



HEALTHY LAND. CLEAN WATER. VIBRANT COMMUNITY.

2018 Mad River Watershed Report to LaRosa

Summary

In 2018, Mad River Watch program volunteers drew samples on six dates at 35 sites on June 11, June 25, July 9, July 23, August 6, and August 20. 13 sample sites were located on the main stem of the Mad River, 21 on tributaries, and one on Blueberry Lake.

The Friends of the Mad River lab analyzed samples from 12 of our 35 sites for *E. coli* (using the IDEXX QuantiTray method), and collected other information on each sampling date including temperature and flow (data from USGS gauge in Moretown).

Through the LaRosa partnership, samples from 27 of 35 sites, 6 on the main stem of the Mad River and 21 on tributaries were analyzed for phosphorus, nitrogen, and turbidity.

Vermont Water Quality Standards

The Vermont Water Quality Standards set the allowable limits for *E. coli*, total Phosphorus, turbidity, total nitrogen for the Class B2 (cold water fishery) waters of the Mad River and its tributaries as follows:

Total Phosphorus

Not to exceed 12 µg/l

Total Nitrogen

Not to exceed 5 mg/l

Turbidity

Not to exceed 25 NTU

E. coli

Not to exceed 235 per milliliter; this is considered a “Beach Action Value” that corresponds to 8 illnesses per 1,000 swimmers and is slightly more conservative than EPA’s base recommendation of 410 *E. coli* per milliliter

Phosphorus

Of the total of 161 samples analyzed for total Phosphorus, 47 samples (29 percent) exceeded the standard of 12 µg/l. This is a slight decrease from last year, where 47 percent of samples had exceeded the water quality standard, yet the flow conditions during sampling varied between sampling seasons.

Table 1. 2018 Total Phosphorus at 27 sites in the Mad River Watershed (µg/l)

		6/11/2018	6/25/2018	7/9/2018	7/23/2018	8/6/2018	8/20/2018
FLOW CONDITION -->		LS	LD	LS	LR	LD	LD
Site Name	Site #						
Bobbin Mill (Lincoln Brook)	2	0	0	8.5	7.44	0	5.1
Warren Store (Freeman Brook)	4	8.18	8.32	10.1	5.45	6.87	6.02
Bottom of Sugarbush Access Rd (Clay Brk)	8	7.49	6.8	18.1	11.1	5.16	7.33
Route 100 crossing (Folsom Brook)	10	15.8	18.4	10.8	17.2	20.5	20.2
"Dip" on East Warren Rd. (Folsom Brook N)	10.6	9.22	11.2	9.9	9.71	11.7	9.17
Folsom Brook (S tributary)	10.8	11.9	12.2		12.9	10.7	10.8
Sugarbush Health Club (Rice Brook)	11	8.77	6.68	5.72	16.9	6.62	6.71
Inferno Road Crossing (Clay Brook)	12	5.38	6.31	6.03	8.69	5.82	6.61
German Flats, Rt 17 (Chase Brk)	16	7.21	5.8	5.4	21.6	7.68	7.31
German Flats, Rt 17 (Mill Brk)	17	21.1	9.96	8.55	53.9	0	5.03
Mill Brook east of MRG	17.1	0	0	8.71	7.69	0	5.25
Mill Brook	18.1	0	5.64	7.03	12.5	6.67	6.16
Waitsfield Covered Bridge (Mad River)	20	6.21	13.2	6.6	12.7	7.2	6
Joslin Hill Road Culvert (High Bridge Brook)	20.1	10.5	12.9	16	13	11.9	12.1
High Bridge Brook North	20.1-1	12.1	14.3	26.1	14.8	12.7	12.8
High Bridge Brook North US	20.1-12	19.2	26.4	100	29.9	15.5	19.4
High Bridge Brook Mid	20.1-2	10.7	13.2	14	11.6	11.4	10.1
Route 100 Bridge (Shepard Brook)	24	5.13	5.7	15	6.22	5.9	6.36
Route 100 Bridge (Dowsville Brook)	25	6.83	8.52	13	11.5	7.39	7.62
North Road near Moretown (Mad River)	26	6.09	5.32	7.1	7.74	7.51	7.2
Moretown Village Swim Access (Mad River)	27	6.25	6.27	11.2	0	7.34	7.65
Ward Clapboard Mill (Mad River)	28	5.63	5.92	14.3	7.35	6.53	8.15
Near Stevens Brook Road (Welder Brook)	28.05	11.3	13.1	18.1	12.3	11.4	14.6
Welder Mid-Stream	28.05-2	14.8	17.3	19	19.3	17.6	17.7
Welder Upstream (Welder Brook)	28.05-1	5.85	12.4	6.85	9.96	7.89	8.83
USGS Gage (Mad River)	Gage	6.52	9.14	8	6.86	8.02	7.15
Lover's Lane Bridge (Mad River)	31	8.08	10.8	9.18	7.12	9.25	11.1

Four sites, at Lower Folsom Brook (10), the North and North Upstream sites on High Bridge Brook (20.1-1 and 20.1-12), and Welder Brook Mid-Stream (28.05-2) were in violation on five and six of the sampling days, regardless of the flow conditions. This indicates that the areas upstream of these sites are consistently contributing to the phosphorus input into the watershed. The High Bridge and Welder Brook sites were located in 2016 and 2017 to pinpoint sources upstream.

On June 25 (10 violations), July 9 (10 violations), & July 23 (12 violations), the highest number of violations were recorded. The FMR flow conditions those days were Low and Declining, Low and Steady, and Low and Rising, respective based on Moretown USGS Gage information.

Based on this year's sampling, it would appear that Welder Brook's Phosphorus problem originates upstream/around the new upstream site (28.05-2). Furthermore, High Bridge Brook appears to have a phosphorus contribution above this year's new upstream site (20.1-12).

Nitrogen

Out of 77 samples taken and analyzed for Total Nitrogen, none exceeded the standard of 5 mg/l. The highest value found during the sampling season was 0.8 mg/l at Freeman Brook (4). Samples from Freeman, Folsom, High Bridge, and Welder Brooks sites were generally higher than elsewhere in the watershed. This was our third year of sampling for total nitrogen, and these results are consistent with 2016 and 2017.

Table 2. 2018 Total Nitrogen at 13 sites in the Mad River Watershed (mg/l)

		6/11/2018	6/25/2018	7/9/2018	7/23/2018	8/6/2018	8/20/2018
FLOW CONDITION -->		LS	LD	LS	LR	LD	LD
Site Name	Site #						
Bobbin Mill (Lincoln Brook)	2	0.17	0.17	0.21	0.24	0.18	0.14
Warren Store (Freeman Brook)	4	0.8	0.71	0.73	0.68	0.45	0.48
Route 100 crossing (Folsom Brook)	10	0.59	0.55	0.47	0.47	0.35	0.39
"Dip" on East Warren Rd. (Folsom Brook N)	10.6	0.57	0.44	0.48	0.41	0.38	0.3
Folsom Brook (S tributary)	10.8	0.27	0.27	--	0.37	0.25	0.21
High Bridge Brook North	20.1-1	0.49	0.57	0.62	0.55	0.34	0.37
High Bridge Brook North US	20.1-12	0.5	0.4	0.52	0.46	0.31	0.33
High Bridge Brook Mid	20.1-2	0.7	0.63	0.62	0.73	0.54	0.48
Near Stevens Brook Road (Welder Brook)	28.05	0.31	0.34	0.39	0.38	0.32	0.33
Welder Mid-Stream	28.05-2	0.63	0.34	0.39	0.39	0.3	0.32
Welder Upstream (Welder Brook)	28.05-1	0.33	0.34	0.39	0.34	0.36	0.33
USGS Gage (Mad River)	Gage	0.44	0.4	0.39	0.37	0.3	0.2
Lover's Lane Bridge (Mad River)	31	0.45	0.39	0.39	0.33	0.3	0.25

Turbidity

Among the 145 samples taken and analyzed for turbidity, all met the turbidity standard of 25 NTU. Most sample days were lower flow conditions, or high yet declining.

Table 3. 2018 Turbidity at 13 sites in the Mad River Watershed (NTU)

		6/11/2018	6/25/2018	7/9/2018	7/23/2018	8/6/2018	8/20/2018
FLOW CONDITION -->		LS	LD	LS	LR	LD	LD
Site Name	Site #						
Bobbin Mill (Lincoln Brook)	2	0.41	1.05	0.36	2.23	0.89	0.37
Warren Store (Freeman Brook)	4	0.46	0.69	1.06	0.46	0.36	0.73
Bottom of Sugarbush Access Rd (Clay Brk)	8	0.94	1.88	5.18	2.81	0.59	0.54
Route 100 crossing (Folsom Brook)	10	1.05	0.44	0.63	0.77	0.8	0.58
Sugarbush Health Club (Rice Brook)	11	0.43	1.87	0.63	1.41	0.36	2.23
German Flats, Rt 17 (Chase Brk)	16	0.42	1.27	0.42	2.25	0.3	0
Mill Brook east of MRG	17.1	0.8	0.5	0.32	0.39	0.71	0
Mill Brook	18.1	0.54	0.59	0.55	3.34	0.39	0.21
Joslin Hill Road Culvert (High Bridge Brook)	20.1	1.52	3.54	1.15	0.7	1.33	0.75
Route 100 Bridge (Shepard Brook)	24	0.77	0.44	0.31	0.23	0.51	0
Route 100 Bridge (Dowsville Brook)	25	1.79	1.48	1.77	2.1	0.74	0.57
Near Stevens Brook Road (Welder Brook)	28.05	1.41	1.93	1.08	1.51	1.19	1.31
USGS Gage (Mad River)	Gage	0.79	1.17	1.02	0.98	1.43	1.54

E. coli

Of the 72 samples analyzed, 4 had unfavorable values of *E. coli* for recreation (235 *E. coli* per 100 milliliters). All of these violations were on the sampling date of July 23 when FMR's flow condition of the Mad River was Low and Rising. These four violations were on the Mad River (in Waitsfield and Moretown) and include: Couples Club Field (19.2), Tremblay Road (21.5), Meadow Bridge Road (23), and the Ward Swimhole (29). Lareau Swimhole (19) and Moretown Village Swim Access (27) were close to the 235 colonies concentration on the same day.

Table 4. 2018 *E. coli* at 12 sites in the Mad River Watershed (*E. coli*/100 ml)

		6/11/2018	6/25/2018	7/9/2018	7/23/2018	8/6/2018	8/20/2018
FLOW CONDITION -->		LS	LD	LS	LR	LD	LD
Site Name	SITE #						
Blueberry Lake	BBL	7.5	13.5	20.1	17.3	17.1	45.9
Warren Falls (Mad River)	1	7.5	13.1	14.2	95.9	12.0	4.1
Bobbin Mill (Lincoln Brook)	2	< 1.0	12.2	6.3	79.5	11.0	6.3
Warren Store (Freeman Brook)	4	22.6	74.4	14.2	65.3	37.9	13.2
Warren Riverside Park (Mad River)	7	2.0	17.3	21.3	16.3	35.0	4.1
Lareau Swimhole (Mad River)	19	34.1	45.5	65.7	204.6	67.0	95.9
Couples Club Field (Mad River)	19.2	6.3	36.9	95.9	770.1	133.3	54.6
Waitsfield Covered Bridge (Mad River)	20	9.8	7.3	11.8	52.0	73.3	53.8
Tremblay Road (Mad River)	21.5	5.2	35.0	99.0	517.2	72.3	88.4
Meadow Road Bridge (Mad River)	23	3.1	178.9	71.2	275.5	78.0	67.7
Moretown Village Swim Access (Mad River)	27	9.8	38.0	78.0	220.9	25.7	22.3
Ward Swimhole (Mad River)	29	6.3	22.7	57.8	517.2	23.3	70.6

Quality Control

Table 5. Field Duplicate Relative Percent Differences (RPD) – TP, TN, & Turbidity

Date	Site #	Test	Sample	Duplicate	RPD (%)	Precision for Field Duplicates (RPD)	Notes
6/11/2018	2	TP(ug P/L)	5	5	0.00	≤30%	
6/11/2018	11	TP(ug P/L)	8.77	26	99.11	≤30%	Likely contamination
6/25/2018	17	TP(ug P/L)	9.96	6.2	46.53	≤30%	Likely contamination
6/25/2018	20	TP(ug P/L)	13.2	12.3	7.06	≤30%	
6/25/2018	Gage	TP(ug P/L)	9.14	5.73	45.86	≤30%	Likely contamination
7/9/2018	4	TP(ug P/L)	10.1	10.8	6.70	≤30%	
7/9/2018	12	TP(ug P/L)	6.03	5.91	2.01	≤30%	
7/9/2018	26	TP(ug P/L)	7.1	8.04	12.42	≤30%	
7/23/2018	8	TP(ug P/L)	11.1	12	7.79	≤30%	
7/23/2018	28.05	TP(ug P/L)	12.3	12.5	1.61	≤30%	
7/23/2018	20-1-2	TP(ug P/L)	11.6	11.8	1.71	≤30%	
8/6/2018	10	TP(ug P/L)	20.5	19.2	6.55	≤30%	
8/6/2018	10.6	TP(ug P/L)	11.7	9.78	17.88	≤30%	
8/6/2018	27	TP(ug P/L)	7.34	6.24	16.20	≤30%	
8/20/2018	17.1	TP(ug P/L)	5.25	5.31	1.14	≤30%	
8/20/2018	18.1	TP(ug P/L)	6.16	5.11	18.63	≤30%	
8/20/2018	28.05-2	TP(ug P/L)	17.7	17.3	2.29	≤30%	
6/11/2018	2	TN (mg-N/l)	0.17	0.17	0.00	≤20%	
6/11/2018	20.1-1	TN (mg-N/l)	0.49	0.51	4.00	≤20%	
6/25/2018	20.1-12	TN (mg-N/l)	0.4	0.39	2.53	≤20%	
6/25/2018	Gage	TN (mg-N/l)	0.4	0.39	2.53	≤20%	
7/9/2018	4	TN (mg-N/l)	0.73	0.74	1.36	≤20%	
7/23/2018	20-1-2	TN (mg-N/l)	0.73	0.74	1.36	≤20%	
8/6/2018	10	TN (mg-N/l)	0.35	0.35	0.00	≤20%	
8/20/2018	28.05-2	TN (mg-N/l)	0.32	0.3	6.45	≤20%	
6/11/2018	2	Turbidity (NTU)	0.41	0.63	42.31	≤15%	At these low levels, a high RPD is expected.
6/11/2018	11	Turbidity (NTU)	0.43	0.22	64.62	≤15%	At these low levels, a high RPD is expected.
6/25/2018	16	Turbidity (NTU)	1.27	0.97	26.79	≤15%	At these low levels, a high RPD is expected.
6/25/2018	Gage	Turbidity (NTU)	1.17	1.37	15.75	≤15%	At these low levels, a high RPD is expected.
7/9/2018	4	Turbidity (NTU)	1.06	0.87	19.69	≤15%	At these low levels, a high RPD is expected.
7/23/2018	8	Turbidity (NTU)	2.81	3.16	11.73	≤15%	
8/6/2018	10	Turbidity (NTU)	0.8	0.7	13.33	≤15%	
8/20/2018	18.1	Turbidity (NTU)	0.21	0.32	41.51	≤15%	At these low levels, a high RPD is expected.

Table 6. Field Duplicate Relative Percent Differences (RPD) – E. coli

Date	Site #	Actual (mpn/100 ml)	Duplicate (mpn/100 ml)	RPD (%)
6/11/2018	2	1.00	4.13	122.03
6/25/2018	20	7.3	36.92	133.97
7/9/2018	19.2	95.9	93.21	2.84
7/9/2018	4	14.2	107.12	153.18
7/23/2018	19	204.6	261.25	24.32
7/23/2018	29	517.2	726.99	33.72
8/6/2018	27	25.7	148.3	140.92
8/20/2018	21.5	88.40	1	195.53

RPD Seasonal Averages:

- Total Phosphorus – 17.26%
- Total Nitrogen – 2.28%
- Turbidity – 29.46%
- E. Coli – 100.81%

Table 7. Blank Comparisons

Date	Site #	E. Coli. (mpn/100m l)	TN (mg-N/l)	TP (ug P/L)	Turbidity (NTU)	Notes
6/11/2018	2	< 1	< 0.1	< 5	< 0.2	
6/11/2018	11			< 5	0.3	
6/11/2018	20.1-1		< 0.1			
6/25/2018	16				0.2	
6/25/2018	17			< 5		
6/25/2018	20	< 1		< 5		
6/25/2018	20.1-12		< 0.1			
6/25/2018	Gage		< 0.1	< 5	< 0.2	
7/9/2018	4	< 1	< 0.1	< 5	< 0.2	
7/9/2018	12			< 5		
7/9/2018	19.2	< 1				
7/9/2018	26			< 5		
7/23/2018	8			< 5	< 0.2	
7/23/2018	19	145.49				Likely contamination
7/23/2018	28.05			5.75		
7/23/2018	29	< 1				
7/23/2018	20.1-2		< 0.1	< 5		
8/6/2018	10		< 0.1	5.65	0.26	Does not exceed 6
8/6/2018	10.6			5.52		Does not exceed 6
8/6/2018	27			< 5		
8/6/2018	27	< 1				
8/20/2018	17.1			< 5		
8/20/2018	18.1			< 5	< 0.2	
8/20/2018	21.5	< 1				
8/20/2018	28.05		< 0.1	< 5		

Total Phosphorus

The seasonal relative percent difference (RPD) of phosphorus field duplicate samples for the six sampling dates was 17%, which is within the estimated range of precision specified in the Quality Assurance Project Plan (QAPP) – less than or equal to 30% RPD. Two field sample duplicates taken on June 25 and one on June 11 showed a difference greater than 30%. This large difference may have been due to sampling procedure because two of the three samples were taken by new volunteers.

Field blanks were also collected at each site during sampling. Field blanks had only trace phosphorus, except for three which had just above 5, but below 6 ug P / L.

Data completeness for the 2018 season is 99.4%, with only one sample missing.

Total Nitrogen

The average relative percent difference (RPD) of nitrogen field duplicate samples for the six sampling dates was 2%, within the estimated range of precision specified by the Quality Assurance Project Plan (QAPP) – less than or equal to 20% RPD. No field sample duplicates showed RPDs greater than 20%.

Field blanks were also taken at each sampling. All field blanks only had trace amounts of nitrogen, suggesting that no environmental factors affected the actual samples.

Data completeness for the 2018 season is 98.7%, with only one sample missing.

Turbidity

The average relative percent difference (RPD) of turbidity field duplicate samples for the six sampling dates was 29%, which is above the estimated range of precision specified in the QAPP (less than or equal to 15% RPD). At such low turbidity levels, however, a high RPD is expected.

Data completeness for the 2018 season is 100%.

E. coli

The seasonal relative percent difference (RPD) of E. coli field duplicate samples for the six sampling dates was 100%, which is within the estimated range of precision specified in the Quality Assurance Project Plan (QAPP) – less than or equal to 125% RPD.

DEC Flow and Level

In 2015, the Vermont DEC formalized a protocol to capture flow data and make qualitative observations on the flow condition at their respective sites. The Mad River Watch program has historically used a different categorization, based on the Moretown USGS Gage discharge information. Volunteers determine flow to be Low (L), Medium (M), or High (H), as well as the level to be Base (B), Flooding (F), or Hydro (H) conditions. These observations are made and recorded at each site during sampling and then generalized across the watershed to more easily make comparisons.

Table 8 illustrates the DEC Flow Category and Level and time of observation.

Table 8. DEC Flow Category and Level

SITE #	6/11/2018			6/25/2018			7/9/2018		
	Time Sampled (24 h)	DEC Flow Level	DEC Flow Category	Time Sampled (24 h)	DEC Flow Level	DEC Flow Category	Time Sampled (24 h)	DEC Flow Level	DEC Flow Category
BBL	7:45	L	B	7:30	L	B	7:40	L	B
1	8:10	L	B	7:50	L	B	8:00	L	B
2	8:30	L	B	8:00	L	B	8:15	L	B
4	8:55	L	B	8:10	L	B	8:35	L	B
7	9:05	L	B	8:20	L	B	8:45	L	B
8	9:10	L	B	8:30	L	B	8:55	L	B
10	9:20	L	B	8:35	L	B	9:05	L	B
10.6	8:50	M	B	8:22	M	B	8:30	M	B
10.8	8:35	M	B	8:39	M	B	N/A	N/A	N/A
11	7:10	L	B	7:25	L	B	7:08	L	B
12	6:58	M	B	7:14	L	B	6:57	L	B
16	7:31	L	B	7:46	L	B	7:23	L	B
17	7:35	L	B	7:51	L	B	7:25	L	B
17.1	7:50	L	B	8:06	L	B	7:38	L	B
18.1	8:04	M	B	8:20	L	B	7:51	L	B
19	8:08	M	B	9:06	M	B	9:19	M	B
19.2	8:24	M	B	9:20	M	B	9:30	M	B
20	7:30	L	B	7:30	L	B	7:20	L	B
20.1	6:30	L	B	7:20	L	B	7:05	L	B
20.1-1	6:05	L	B	7:00	L	B	6:45	L	B
20.1-12	5:50	L	B	6:45	L	B	6:30	L	B
20.1-2	6:15	L	B	7:10	L	B	6:55	L	B
21.5	8:39	M	B	9:30	M	B	9:51	M	B
23	8:52	M	B	9:40	M	B	9:59	M	B
24	7:06	M	B	7:53	L	B	7:31	L	B
25	7:18	M	B	8:06	L	B	7:49	L	B
26	7:51	M	B	8:33	L	B	8:42	L	B
27	7:40	M	B	8:15	L	B	8:05	L	B
28	7:28	M	B	8:25	L	B	8:15	L	B
28.05	8:04	L	B	8:15	M	B	8:35	L	B
28.05-2	7:59	L	B	8:10	M	B	8:28	L	B
28.05-1	7:54	L	B	8:05	M	B	8:22	L	B
Gage	7:46	M	B	7:52	M	B	8:11	L	B
29	7:40	L	B	7:42	M	B	8:03	L	B
31	8:40	M	B	7:31	M	B	7:54	L	B

SITE #	7/23/2018			8/6/2018			8/20/2018		
	Time Sampled (24 h)	DEC Flow Level	DEC Flow Category	Time Sampled (24 h)	DEC Flow Level	DEC Flow Category	Time Sampled (24 h)	DEC Flow Level	DEC Flow Category
BBL	7:45	L	B	7:30	L	B	7:10	L	B
1	8:05	L	B	7:50	L	B	7:20	L	B
2	8:20	L	B	8:05	L	B	7:30	L	B
4	8:35	L	B	8:15	L	B	7:45	L	B
7	8:45	L	B	8:30	L	B	7:55	L	B
8	8:55	M	F	8:35	L	B	8:00	L	B
10	9:20	L	B	8:45	L	B	8:05	L	B
10.6	7:13	L	F	8:45	L	B	8:16	M	B
10.8	7:22	L	F	8:30	L	B	8:28	M	B
11	7:17	L	B	7:17	L	B	7:16	L	B
12	7:09	L	B	7:10	L	B	7:09	L	B
16	7:32	L	B	7:37	L	B	7:34	L	B
17	7:35	L	B	7:36	L	B	7:35	L	B
17.1	7:47	L	B	7:50	L	B	7:49	L	B
18.1	8:02	L	B	8:02	L	B	8:05	L	B
19	9:15	L	F	8:00	M	B	9:00	M	B
19.2	9:30	L	F	8:30	M	B	9:10	M	B
20	7:50	L	F	7:40	L	B	7:25	L	B
20.1	7:35	L	F	7:30	L	B	7:15	L	B
20.1-1	7:10	L	F	7:05	L	B	6:55	L	B
20.1-12	6:55	L	F	6:50	L	B	6:40	L	B
20.1-2	7:25	L	F	7:15	L	B	7:05	L	B
21.5	9:47	L	F	8:48	M	B	9:25	M	B
23	9:55	L	F	8:58	M	B	9:40	M	B
24	8:13	L	B	7:27	L	B	7:50	L	B
25	8:24	L	B	7:41	L	B	8:02	L	B
26	8:50	L	B	8:37	L	B	8:26	L	B
27	8:32	L	B	8:10	L	B	8:10	L	B
28	8:43	L	B	8:19	L	B	8:17	L	B
28.05	9:35	L	F	8:00	L	B	9:10	M	F
28.05-2	9:25	L	F	7:53	L	B	9:00	M	F
28.05-1	9:15	L	F	7:45	L	B	8:52	M	F
Gage	8:55	L	F	7:36	L	B	8:40	M	F
29	8:44	L	F	7:28	L	B	8:35	M	F
31	8:24	L	F	7:20	L	B	8:25	M	F

Conclusions

Based on our analysis of the sampled total phosphorus data we would conclude that the sites at the North (20.1-1) and North Upstream (20.1-12) of High Bridge Brook represent areas where phosphorus inputs are significant enough to justify further monitoring and source research. Further analysis and source research of Welder Brook between upstream 28.05-2 and downstream 28.05 are important in 2019.

Nitrogen loading in the watershed does not appear to be an issue, as there were no violations of the water quality standards in 2016 or 2017. However, as this was only our third year sampling for total nitrogen, it is unclear if further sampling should be conducted in order to produce a historical record, and determine if any trends are apparent. Both Folsom, Freeman, High Bridge, and Welder Brooks would benefit from further analysis in 2019.

Sampling in the watershed during 2018 did not indicate many big turbidity challenges at the low flow conditions we captured.

Only 4 of the 72 samples for *E. coli* were greater than 235 organisms/100ml.