAUQUECHEE MONITORING PLAN

Submitted to:
Jim Kellogg - Environmental Scientist
VT Department of Environmental Conservation – Watershed Management Division
Biomonitoring and Aquatic Studies Section
1 National Life Dr.
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Montpelier, VT 05602-3522

Submitted by:
Chris Yurek – ORG Coordination Assistant
VT Department of Environmental Conservation – ECO AmeriCorps
38 Ascutney Park Rd.
Ascutney, VT 05030

This Project Proposal includes:

1) A description of the project waters;
   The Ottauquechee River and selected tributaries including:

   Roaring Brook   Falls Brook
   North Branch   Kedron Brook

2) Parameters Requested: *E. coli*, Turbidity, Total Phosphorus, Chloride, Total Nitrogen

3) Sampling Dates: (Thursdays following SeVWA dates)
   June 22; July 6; July 20; August 3; August 17; August 31

4) Sites for 2017:

Site Name	Site ID	Latitude	Longitude
Hartland covered bridge swim area	OtR006	43.5931 N	-72.3488 W
Below Quechee WWTF	OtR070	43.6477 N	-72.4108 W
Below Taftsville WWTF	OtR132	43.6299 N	-72.4669 W
Above Taftsville WWTF & Dam	OtR133	43.63203 N	-72.46867 W
Below Woodstock WWTF	OtR157	43.6303 N	-72.5090 W
Above Woodstock WWTF	OtR163	43.6292 N	-72.5075 W
Behind Woodstock Union High School	OtR185	43.61223 N	-72.54421 W
Below Bridgewater WWTF	OtR245	43.5858 N	-72.6184 W
Above Bridgewater WWTF	OtR246	43.58637 N	-72.61995 W
Route 100A Bridge	OtR254	43.58648 N	-7265647 W
Rabeck Road Bridge	OtR384	43.65093 N	-72.76862 W
Falls Brook/Ottauquechee Confluence	FaB002	43.60423 N	-72.75102 W
Kedron Brook below Horse Stables	KeB032	43.575140 N	-72.515449 W
Kedron Brook below WWTF	KeB045	43.5652 N	-72.5281 W
Kedron Brook above WWTF	KeB046	43.56508 N	-72.52874 W
Kedron Brook above GMHA	KeB057	43.554160 N	-72.545467 W
North Branch/Otto Confluence	NBO001	43.59335 N	-72.66113 W
Roaring Brook above Roaring/Otto Confluence	RoB002	43.658907 N	-72.773887 W
Roaring Brook/Mountain View Road Crossing	RoB010	43.64901 N	-72.78779 W
Roaring Brook above WWTF (just u/s of Ravine Road bridge)	RoB028	43.634434 N	-72.786835 W

Project Waters:

The Ottauquechee River runs approximately 38 miles in length and encompasses roughly 223 square miles of drainage area. The headwaters of the Ottauquechee are located in the Green Mountain Range in Killington, Vermont. From there the river travels through east-central Vermont before drainage into the main stem Connecticut River in North Hartland, Vermont. There are a number of major tributaries to the river, including the North Branch Ottauquechee, Broad Brook, Pinney Hollow Brook, Barnard Brook, Kedron Brook, and Roaring Brook.

Fourteen segments within the watershed are listed as stressed, impaired, and altered by stormwater inputs, nutrients, sediment, organic enrichment, iron, metals, artificial flow, dewatering, annual water level fluctuations, *E. coli*, temperature, and/or physical alterations. This is caused by a combination of hydroelectric facility operations (FERC licenses to expire in 2021), golf course, ski area and horse recreation development, channelization, river-road conflicts, erosion, non-point source pollution, WWTF's, etc. Additionally, two segments of Roaring Brook and an unnamed tributary to the Ottauquechee in Bridgewater are listed on VT DEC's 303(d) list of impaired waters in need of TMDL for stormwater inputs, iron, and metals.

The Ottauquechee River has many important recreational functions including boating, kayaking, swimming, and fishing for both coldwater and warmwater species (warmwater fishery limited to as far up river as the North Hartland Dam down to the confluence with the Connecticut River). The watershed holds populations of both native and stocked trout (Rainbows, Browns, and Brook Trout).

In addition to its many recreational uses and aquatic organism habitat, the Ottauquechee Watershed is also home to many other important wildlife species including Osprey, Common Loon, American Bittern, American Black Duck, Pied Billed Grebe, Blue Winged Teal, and American Bald Eagle.

Data Needs & Intended Usage:

The data derived from this monitoring effort has in the past, and will continue to be invaluable for identification of impaired stream segments as a preliminary step to implementing ecosystem restoration projects. Additionally, this data can help inform DEC and partner organizations when or if any waste water treatment facilities are not adequately treating effluent. Furthermore, data collected through this project will help inform the public as to when this heavily utilized recreational resource is unsafe for swimming or boating due to high *E. coli* concentrations.

Sample Collection Method:

Samples will be collected via grab method, using all of the proper rinsing methods and other quality assurance/quality control protocol as prescribed by the USEPA Project QAPP, including field blanks and field duplicates. For sample names and locations, see table above.

Frequency & Timing of Sampling Dates:

This proposal consists of the sampling of twenty sites for five parameters on six dates throughout the course of the summer of 2017. Samples will be collected on a bi-weekly basis every other Thursday following the sampling dates of the Southeastern Vermont Watershed Alliance (SeVWA). Samples will be delivered to the laboratory the same day they are collected.

PARAMETERS & NUMBER OF SAMPLES REQUESTED	
Twenty stations are being requested	
Parameter	Number of Samples Requested
Phosphorus	120
Nitrogen	120
Chloride	120
Turbidity	120
E. coli	120
Total Number of Samples	**600**

Data Summarization & Reporting:

Data will be summarized and reported on at the end of the 2017 monitoring season by simply taking the raw data, graphing it in an interpretable way, analyzing it, and adding it to the existing six year ORG summary (last revised 01/05/2017). QA/QC data will be reviewed, analyzed, and added into the report as well as data completeness statistics and flow data based upon USGS gauging stations. Narrative analysis of the data will be completed and included.

Anticipated Outcomes & Public Outreach:

ORG anticipates that the results of the 2017 monitoring season will continue to be incredibly valuable. This data is important as it informs the public as to when this valuable recreational resource is unsafe for swimming or other recreational uses due to high bacteria counts, and it helps inform state and regional governmental agencies, as well as non-profits and other NGO's identify potential contributors to nutrient enrichment and pollution as a preliminary means to mitigate those sources.

ORG plans to make monitoring data readily available to the public, and will be sure that anyone who would like a copy of ORG's report can easily access it. ORG will schedule a meeting after the completion of the 2017 monitoring season to present the findings to the public, provided there is public interest.

Implementation Plans

Through findings derived from the 2017 monitoring season, ORG and partner agencies and organizations will attempt to identify contributors to nutrient enrichment and pollution in the Ottauquechee Watershed; and in partnership with potential funders (VT Ecosystem Restoration Program, VT Watershed Grant, NE Grassroots Environmental, etc.) agencies and organizations will attempt to implement agricultural BMP's, GSI projects, and other practices in an effort to improve the ecological health of the project waters.

Contact Information

Todd Menees – Program Coordinator

802-345-3510
applehill@vermontel.net
91 Applehill Road
Bridgewater Corners, VT 05035

Chris Yurek – Program Coordination Assistant
603-690-5211
yurek001@live.com
38 Ascutney Park Road
Ascutney, VT 05030

APPENDIX C – 2017 OTTAUQUECHEE RIVER GROUP QUALITY ASSURANCE PROJECT PLAN

1. Title and Approval

A. Your Specific Project in cooperation with VTDEC/VAEL "2017 Volunteer LaRosa Partnership Program Analytical Services Grant:

Ottauquechee Water Quality Monitoring Program
(Your Project's Name)

Ottauquechee River Group
(Name of Your Organization)

April 4, 2017
(Date)

INSTRUCTIONS: Please fill in the spaces below with appropriate information for your project and organization. Collection of samples for this project must not take place until the QAPP is delivered to VTDEC for signature.

Project Coordinator Signature/Date: ___________________________________

Project QA Officer Signature/Date: ____________________________________

Project QAPP Prepared by: Chris Yurek

Approval by*:* ____

James Kellogg

VTDEC Environmental Scientist
LaRosa Partnership Program Coordinator

Date

B. Generic Volunteer - Based Water Quality Monitoring Project QAPP:

Vermont General Quality Assurance Project Plan for Volunteer, Educational and Local Community Monitoring and Reporting Activities

Ottauquechee Water Quality Monitoring Program
(Project Name)

VT Department of Environmental Conservation
(Responsible Agency)

April 5, 2017
(Date)

QAPP Prepared by:
Lee Steppacher & Diane Switzer, EPA New England
and *Modified by James Kellogg, VTDEC.*

2. Table of Contents

INSTRUCTIONS: Change page numbers and appendices as needed for your project. Insert information for any pages of additional information you attach (e.g., maps, manuals, written procedures, etc.)

3. Distribution List

A. Names and telephone numbers of those receiving copies of this QAPP.

i. Jim Kellogg, VT Department of Environmental Conservation. Watershed Management Division, 1 National Life Drive, Main Building - 2cd Floor, Montpelier, VT 05602-3522. 1(802) 490-6146. Jim.Kellogg@vermont.gov

ii. Multiple 2017 LaRosa Partnership Program (LPP) participants – complete list available upon request.

iii. Marie Caduto, VT Department of Environmental Conservation, Watershed Management Division. 100 Mineral Street, Springfield, VT 05156-3168. 802-289-0633. marie.caduto@vermont.gov.

iv. Todd Menees. VT Department of Environmental Conservation, Watershed Management Division. 1 National Life Drive, Main 2, Montpelier, VT 05620-3522. 802-345-3510. todd.menees@vermont.gov.

v. Chris Yurek. Ottauquechee River Group. Program coordinator. Post Office Box 320, Ascutney, VT 05030. 802-674-9201. yurek001@live.com.

4. Project/Task Organization

A. Table 4a – VTDEC/VAEL – Primary Contact and Their Responsibilities.

Project Title/Responsibility	Name
VTDEC LaRosa Partnership Program (LPP) Coordinator	Jim Kellogg
VT Agriculture and Env. Laboratory (VAEL) Director	Guy Roberts
VAEL Supervisor	Dan Needham

B. Table 4b - Key Project People and Their Responsibilities

INSTRUCTIONS: Fill in the name and affiliation (if not from your organization) of the person that corresponds to the title and description in the left column. Note that one person may have more than one responsibility and may be listed more than once, however, the person responsible for QA should not be the project leader. If you are not using a laboratory, put an N/A (Not Applicable) in the name space. Add other key people as needed.

Project Title/Responsibility	Name/Affiliation
Project Coordinator – responsible for all project aspects and primary contact with LPP Coordinator.	Todd Menees/ VDEC
Project Volunteer Coordinator – responsible for overseeing. volunteer activities, including recruiting, maintaining training and participation records.	Todd Menees/ VDEC Chris Yurek/ ORG
Project Field/Sampling Leader – responsible for training and supervising volunteers in field work, filling out field forms, and performing QC checks to make sure procedures are followed or corrected, as needed.	Todd Menees/ VDEC Chris Yurek/ ORG
Project QA Coordinator – responsible for ensuring that procedures in the field and laboratory are performed in accordance with this QAPP and keeps other leaders informed of project status in relation to QAPP. Works with other leaders in conducting QC checks on sampling and analysis techniques. A primary contact with LPP Coordinator.	Marie Caduto/ VDEC Chris Yurek/ ORG
Project Laboratory Contact – primary contact with lab to ensure analysis done according to QAPP. Ensure the QAPP, sample delivery, lab instructions, training, holding times are met and laboratory provides complete documentation. Works closely with the QA Coordinator.	Jim Kellogg/ VDEC
Project Data Management Coordinator – Maintains the data systems for the organization, performs data entry, and checks entries for accuracy against field and laboratory forms.	Chris Yurek/ ORG

5. Background of Volunteer LaRosa Partnership Program Analytical Services Grant.

The Vermont Department of Environmental Conservation (VTDEC), through the Vermont Agriculture and Environment Laboratory, has made available to interested lake, river, and watershed associations grants for sample analyses since the 2003 field season. The purpose of this program is to help volunteer associations and monitoring groups to implement new and/or on-going surface water monitoring projects, for waters in need of water quality assessment.

What are laboratory services?
One of the costliest items involved in a monitoring program is laboratory analysis. VTDEC recognizes that the cost of laboratory services hinders the widespread application of volunteer surface water quality monitoring in Vermont. Analytical services provided under this grant program are essentially 'slots' for tests to be run at the LaRosa Laboratory, free of charge to grantees. VAEL is a full-service analytical facility with complete capabilities for routine water quality monitoring tests. Examples of such tests include: phosphorus, nitrogen, chlorophyll-a, total suspended solids, *E. coli*, turbidity, alkalinity, conductivity, pH, priority pollutants and metals; and numerous other compounds. More information about the VAEL's services are available online (http://dec.vermont.gov/about-dec/laboratory).

Who is eligible?
Volunteer associations across Vermont are eligible for this project. Such associations include river, lake, and watershed groups, secondary-level educational groups, and water quality and conservation committees associated with local municipalities. Post-secondary academic institutions and statewide not-for-profit non-governmental organizations are eligible provided that the projects are either: designed jointly with a local association to assess current water quality conditions; or, structured to address a water quality problem of statewide importance.

What are the eligible project types?
Many project types are eligible for this program. Waters under evaluation should be of interest to the local association sponsoring the project and of interest to VTDEC-MAPP. Waters of interest to VTDEC include impaired and state priority waters, waters on which minimal or no monitoring has been performed in the past, waters with significant public swimming use, waters where a suspected water quality problem needs further assessment, and waters where the causes of known problems remain undiagnosed. Proposals for projects exceeding one field season in duration will be accepted, although subsequent years will be approved only subject to continued availability of state funding for this program. Please note that participants in this program shall share with VTDEC ownership of all laboratory data produced by individual projects.

6. Individual Project Purpose/Task Description

Instructions - For Parts A and B below, please <u>check the boxes that apply to your project and add specific information as needed</u>. Include all pertinent background information that helps support the purpose of your project, including a brief summary of previously collected data. The summary can either be in table format or a brief narrative.

Attach a map in Part C, to identify waterbodies being sampled and sampling sites. If you are unable to locate sampling sites until the project is initiated, please explain your circumstances below.

A. Objectives of Projects

The principal objectives of projects under this QAPP are to 1) provide a perspective on the range of water quality conditions across Vermont; 2) describe water quality conditions of individual waterbodies; 3) establish a data base for waterbodies for use in documenting future changes in water quality; and, 4) educate and involve residents in waterbody protection.

General guidelines for projects under this QAPP are:

- Data should be collected the during spring, summer and early fall months at regular intervals, but not in severe weather, such as thunderstorms or high winds (safety comes first!). Projects addressing *E. coli* should be designed specifically to address either dry-only weather conditions, or segregate between wet and dry weather conditions. Current and the previous 24 hours' weather conditions must be recorded for all *E. coli* sampling events.

- Follow VTDEC guidelines as outlined in the RFP to fully understand the LPP criteria for selection and monitoring objectives.

- If some data will be collected every week, and other data will be collected only once during the sample season or appropriate index period (e.g., low flow, high temperature, etc.), such should be noted in Section 10B, Sample Design Logistics, in this QAPP.

- Report flows according to the VTDEC "Guidance on Streamflow Observations at Time of Sampling of Rivers and Streams" in addition to your own projects flow categorization methodology.

- Data will be analyze and reviewed for quality assurance, summarized and interpreted on an annual basis. Projects will be required to report to VTDEC at the completion of the project. There will be a training and orientation meeting held in late March or early April organized by VTDEC, but held at VAEL. The Project Coordinator, Field Leader or a designated representative must attend. Besides the above individuals, that person who will be interacting the most with VAEL from the individual projects should attend. For instance, if a person has been designated the responsibility of sample transport and transfer of the cooler to VAEL staff, that would be a key individual to attend. Notification of sample delivery is critical for time dependent samples such as turbidity and E. coli.

- Information should be presented to the local community in a suitable format, be it a press release, public meeting, or another event.

- Data that meets project quality objectives will enter VTDEC's Water Quality data management system as well as the EPA's national water quality data storage system known as STORET.

B. Intended Uses of Data

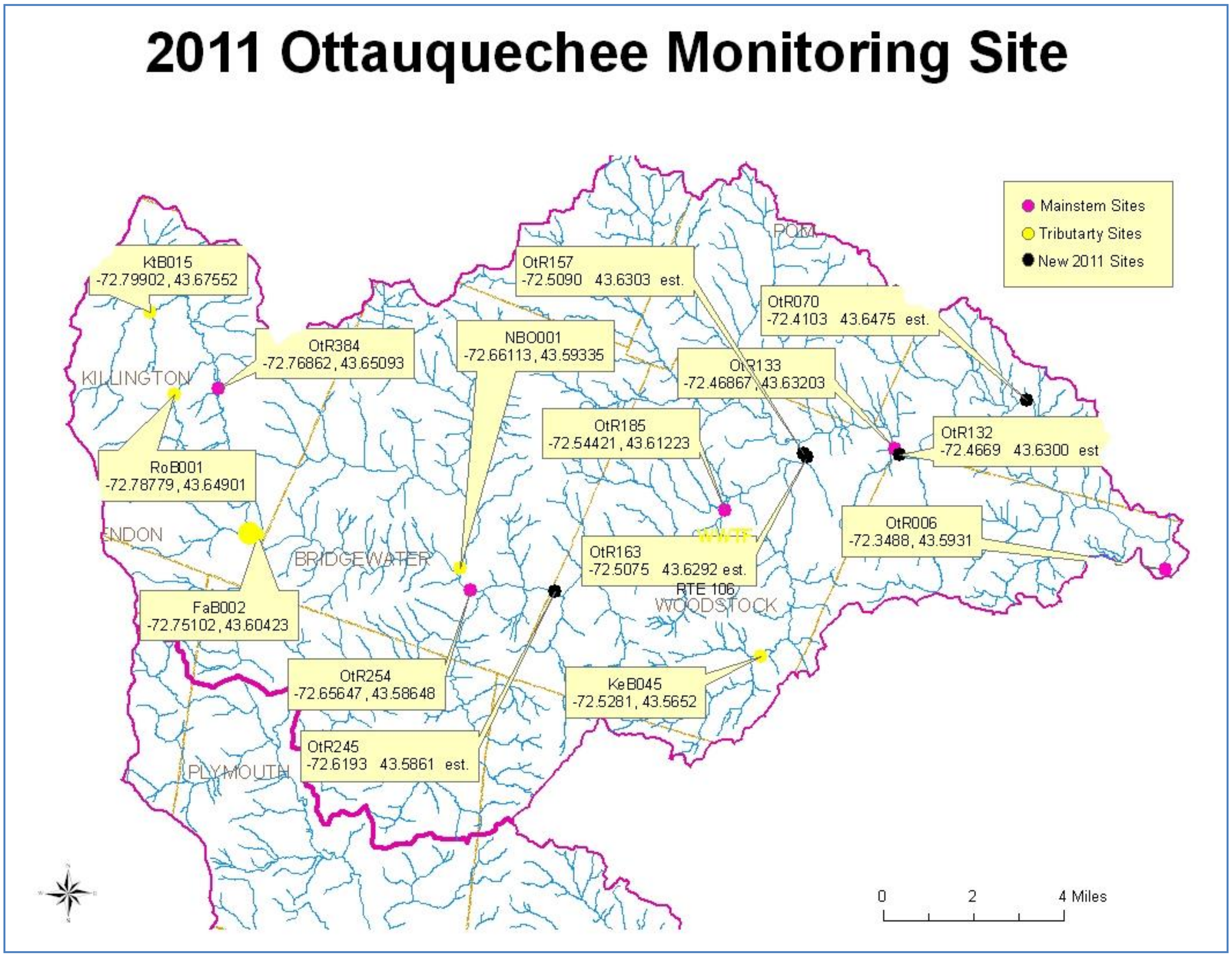
Instructions: Please place a checkmark beside the uses which are applicable for your project's data.

The data generated by projects under this Generic QAPP will serve at least one of the following uses, as specified in project proposals and work plans.

✓ Track phosphorus concentrations and/or loadings
❑ Identify the presence, density and spread of nuisance aquatic species
✓ Describe water quality conditions at specific locations
✓ Document the presence and severity of localized problems (e.g. bacteria as pathogen indicators)
❑ Identify sources of local problems
❑ Evaluate sedimentation and erosion problems
❑ Evaluate habitat & embeddedness with regards to aquatic life use
❑ Educate school children and local communities about water quality, and any problems and improvements.
❑ Evaluate the effectiveness of restoration projects and other management activities
❑ ____
____
____

C. Map of Area and Waterbody

For individual projects under this generic QAPP, a map is to be provided here that identifies waterbody and sample sites.



D. Table 6a - Project Timetable

Activity	Projected Start Date	Anticipated Completion Date
Project Planning Meeting	June 1, 2017	-
Fill out and submit this QAPP to VTDEC	April 7, 2017	-
QAPP Approved by VTDEC	April 15, 2017	-
Training Volunteers/Samplers	June 15, 2017	June 20, 2017
Sampling Begins	June 22, 2017	-
Sampling Ends	-	August 31, 2017
Analytical Results Evaluated * Check/Correct Errors Due to Math Miscalculations or Transferring Data from Field/Lab Forms * Confirm Useable Data * Separate Unusable Data	October, 2017	December, 2017
Data Entered into Project Database	October, 2017	November, 2017
QC Review of Database	November, 2017	December, 2017
Data Summarized	November, 2017	January, 2018
Submit Final Report	-	February, 2018
Presentation(s) of Information at Local Meeting (s) or other venue(s)	February, 2018	March, 2018

7. Project Quality Objectives

Instructions: Please check to ensure that you can meet the accuracy and precision requirements, and if you cannot please indicate and explain. Check the appropriate boxes on the left for parameters to be sampled in your project. If you plan to use a different field or laboratory method add your information to this table and provide the written procedures when submitting this completed project QAPP.

A. Data Precision, Accuracy, Measurement Range Requirements

Table 7a – Field Analysis Protocols for Water Samples

Parameter	Field Analysis Method	Method Reference[1]	Accuracy[2]	Precision[2]
Transparency	Secchi Disk	Vermont Lay Monitoring Program Manual, 2000	--	+/- 0.1 meter
Dissolved Oxygen by Meter	DO Meter or multiprobe	*Standard Methods for the Examination of Water and Wastewater*, 20 ed., 4500-O G. Membrane Electrode Method	+/- 0.5 mg/l	+/- 0.5
Temperature	Alcohol Thermometer	Testing the Waters; Chemical & Physical Signs of a River, River Network,1997	+/- 1.0º C	+/- 1.0º C
pH	pH Meter or multiprobe	*Standard Methods*, etc.,20th ed., 4500-H^+B Electrode Method	± 0.2 std.un.	± 0.2 std.un.

Footnotes:
1–The full citations for each of these publications are:
APHA, AWWA & WEF. Standard Methods for the Examination of Water and Wastewater, prepared and published jointly by the American Public Health Association, American Water Works Association and Water Environment Federation, 20th ed., 1998
Behar, Sharon. Testing the Waters; Chemical & Physical Vital Signs of a River, published by River Network, 1997
Vermont Agency of Natural Resources. Vermont Lay Monitoring Program Manual; 2000, by Water Quality Division, Vermont Dept. of Env. Conservation.
2– Accuracy of field protocols will generally not be measured in the field, but at training and quality control check sessions. Accuracy and Precision measures given are generic. Individual protocols may themselves provide more accurate and precise measures than expressed here.

Table 7b – Primary Laboratory Analysis Protocols for Water Samples:

Parameter	Reporting Limit [A]	Accuracy [B] (% Recovery)	Estimated Precision for Field Duplicates [C] (RPD)	Laboratory Precision (RPD)	Analytical Method Reference [B]
Chlorophyll-*a*	0.5 ug/l	--	≤15%	10%	EPA 445.0
Total and dissolved phosphorus	5 µg/l	85-115%	≤30%	15% [B]	*Std. Methods* (21st ed.) 4500-P H
E. coli [D, E]	1 MPN /100ml	N/A	125% (<25cfu) 50% (>25 mpn)	125% (<25cfu) 75% (>25 mpn)	*Std. Methods* (21st ed.) 9223 (Colilert)
Chloride (Cl)	2 mg/l	85-110%	≤ 5%	≤ 5%	*Std. Methods* (21st ed.) 4500-Cl G
Total Suspended Solids (TSS)	1 mg/l	80-120%	≤15%	≤ 15%	*Std. Methods* (21st ed.) 2540D
Turbidity	0.2 NTU	N/A	≤ 15%	≤15%	EPA 180.1
Alkalinity	1 mg/l	N/A	≤5% (>20 mg/l) <15% (<20 mg/l)	≤5% (>20 mg/l) <15% (<20 mg/l)	*Std. Method*s (21st ed.) 2320B
Total nitrogen (TN) (persulfate digestion)	0.1 mg/l	85%-115%	≤20%	≤10%	*Std. Methods* (21st ed.) 4500-N C
Total NOx	0.05 mg/l	85%-110%	≤10%	≤5%	EPA 353.2

(A) - Reporting Limit is the minimum reported value (lowest standard in calibration curve or MDLx3)
(B) - Section 5.0, Vermont Dept. of Conservation Laboratory QA Plan, 2008
(C) - Generated by the analysis of field duplicates
(D) - EPA's New England Regional Laboratory recommends that all samples resulting in Too Numerous to Count (TNTC) growth, defined as greater than 200 colonies on the membrane filter, be recorded as "TNTC."
(E) -As a quality control check on bacteria counts, if two or more analysts are available, each should count colonies on the same membrane plate for about 10% of the samples, and agree on the # of colonies within 10%.

Instructions: For the following sections (B, C, D), which address data representativeness, comparability and completeness, the VTDEC maintains a minimum goal of 80%. On rare occasions a project requires higher goals and this may be a point of discussion during the review of your QAPP. If you think your project might be unable to meet the minimum goal, please provide the information in the lines provided below each element.

B. Data Representativeness

Samples collected at locations and depths described in this QAPP will reflect conditions of individual waterbodies and tributaries in Vermont. To ensure representativeness all samples will be collected, preserved and analyzed according to the procedures in this QAPP, and within the specified holding times. Those results not meeting the project quality objectives of this program will be flagged and reviewed to determine if appropriate quality controls are in place. They should be discussed in the data report and may be excluded from entry into VTDEC's long-term water quality data archive referred to as WQX.

C. Data Comparability

All samples for each specific parameter will be collected and analyzed using the respective procedures described in this QAPP to ensure that comparisons between different sample sites, sample dates, depths and projects can be appropriately made.

NOTE: The information in Table 7c – Project Completeness (below) about field samples, and field and lab duplicate samples collected, is <u>not needed for the QAPP submission</u>; however, please review it so you will be able to submit it at the end of the project.

If a project compares historical data with the data generated under this QAPP, the historical data should have used SOPs that provide the same data quality as defined here.

D. Data Completeness

At least 80% of the anticipated number of samples will be collected, analyzed and determined to meet data quality objectives for the project to be considered successful. Individual projects may have different completeness goals, which will be presented in the table below. The data report for each project will contain information, similar to that presented below, containing the number of samples meeting the data quality objectives and the resulting calculation of "Percent Complete".

Table 7c – Project Completeness

Parameter	Number of Samples Anticipated	Number of Valid Samples Collected & Analyzed	Percent Complete *
Chlorophyll-*a*			
Chloride	120	108	90.0%
Total and Dissolved Phosphorus	120	105	87.5%
E. coli	120	106	88.3%
Total Suspended Solids			
Transparency			
Alkalinity			
pH			
Turbidity	120	108	90.0%
Total nitrogen (persulfate digestion)	120	107	89.2%
Total NOx			
Si, dissolved			
Dissolved Oxygen			
Conductivity			
Temperature			

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

8. Training Requirements and Certification

A. Training Logistical Arrangements

Instructions: Make changes as needed to the table below to reflect your project. Note however that what is contained in this table is, for the most part, considered minimal training.

The Project Coordinators will arrange in-house volunteer training sessions and keep a record of each volunteer's training needs and accomplishments. Project Coordinators are encouraged to discuss their training needs with the VTDEC-LPP Coordinator.

Table 8a - Training Process

Type of Volunteer Training	Frequency of Training/Certification
Initial orientation to the Project	Each March or April
Recruitment and training of citizen scientists in sampling and analysis to be provided by project coordinator	One full training session annually before each sampling season begins
On-site visit by Project Coordinator	Once during sampling season
Other: Under consideration: On-site visit by LPP Coordinator or other VTDEC staff On-line testing Video	

9. Documentation and Records

Documentation for each project will include 1) sample forms 2) field sheets and 3) written assessments from on-site visits of Project Leader & QA Coordinator (see Section 8A). The Project Coordinator will maintain a record of each volunteer's training and participation in projects. Field sheets will be filled out by the Sampling Volunteer and maintained by the Project Coordinator. Each group will attach a copy of their field sheets to the individual project's version of this QAPP they submit. All samples submitted for laboratory analysis will be accompanied by VTDEC's sample submission form (Appendix B).

---

10. Sampling Process Design

A. Rationale for Selection of Sampling Sites

SAMPLE SITE DESCRIPTION – Please provide a description of each sample site, and note the approximate location on the submitted map. Provide road names if sampled from bridges and if sampled up/downstream from bridge. If sampled from private property please get permission and record street address here. All new sites from previous years must be clearly marked as new so that they can be readily added to the LaRosa site simplifying the year end QC process.

Site #	Description
OtR006	Hartland covered bridge swimming area
OtR070	Below Quechee WWTF
OtR132	Below Bridgewater WWTF
OtR133	Above Bridgewater WWTF & Dam
OtR157	Below Woodstock WWTF
OtR163	Above Woodstock WWTF
OtR185	Behind Woodstock Union High School
OtR245	Below Bridgewater WWTF
OtR246	Above Bridgewater WWTF
OtR254	Route 100A Bridge
OtR384	Rabeck Road Bridge
FaB002	Falls Brook/Ottauquechee Confluence
KeB032	Kedron Brook below Horse Stables
KeB045	Kedron Brook below WWTF
KeB046	Kedron Brook above WWTF
KeB057	Kedron Brook above Green Mountain Horse Association (GMHA)
NBO001	North Branch/Ottauquechee Confluence
RoB002	Roaring Brook above Roaring/Ottauquechee Confluence
RoB010	Roaring Brook/Mountain View Road crossing
RoB028	Roaring Brook above WWTF

PHYSICAL HABITAT & SURROUNDING FEATURES – Characteristics of the physical habitat, land use in the immediate area, or specific features like distance from point source discharges. This will help determine where sample sites are located (e.g., macroinvertebrate sampling may take place only in riffle areas). Where this is the case, please describe the rationale for site selection. Sampling below waste water treatment plants (WWTP) must be done with consultation with the LPP Coordinator. VTDEC values this sampling approach, but for this data to be meaningful it must be collected below the waste management zone (WMZ) and VTDEC will provide the minimum distance and appropriate location in the stream. In many cases, it will line up with an existing monitoring station and provide chemistry data to supplement the VTDEC's Ambient Bio Monitoring Network. The intensity of the description will depend on individual projects, and must meet the requirements necessary to use the data for the project's purpose.

Site #	**Habitat/Surrounding Features**
OtR006	Deep, pooled water. Likely receiving agricultural runoff. Subject to heavy dam influence.
OtR070	Relatively deep water and wide channel. Located below Quechee Waste Water Treatment Facility
OtR132	Wide, moderately deep channel. Located immediately below Taftsville Waste Water Treatment Facility and Taftsville Dam
OtR133	Located in a deep dam impoundment area. Likely subject to thermal stress. Located in very close proximity to a dirt road with no vegetative buffer present.
OtR157	Wide, shallow channel. Located below the Woodstock WWTF.
OtR163	Wide, shallow channel. Located above the Woodstock WWTF.
OtR185	Very shallow, wide channel located behind Woodstock Union HS.
OtR245	Wide, shallow channel. Located immediately below the Bridgewater Waste Water Treatment Facility.
OtR246	Above Bridgewater WWTF behind the Bridgewater shopping district.
OtR254	Shallow, wide channel located immediately below Route 100A Bridge.
OtR384	Deep channel located at the Rabeck Road Bridge.
FaB002	Narrow, shallow, high gradient segment upstream of Otto confluence.
KeB032	Located immediately below a number of horse stables.
KeB045	Immediately below WWTF
KeB046	Immediately above WWTF
KeB057	Located above the Green Mountain Horse Association.
NBO001	Upstream of confluence with the Ottauquechee River.
RoB002	Just above confluence with the Ottauquechee River.
RoB010	Roaring Brook at Mountain View Road Crossing.
RoB028	Located immediately above WWTF.

LOCATIONAL DATA – The latitude/longitude of each sample site will be recorded in decimal degrees using a Global Positioning System. If this is not available, map coordinates including the map datum from which the coordinates were derived must be provided.

Site #	DD.mmmmm North	DD.mmmmm West
OtR006	43.5931 N	-72.3488 W
OtR070	43.6477 N	-72.4108 W
OtR132	43.6299 N	-72.4669 W
OtR133	43.63203 N	-72.46867 W
OtR157	43.6303 N	-72.5090 W
OtR163	43.6292 N	-72.5075 W
OtR185	43.61223 N	-72.54421 W
OtR245	43.5858 N	-72.6184 W
OtR246	43.58637 N	-72.61995 W
OtR254	43.58648 N	-7265647 W
OtR384	43.65093 N	-72.76862 W
FaB002	43.60423 N	-72.75102 W
KeB032	43.575140 N	-72.515449 W
KeB045	43.5652 N	-72.5281 W
KeB046	43.558496 N	-72.531833 W
KeB057	43.554160 N	-72.545467 W
NBO001	43.59335 N	-72.66113 W
RoB002	43.658907 N	-72.773887 W
RoB010	43.64901 N	-72.78779 W
RoB028	43.634434 N	-72.786835 W

RIVERS/STREAM WATER QUALITY – Wadeable stream samples will generally be collected away from the edge of the stream, near the center of the stream (centroid of flow). Water quality samples will be taken from just below surface to near bottom. Individual grab samples, composited grab samples or a core sample can be collected from the water column. Specific projects will designate the type of sample, which must be in accordance with quality control requirements and the purpose of each project.

Depending on the bottom substrate, water quality samples from deep rivers should be collected at mid-depth, but no closer than 0.5 meters from the sediment interface. If the substrate is very soft/silty a greater distance may be designated so as not to contaminate the water sample or the sampling device

For this specific project, the samples will be collected by:

- ✓ Individual grab samples that will be analyzed separately

- ❑ Time composite samples – the same volume is collected at constant time intervals (e.g., 4 hours apart) at the same site, and combined to form a composite sample for that site

- ❑ Core samples – a single sample collected vertically in the water column across a series of depths.

Table 10a – Overview of Types of Waterbody, Sample Site(s) & Sample Depth(s)

TYPE OF WATERBODY	**SAMPLE SITE(S)** **For Each Waterbody**	**SAMPLE DEPTH(S)** **At Each Site**	**TRANSECT(S)** **Across Length or Width of Each Waterbody**
How many RIVERS & STREAMS will be sampled? Five (5)			
Name of River/Stream: Ottauquechee River **Site ID:** OtR006	❑ **Upstream of:** Confluence w/ CT River ❑ **Downstream of:** Hartland Covered Bridge ❑ Wadeable ✓ Deepwater	❑ Surface ✓ Mid-Depth ❑ Near Bottom ❑ Bottom ❑ Surface to Bottom Profiles ❑ Bottom Substrate	❑ Upstream to Downstream Transect ❑ Cross Transect
Name of River/Stream: Ottauquechee River **Site ID:** OtR070	❑ **Upstream of:** Hartland Covered Bridge ❑ **Downstream of:** Quechee WWTF ❑ Wadeable ✓ Deepwater	❑ Surface ✓ Mid-Depth ❑ Near Bottom ❑ Bottom ❑ Surface to Bottom Profiles ❑ Bottom Substrate	❑ Upstream to Downstream Transect ❑ Cross Transect
Name of River/Stream: Ottauquechee River **Site ID:** OtR132	❑ **Upstream of:** Quechee WWTF ❑ **Downstream of:** Taftsville WWTF ❑ Wadeable ✓ Deepwater	✓ Surface ❑ Mid-Depth ❑ Near Bottom ❑ Bottom ❑ Surface to Bottom Profiles ❑ Bottom Substrate	❑ Upstream to Downstream Transect ❑ Cross Transect
Name of River/Stream: Ottauquechee River **Site ID:** OtR133	❑ **Upstream of:** Taftsville WWTF ❑ **Downstream of:** ____________ ❑ Wadeable ✓ Deepwater	✓ Surface ❑ Mid-Depth ❑ Near Bottom ❑ Bottom ❑ Surface to Bottom Profiles ❑ Bottom Substrate	❑ Upstream to Downstream Transect ❑ Cross Transect
Name of River/Stream: Ottauquechee River **Site ID:** OtR157	❑ **Upstream of:** Taftsville WWTF ❑ **Downstream of:** Woodstock WWTF ✓ Wadeable ❑ Deepwater	❑ Surface ✓ Mid-Depth ❑ Near Bottom ❑ Bottom ❑ Surface to Bottom Profiles ❑ Bottom Substrate	❑ Upstream to Downstream Transect ❑ Cross Transect
Name of River/Stream: Ottauquechee River **Site ID:** OtR163	❑ **Upstream of:** Woodstock WWTF ❑ **Downstream of:** ____________ ✓ Wadeable ❑ Deepwater	❑ Surface ✓ Mid-Depth ❑ Near Bottom ❑ Bottom ❑ Surface to Bottom Profiles ❑ Bottom Substrate	❑ Upstream to Downstream Transect ❑ Cross Transect
Name of River/Stream: Ottauquechee River **Site ID:** OtR185	❑ **Upstream of:** Woodstock Union HS ❑ **Downstream of:** ❑ Bridgewater WWTF	❑ Surface ✓ Mid-Depth ❑ Near Bottom ❑ Bottom ❑ Surface to Bottom Profiles ❑ Bottom Substrate	❑ Upstream to Downstream Transect ❑ Cross Transect

TYPE OF WATERBODY	SAMPLE SITE(S) For Each Waterbody	SAMPLE DEPTH(S) At Each Site	TRANSECT(S) Across Length or Width of Each Waterbody
	✓ Wadeable ❑ Deepwater		
Name of River/Stream: Ottauquechee River **Site ID:** OtR245	❑ **Upstream of:** ________ ❑ **Downstream of:** ❑ Bridgewater WWTF ❑ Wadeable ✓ Deepwater	✓ Surface ❑ Mid-Depth ❑ Near Bottom ❑ Bottom ❑ Surface to Bottom Profiles ❑ Bottom Substrate	❑ Upstream to Downstream Transect ❑ Cross Transect
Name of River/Stream: Ottauquechee River **Site ID:** OtR254	❑ **Upstream of:** ________ ❑ **Downstream of:** ❑ Route 100A Bridge ✓ Wadeable ❑ Deepwater	❑ Surface ✓ Mid-Depth ❑ Near Bottom ❑ Bottom ❑ Surface to Bottom Profiles ❑ Bottom Substrate	❑ Upstream to Downstream Transect ❑ Cross Transect Name of River/ Stream:
Name of River/Stream: Ottauquechee River **Site ID:** OtR384	❑ **Upstream of:** Rabeck Rd Bridge ❑ **Downstream of:** ________ ❑ Wadeable ✓ Deepwater	✓ Surface ❑ Mid-Depth ❑ Near Bottom ❑ Bottom ❑ Surface to Bottom Profiles ❑ Bottom Substrate	❑ Upstream to Downstream Transect ❑ Cross Transect
Name of River/Stream: North Branch Ottauquechee River **Site ID:** NBO001	❑ **Upstream of:** Confluence w/ Ottauquechee ❑ **Downstream of:** ________ ✓ Wadeable ❑ Deepwater	❑ Surface ✓ Mid-Depth ❑ Near Bottom ❑ Bottom ❑ Surface to Bottom Profiles ❑ Bottom Substrate	❑ Upstream to Downstream Transect ❑ Cross Transect
Name of River/Stream: Kedron Brook **Site ID:** KeB045	❑ **Upstream of:** ________ ❑ **Downstream of:** WWTF ✓ Wadeable ❑ Deepwater	❑ Surface ✓ Mid-Depth ❑ Near Bottom ❑ Bottom ❑ Surface to Bottom Profiles ❑ Bottom Substrate	❑ Upstream to Downstream Transect ❑ Cross Transect
Name of River/Stream: Kedron Brook **Site ID:** KeB032	❑ **Upstream of:** ________ ❑ **Downstream of:** Horse Stables ❑ Wadeable ✓ Deepwater	✓ Surface ❑ Mid-Depth ❑ Near Bottom ❑ Bottom ❑ Surface to Bottom Profiles ❑ Bottom Substrate	❑ Upstream to Downstream Transect ❑ Cross Transect
Name of River/Stream: Kedron Brook **Site ID:** KeB046	❑ **Upstream of:** WWTF ❑ **Downstream of:** ________	✓ Surface ❑ Mid-Depth ❑ Near Bottom ❑ Bottom ❑ Surface to Bottom Profiles	❑ Upstream to Downstream Transect ❑ Cross Transect

TYPE OF WATERBODY	**SAMPLE SITE(S) For Each Waterbody**	**SAMPLE DEPTH(S) At Each Site**	**TRANSECT(S) Across Length or Width of Each Waterbody**
	❑ Wadeable ✓ Deepwater	❑ Bottom Substrate	
Name of River/Stream: Kedron Brook **Site ID:** KeB057	❑ **Upstream of:** GMHA ❑ **Downstream of:** ____________ ❑ Wadeable ✓ Deepwater	✓ Surface ❑ Mid-Depth ❑ Near Bottom ❑ Bottom ❑ Surface to Bottom Profiles ❑ Bottom Substrate	❑ Upstream to Downstream Transect ❑ Cross Transect
Name of River/Stream: Roaring Brook **Site ID:** RoB010	❑ **Upstream of:** Mnt. View Rd Crossing ❑ **Downstream of:** ____________ ❑ Wadeable ✓ Deepwater	✓ Surface ❑ Mid-Depth ❑ Near Bottom ❑ Bottom ❑ Surface to Bottom Profiles ❑ Bottom Substrate	❑ Upstream to Downstream Transect ❑ Cross Transect
Name of River/Stream: Roaring Brook **Site ID:** RoB028	❑ **Upstream of:** WWTF ❑ **Downstream of:** ____________ ❑ Wadeable ✓ Deepwater	✓ Surface ❑ Mid-Depth ❑ Near Bottom ❑ Bottom ❑ Surface to Bottom Profiles ❑ Bottom Substrate	❑ Upstream to Downstream Transect ❑ Cross Transect
Name of River/Stream: Roaring Brook **Site ID:** RoB002	❑ **Upstream of:** Roaring/Otto Confluence ❑ **Downstream of:** ____________ ❑ Wadeable ✓ Deepwater	✓ Surface ❑ Mid-Depth ❑ Near Bottom ❑ Bottom ❑ Surface to Bottom Profiles	❑ Upstream to Downstream Transect ❑ Cross Transect
Name of River/Stream: Falls Brook **Site ID:** FaB002	❑ **Upstream of:** Falls Brook/Otto Confluence ❑ **Downstream of:** ____________ ✓ Wadeable ❑ Deepwater	❑ Surface ✓ Mid-Depth ❑ Near Bottom ❑ Bottom ❑ Surface to Bottom Profiles ❑ Bottom Substrate	❑ Upstream to Downstream Transect ❑ Cross Transect

B. Summary of Sample Collection

Individual projects will identify the number of samples, sampling frequency and specific sampling method for each parameter in accordance with their objectives. During sample collection, all sample apparatuses are to be rinsed 3x in sample water prior to collection of the actual sample (**except where noted**). Filtration apparatuses and bottle rinse guidelines are shown in Table 11a.

Table 10b – Sample Collection

	Type of Sample/ Parameter	**Total Number of Samples (Indicate if this is for the project or per week, etc.)**	**Sampling Frequency (How often – once/weekly/bi-weekly?)**	**Sampling Method (Grab, Discrete-depth sampler, depth-integrating core sampler, meter) ***
Biological	*E. coli*	120	Bi-weekly	Grab
Chemical	Chlorophyll-*a*			
	Chloride	120	Bi-weekly	Grab
	Total and Dissolved Phosphorus	120	Bi-weekly	Grab
	Transparency			
	Dissolved Oxygen			
	Temperature			
	pH			
	Alkalinity			
	Total Nitrogen (persulfate digestion)	120	Bi-weekly	Grab
	Total NOx			
	Si, dissolved			
Physical	Secchi Disk Transparency			
	Total Suspended Solids			
	Turbidity	120	Bi-weekly	Grab
Meters used for data collection (please list make/model of meter(s) or multiprobe(s)	Multiprobe model:			
	pH meter model:			
	Conductivity meter model:			
	Turbidity meter model:			
	DO meter model:			

* see Appendix A, please list sampler type (e.g., Kemmerer, Van Dorn, Hose etc.).

11. Sampling & Analysis Methods

Field and laboratory analytical methods are provided in Section 7, and Field Sampling Methods are listed in Section 10 and in Appendix A. The table below presents containers, preservation and holding times used for projects under this QAPP.

INSTRUCTIONS: If your sampling methods are listed in Appendix A, please list the specific protocols you are using in the table above. If your sampling protocol is different from the descriptions in Sections 7 and 10 or the examples in Appendix A, please attach your protocol(s) to this QAPP.
Check off the appropriate parameters in the table below.

Table 11a –Sample Containers, Preservation & Holding Times [A]

Parameter/Measure	Container	Field Rinse	Preservation	Hold Time [B]
Total / Dissolved Phosphorus	60 ml glass tube [C]	**NO RINSE**, 3X rinse of filtration apparatus w/ sample water or DI	Dissolved phosphorus filtered using *new* 0.45 *u* filter membrane	28 days
E. coli	290ml or 120ml sterile plastic round	**NO RINSE**	Cool to <10°C	8 hours
Chlorophyll-*a*	Filter - Whatman GF-F, 47mm diam., 0.7 µm pore size, stored in black jar	**NO RINSE** of filter, 3X Rinse of filtration apparatus w/ sample water or DI	Freeze (20 to -70ºC), Dark	21 days
Chloride	50 ml polycarbonate centrifuge tube	3x rinse with sample	Cool to <6°C	28 days
Total Suspended Solids	1L plastic, round	3x rinse with sample	Cool to <6°C	7 days
Turbidity	250 ml plastic square	3x rinse with sample	Cool to <6°C	48 hours
Total Nitrogen (persulfate digestion)	50 ml polycarbonate centrifuge tube	3x rinse with sample	Cool to <6°C, acidified within 48h with conc. H_2SO_4 to pH <2	28 days
Total NOx	**50 ml polycarbonate centrifuge tube**	3x rinse with sample	Cool to <6°C, acidified within 24h with conc. H_2SO_4 to pH <2	28 days
Si, dissolved	50 ml polycarbonate centrifuge tube	3x rinse with filtrate or with DI	Cool to <6°C, filter using *new* 0.45*um* filter membrane	28 days
Alkalinity	250 ml plastic square	3x rinse with sample	Cool to <6°C	14 days
DO - Meter	(*in situ*)	3x rinse of probe	None	Direct Analysis
pH Meter	(*in situ*)	3x rinse of probe	None	Direct Analysis
Temperature - Thermometer [D] or meter	(*in situ*)	**NO RINSE**	None	Direct Analysis
Conductivity meter	*(in situ)*	3x rinse of probe	None	Direct Analysis
Turbidity meter	(*in situ*)	3x rinse of probe	None	Direct Analysis

Footnotes:
A – A copy of some field SOPs are attached as Appendix A.
B – Holding times are in accordance with the Code of Federal Regulations, title 40 (Protection of Environment), part 136, section 3 (or 40CFR136.3), and are defined in the VTDEC LaRosa Laboratory Quality Assurance Project Plan.
C – The VT DEC analyzes the entire sample volume in the sampling container, so no acidification is needed. Extra containers of sample will be needed to allow the VT DEC lab to analyze spiked samples.
D – Mercury **thermometers <u>absolutely shall not</u> be used in the field**.

12. Sample Handling and Custody Procedures

ORG Field Data Sheet is included as the final page of this document.

13. Analytical Methods Requirements

Information for this section is included in Tables 7a and 7b.

14. Quality Control Requirements

Instructions: For sections A, B, and C, check only those that are applicable to your project. The goal for quality control checks is 10% replication and blank analysis. Please note if your goal varies from this.

A. Field QC Checks

At least one Field Duplicate and one Field Blank will be submitted for every ten samples collected. Additional types of field quality control samples needed will depend on the parameter and the collection method, and are at the discretion of the Project Manager and QA Manager.

- ❑ **Field Duplicate (required)** – a check on water quality, sampling & analysis consistency. This is a replicated sample collected at the same point in time and space to be considered identical. A field duplicate is a second sample from a second sampling event, collected immediately after the first sampling and given a separate Lab ID number. Otherwise put, these separate samples are said to represent the same population and are carried through *all steps* of the sampling and analytical procedures in an identical manner. They are used to assess precision of the total method, including sampling, analysis, and site heterogeneity.

- ❑ **Field Blanks (required)** – a check for contamination (Accuracy/Bias) in the field by processing laboratory-supplied deionized through the sampling train. This checks for contamination introduced from the sample container(s) or from field contamination.

- ❑ **Matrix Spike (required only for phosphorus)** - This allows the laboratory to perform analytical replication that separates variability in sampling from variability in analytical processing. A spike is a second sample bottle, filled from the same sample collection as the first sample. For grab samples, there is no functional difference between a field duplicate and a matrix spike.

- ❑ **Equipment Blanks** – measures contamination (accuracy/bias) – a sample of water, free of measurable contaminants, is poured over or through decontaminated field sampling equipment that is considered ready to collect or process an additional sample. The purpose of this is to assess the adequacy of the decontamination process and whether equipment needs special cleaning to make sure it doesn't have something that contaminates the sample or influence the results

- ❑ **Field Split Samples** – Two or more representative subsamples are taken from one environmental sample in the field and sent to two different labs for analysis. Prior to splitting, the environmental sample is well-mixed to correct for sample inhomogeneity that would adversely impact sample data comparability. Field splits are used to assess sample handling procedures from field to laboratory and inter-laboratory comparability and precision.

- ❑ **Equipment Calibration Checks** – A check on a meter's accuracy – the verification of the initial calibration that is required at certain times during the sampling day or while analyzing a large number of samples. Checking to see if a pH meter is maintaining its calibration would involve taking a reading of standard solutions (e.g., pH buffers of 4, 7, or 10, etc.). For projects that include long-term repetitive sampling at several sites, the site at which a field quality control sample is collected should change to include at least one duplicate sample at each sample location during the course of the project.

B. Laboratory QC Checks

Laboratory QC samples may include any of the following, depending on the parameter, and are handled by the VAEL as described in the VAEL Quality Assurance Plan.

15. Instrument/Equipment Testing, Inspection, and Maintenance Requirements

The Project Coordinator is responsible for ensuring equipment and instruments are maintained according to standard operating procedures and manufacturer requirements. In preparing for a sampling event, equipment will be inspected and tested by the sampler prior to its intended use. A maintenance log will be maintained by the Project Coordinator for all mechanical and electronic equipment. Any equipment that does not meet the requirements necessary for producing data in accordance with the data quality objectives of specific projects will not be used for sample collection or analysis. Additional equipment (non-mechanical and non-electrical), including buckets, rope, thermometers etc. should be maintained according to the standard operating procedure

Table 15a - Equipment for Project

Equipment Type	Manufacturer	Inspection Frequency	Type of Inspection
DO Meter			
Multiprobe model:			
pH meter model:			
Conductivity meter model:			
Turbidity meter model:			
GPS Unit			

16. Instrument Calibration and Frequency

***Instructions: Please complete the table below*.**

The Project Coordinator will ensure that all field instruments are checked for good working order prior to the day of sample collection, preferably at least 24 hours prior to sampling. On the day of sample collection, or on a routine schedule as defined below, equipment will be calibrated and checked for accuracy before any samples are collected in accordance with the standard operating procedures. The recalibration of meters will be verified by recording each meter's reading of a standard used (or against a calibration instrument). If the amount of drift in instrument readings is not acceptable, data will be flagged as suspect. Calibration checks and readings of standards will be recorded on field sheets or another form set up for that purpose. All documentation regarding instrument calibration will be maintained by the Project Coordinator or their designated individual.

Table 16a - Equipment Calibration

Equipment Type	Calibration Frequency	Standard or Calibration Instrument Used

17. Inspection/Acceptance Requirements

The Project Coordinator will ensure that all equipment, instruments and supplies are clean and maintained according to the standards and conditions required to meet project objectives. Sample containers will be of the appropriate size, pre-cleaned for the parameter for which the sample will be analyzed, and supplied by VAEL. Appropriate containers must be used. Bottles not supplied by the VAEL are considered suspect and samples will be rejected, unless lot certification of bottles is provided along with the sample submission. Other materials, such as nets, gloves, rinse bottles, sampling apparatus, buckets, line, etc., will be kept clean and stored properly to prevent contamination that interferes with producing samples and analytical results that meet project objectives.

18. Data Acquisition Requirements

External data (data that is not generated by the project but is to be used as part of the project e.g., meteorological data, flow data) will be used in accordance with the objectives stated in Section 6B of this QAPP, and should have sufficient documentation that it is at least equivalent to the data quality generated as part of this project (see Section 7).

19. Data Management

The generation of accurate data with accompanying documentation, such as field sheets and quality control sample results, is the responsibility of the individual Project Coordinators. Field sheets are inspected daily and signed by the people performing the sampling before leaving a site or completing a sampling “run.” Field sheets are given to the Field Leader after the sampling event for review. Within 72 hours, the Leader will contact any samplers whose field sheets contain significant errors or omissions.

The LPP Coordinator will review results after the VAEL Supervisor validates and authorizes the samples that allow sample downloads to begin. The Project Coordinator and QA Coordinator initially review analytical results, and identifies questionable data with regards to results or documentation, as described in the LaRosa Laboratory QA Plan. They are the responsible project members to review all field and lab data to determine usability in the project. The LPP Coordinator also goes through a series of QC processes leading up to the electronic storage of results.

All environmental data generated by projects funded by VTDEC under this project will be submitted to the VTDEC in a commonly used format (such as Microsoft EXCEL© or ACCESS©). After additional QA review, this data will be stored in WQX and later uploaded to STORET, the national water quality data storage system.

The data generated under the laboratory services grants project is the joint property of the VTDEC and the project leads.

20. Assessment and Response Actions

For each project funded, there will be an on-site visit by the Project Coordinator or Quality Assurance Coordinator to observe field sampling and field analysis procedures. Generally, this will be done near the beginning of the project. This is in addition to training procedures described in Section 8. A written checklist should be used for the assessments, maintained by the Project Leader, and copies will be provided with the data report. The Project Coordinator and QA Coordinator will determine if field work follows the written procedures or if there needs to be corrections by additional training or revising protocols. Please refer to Section 22 for additional evaluations and response actions regarding data evaluations.

21. Reports

Written final project reports will be submitted to the LPP Coordinator for all funded projects. These need not be excessively long, but should document data results, quality assurance findings, and any specific local actions suggested by the data results. The reports may vary in content according to the type of project and the expected uses of the information. VTDEC will be working to streamline these report for next year. VTDEC strongly encourages project leaders to plan at least one presentation of their project and its results to the local community.

In addition to a written report, data and metadata (information about the data) will be provided as described in Section 19 above.

22. Data Review, Validation, and Verification

All data are reviewed by the individual Project Coordinator, QA Coordinator, and Data Management Coordinator to determine if data meet QAPP requirements.

Data Analysis QC Checks will include:

- Data entry checks by a second person
- Calculation of measures of data quality.

To validate and verify project data, the Project QA Coordinator will compare computer entries to field or laboratory data sheets; look for data gaps and unexpected, or nonsensical results; inspect field forms and information; review field quality control checks and resulting information; and review graphs, tables and other presentations of data, as needed. Graphing data results with time, by parameter, is a useful way to observe problem data points.

Errors in data entry will be corrected. Data that are outside the expected range will be flagged for further review or rejected. A second field sample and/or laboratory aliquot will be taken, if possible, to verify the condition and a determination of necessary corrections, if any, will be made. The LPP Coordinator should be contacted if assistance is needed to identify sources of errors. Problems with data quality will be discussed in the draft and final reports to the VTDEC. The Percent Completeness table presented in Section 7c will be filled in and included with the data report.

23. Validation and Verification Methods

The following simple measures of data quality should be calculated, and included in the final report:

1) To screen for contamination, the average blank concentration, by parameter, should be calculated. This average value should be as close as practical to the Reporting Limit listed in Table 7b.

2) To assess the precision of results, the "Mean Relative Percent Difference" between field duplicate samples should be calculated. The average RPD should be less than or equal to the Estimated Precision listed in Table 7b. This simple measure is calculated as follows:

$RPD_{\text{field duplicate pair 1}}$ = absolute value ($sample_1$-$sample_2$) / average ($sample_1$ and $sample_2$); and,

The Mean RPD for "n" duplicate pair = average ($RPD_{\text{pair 1}}$ + $RPD_{\text{pair 2}}$ + ... + $RPD_{\text{pair n}}$)

24. Reconciliation with Project Quality Objectives (PQOs)

As indicated above, mean blank concentrations and mean relative percent differences will be compared to data quality objectives established in Table 7b.