pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

BUREAU OF POINT & NON-POINT SOURCE MANAGEMENT

Continuous Instream Monitoring Report (CIMR)

Most recent revision: 6/20/2017
Revised by: Bendick

STATION DESCRIPTION:
STREAM CODE: 11494
STREAM NAME: Buffalo Creek
SITE NAME: UPS RT 849 Bridge

COUNTY: Perry

LATITUDE: 40.482404 **LONGITUDE:** -77.174339

LOCATION DESCRIPTION: About 25 Meters Upstream of Route 849 Bridge.

HUC: 02050304

DRAINAGE AREA: 65.03 sq. miles

BACKGROUND AND HISTORY: Buffalo Creek is a freestone tributary to the Juniata River within Juniata Township, Perry County (Figure 1). The basin is characterized by ridged valley topography on both sides of the stream with land use consisting of forested land (67%) with urban land use (0%) and agricultural uses (33%). The purpose of this survey was to collect baseline data on a High Quality-Cold Water Fishes (HQ-CWF), Migratory Fishes (MF) stream to determine water quality.

The primary objectives of the assessment were to:

1. Characterize baseline water temperature, specific conductance, pH, and dissolved oxygen using 24-hour monitoring.
2. Characterize water chemistry.
3. Characterize biological communities.

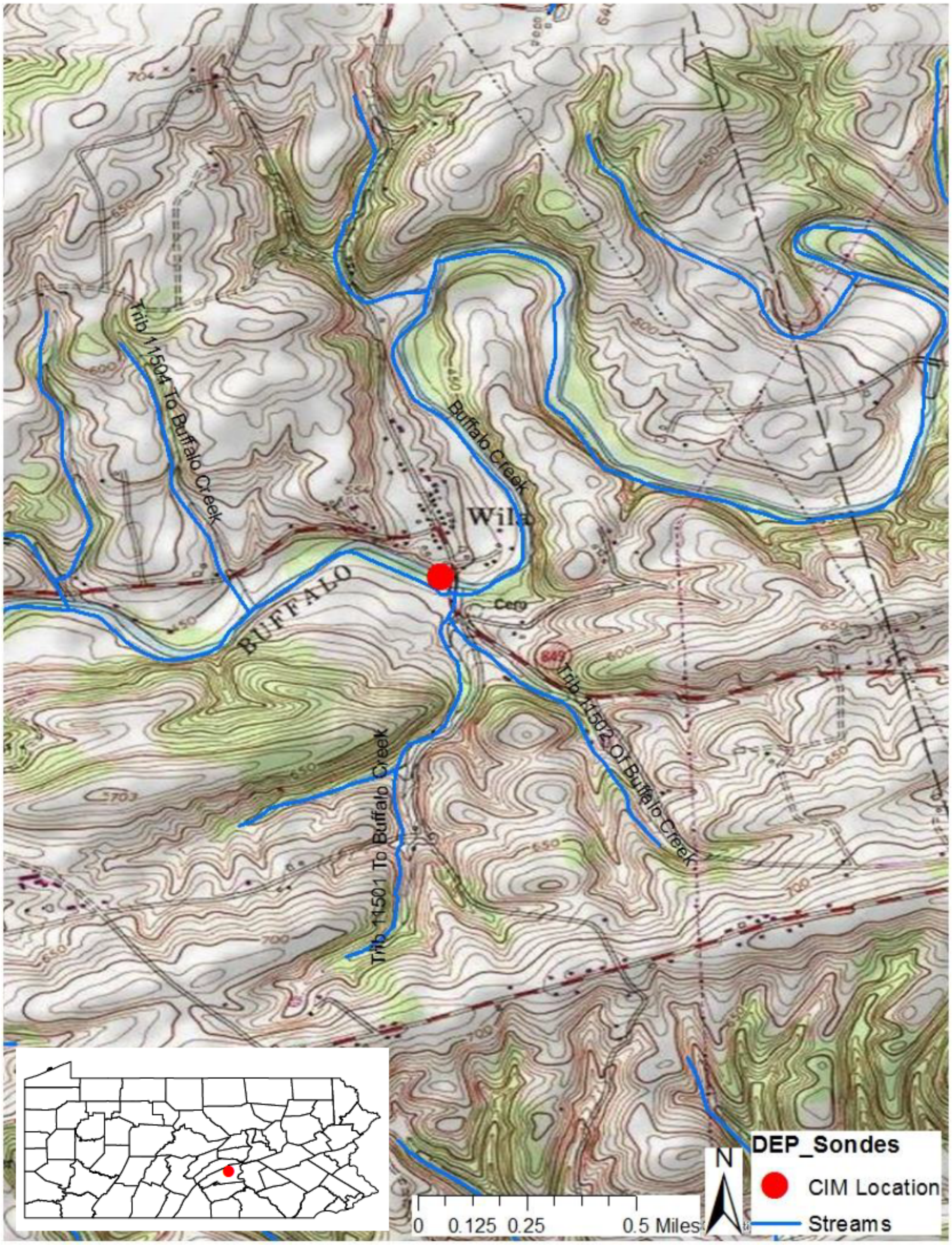

Figure 1. Map of the Buffalo Creek continuous instream monitoring (CIM) site.

Figure 2. Buffalo Creek sampling location.

WATER QUALITY PARAMETERS:

Parameter	Units
Water Temperature	°C
Specific Conductance (@25°C)	µS/cm[c]
pH	standard units
Dissolved Oxygen	mg/L

EQUIPMENT:

A single Yellow Springs Instruments (YSI) YSI 6920v2 (Serial #00018B9B) was used from April 19, 2013 to November 7, 2013. A Measurement Specialties Eureka2 water-quality sonde (Serial #MT04131241) was deployed in the following year from April 14, 2014 to July 15, 2014, at which time the sonde was pulled and replaced due to equipment failures. A Measurement Specialist Eureka2 water-quality sonde (Serial #MT04131243) was used from July 15, 2014 to November 13, 2014. A Yellow Springs Instruments (YSI) 6920 V2 was used as a field meter during revisits.

The sondes were housed in a 24-inch length of 4-inch diameter schedule 80 PVC pipe with holes drilled in it to allow for flow through. One end of the pipe was capped, and a notch was cut to accommodate the metal attachment bar on the top of the sondes. The attachment bar was clipped to an eye-bolt attached to rebar driven into the stream bed. The attachment bar was also clipped to a cable attached to a second piece of rebar located just upstream of the first. The sondes recorded water quality parameters every 30 minutes.

PERIOD OF RECORD: April 19, 2013 to November 7, 2013 AND April 14, 2014 to November 13, 2014

The station was revisited eight times in 2013 and eleven times in 2014 for the purpose of downloading data, checking calibration, and cleaning.

DATA:

Water chemistry grabs were collected seven times during the 2013 sampling period and seven times during the 2014 sampling period. Biological samples were collected following the Department's ICE protocol (PA DEP, 2013b) and Wadable Semi-Quantitative Fish Sampling Protocol (PA DEP, 2013c). Benthic macroinvertebrates were collected on January 14, 2013, August 8, 2013, November 11, 2013, and November 12, 2014 and fishes were collected on July 11, 2013 and July 1, 2014. Continuous data were graded based on a combination of fouling and calibration error (PA DEP, 2013a). One period for pH in 2013 was graded unusable. One small portion of specific conductance data and one small portion of pH data in 2014 were graded unusable and deleted from the final report. Other gaps in the 2014 datasets are due to battery or equipment failure.

Discrete Water Quality Transect Characterization: A transect across the width of the stream was established to characterize water quality. The purpose of the transect was to determine if data collected by the sonde was representative of the surface water as a whole. Discrete water quality measurements were taken at equidistant points across the transect. Transects were conducted two times during the 2013 sampling period and four times throughout the 2014 sampling period.

Temperature, specific conductance, pH, and dissolved oxygen measurements indicated a homogenous system (Figures 3 – 4).

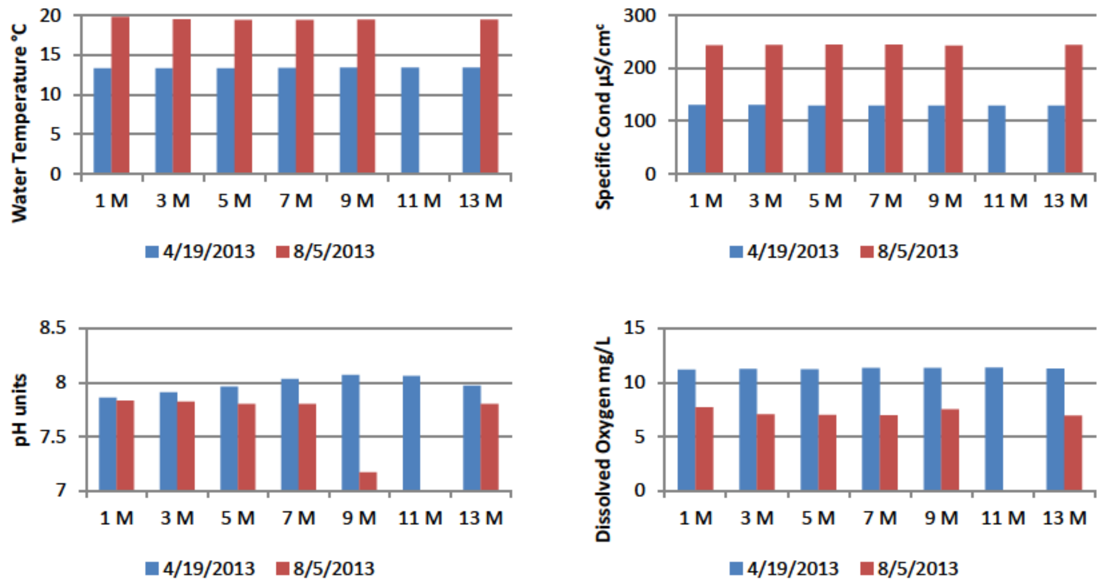

Figure 3. Discrete water quality data from 2013, collected 2 meters apart from the right descending bank to the left descending bank.

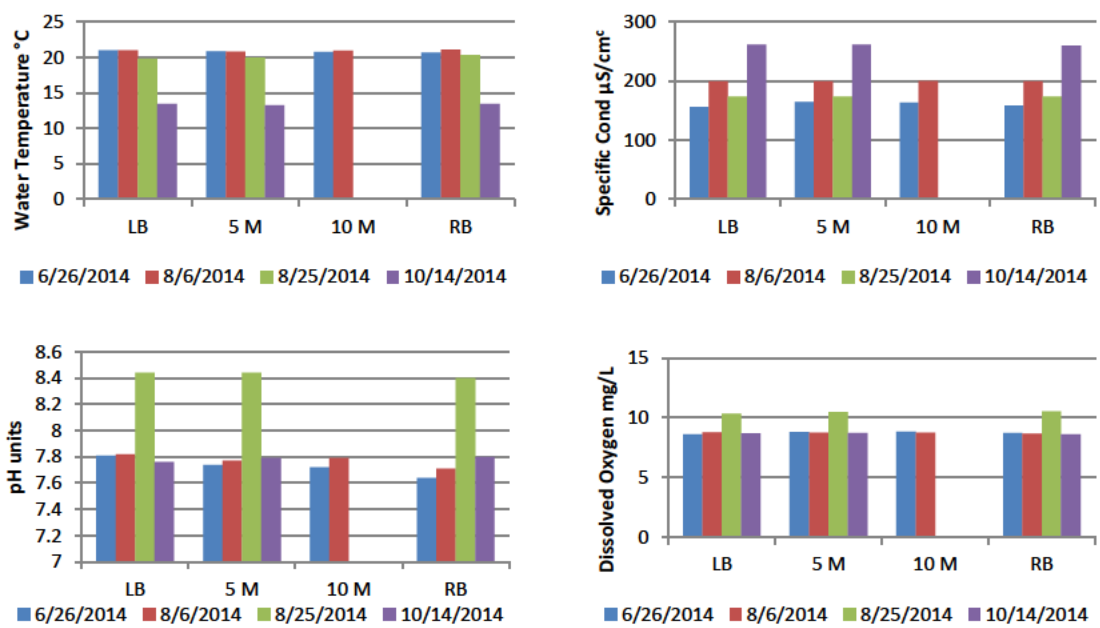

Figure 4. Discrete water quality data from 2014, collected 5 meters apart from the left bank (LB) descending to the right bank (RB) descending.

Depth:
Depth and discharge data are used only as qualitative interpretation for changes in other parameters due to a lack of verification. Depth measured by the non-vented YSI 6920v2 used in the 2013 sampling period is actually the measure of water column pressure plus atmospheric pressure. Changes in atmospheric pressure while the sonde was deployed appear as changes in depth. Data were corrected for barometric pressure using Quality Controlled Local Climatological Data (QCLCD) data from the Harrisburg International Airport NOAA station.

Equipment deployed in 2014 failed to record depth at the site, so provisional discharge data from USGS Shermans Creek gage station was used for qualitative interpretation. Shermans Creek discharge data was chosen because the geographical, climatological, and stream characterstics are similar to those of Buffalo Creek. Data was downloaded from the U.S. Geological Survey's website using USGS station # 01568000, Shermans Creek at Shermans Dale, PA.

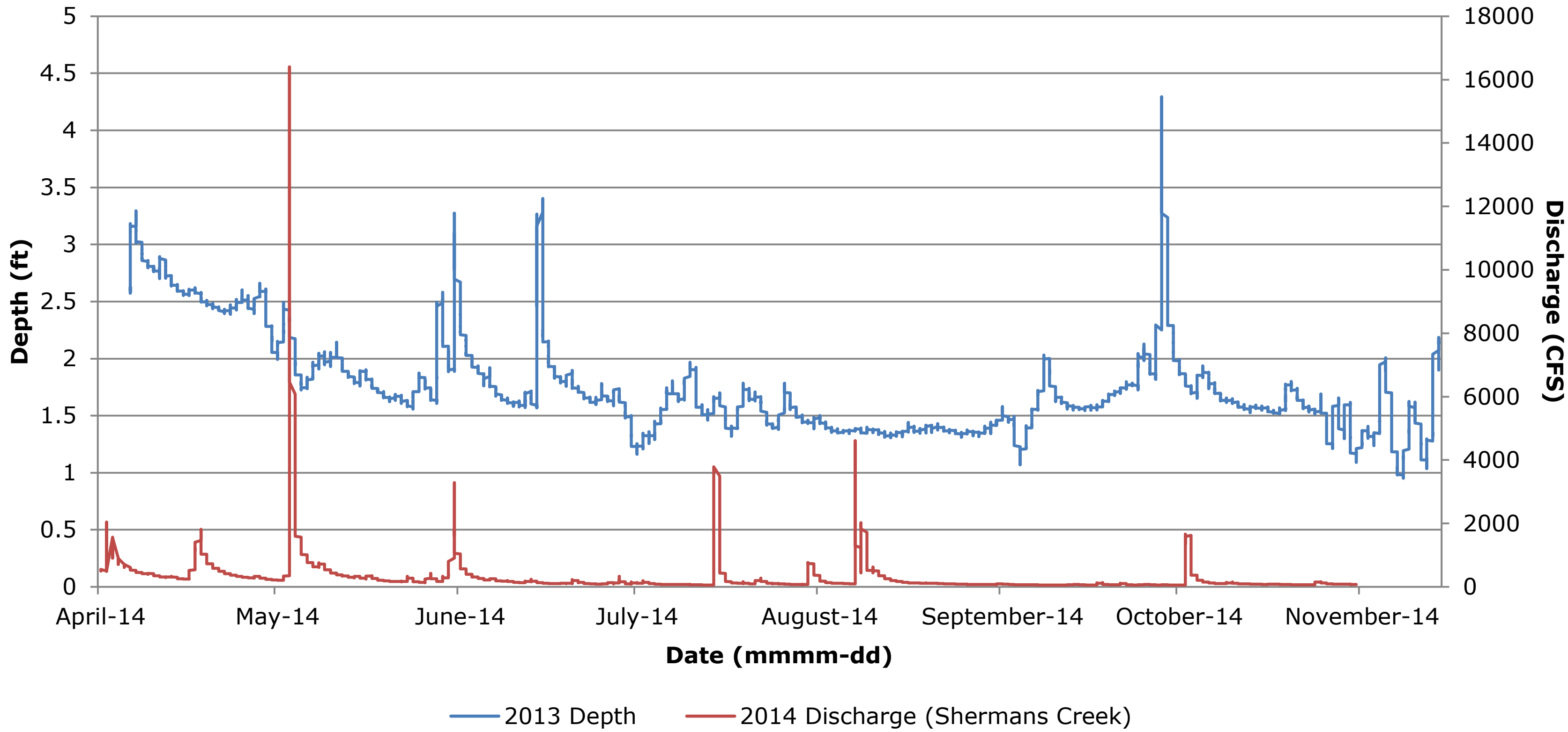

Figure 5. Continuous Buffalo Creek depth (2013) and Shermans Creek discharge (2014) data compared.

Water Temperature:
2013 Statistics - Average: 18.6 °C; Maximum: 30.8°C; Minimum: 4.6 °C.

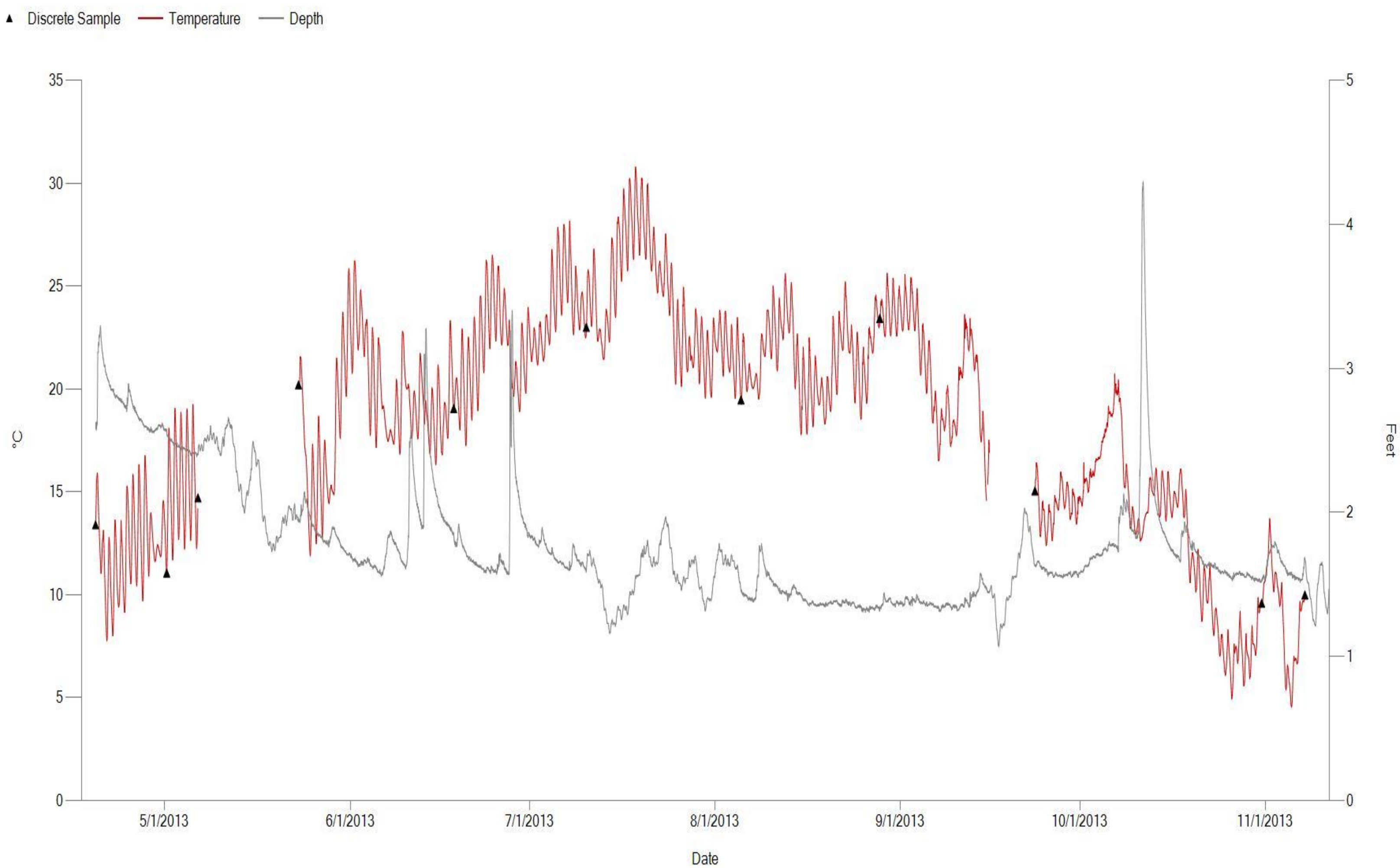

Figure 6. Continuous water temperature, continuous depth and discrete samples from April 19, 2013 to November 7, 2013.

Water Temperature:
2014 Statistics - Average: 16.6°C; Maximum: 26.3°C; Minimum: 4.8°C.

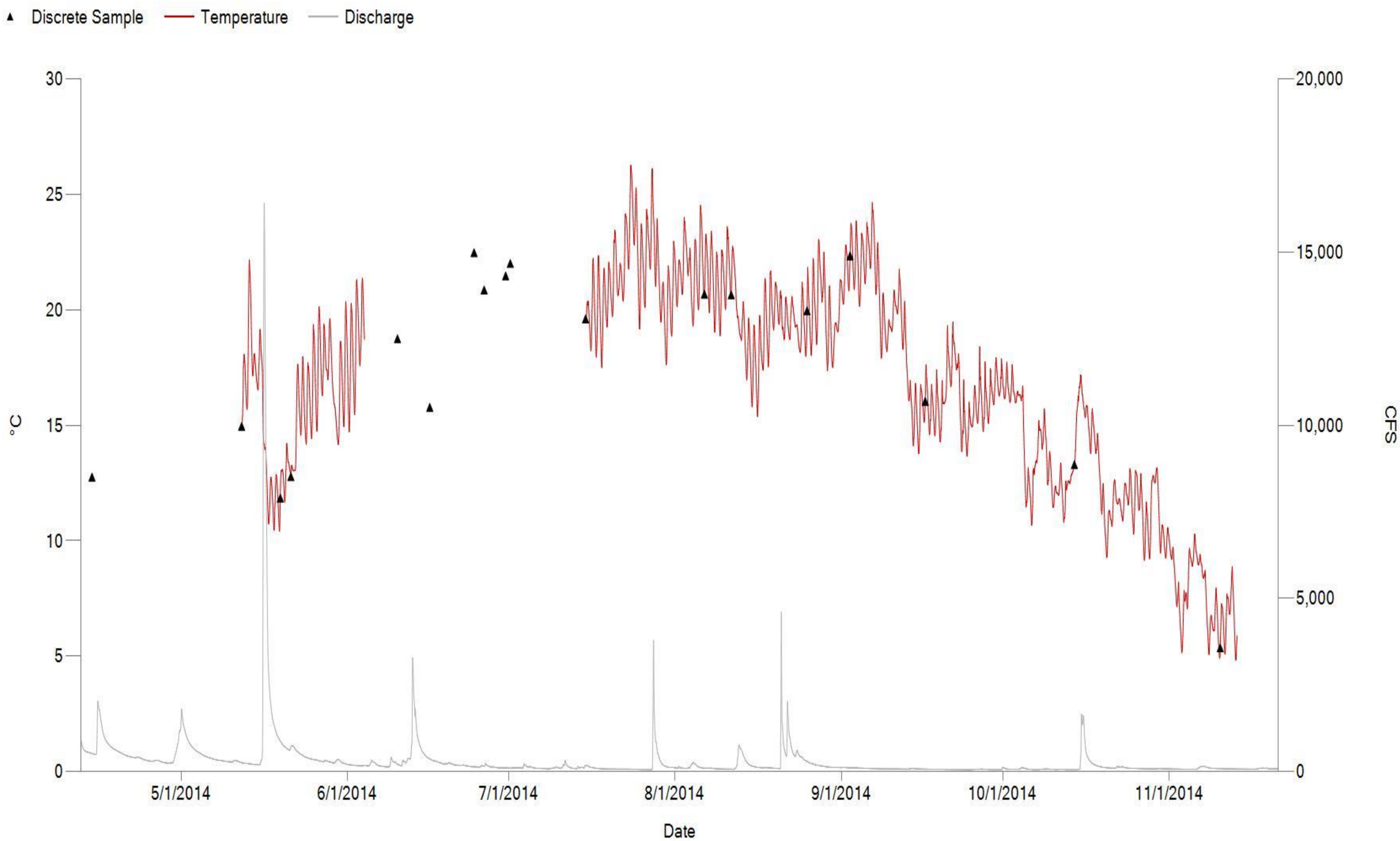

Figure 7. Continuous water temperature, continuous discharge (Shermans Creek) and discrete samples from April 14, 2014 to November 13, 2014. The data gaps are due to equipment failure.

Specific Conductance:
2013 Statistics - Average: 225 µS/cm[c]; Maximum: 302 µS/cm[c]; Minimum: 108 µS/cm[c].

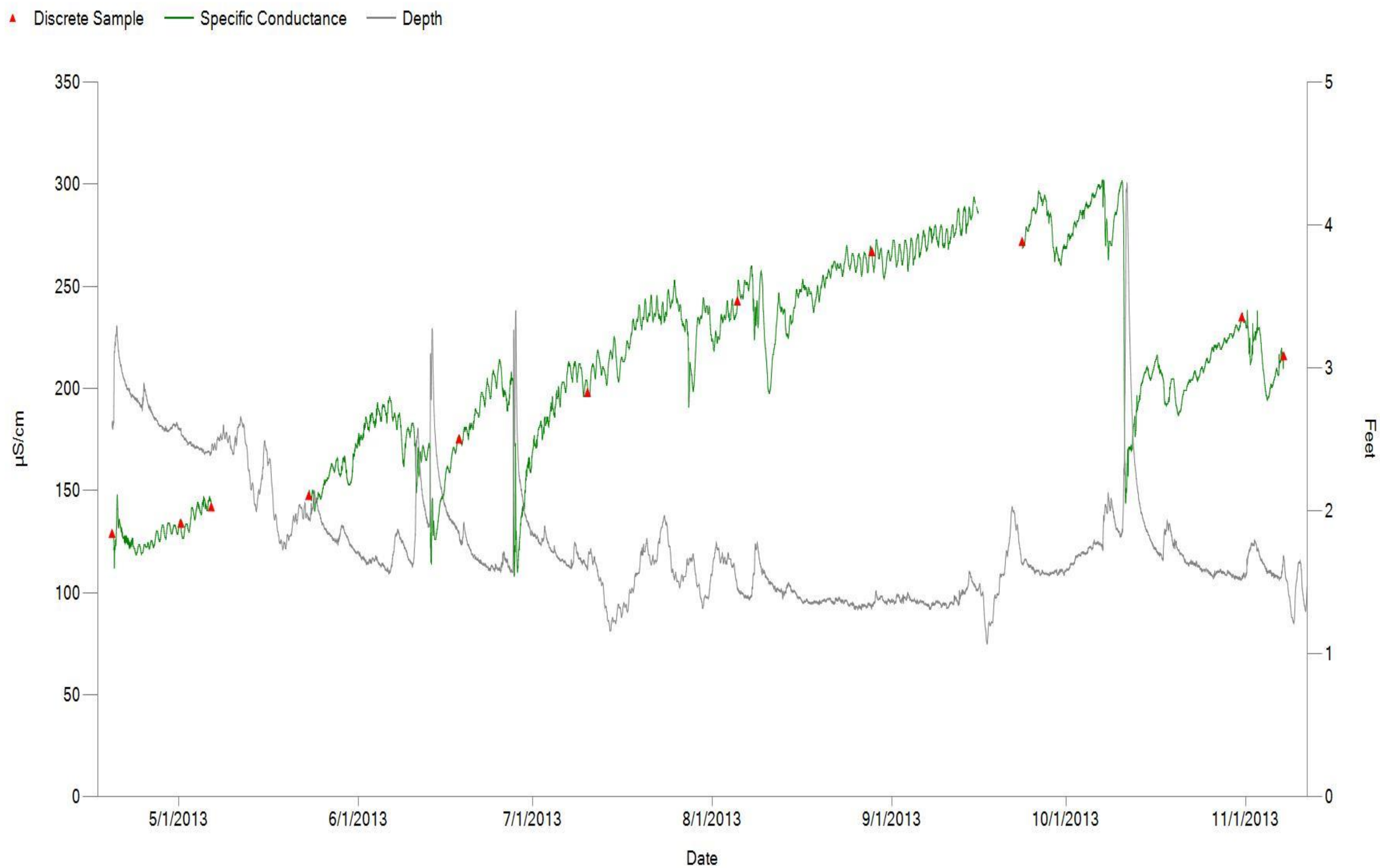

Figure 8. Continuous specific conductance (µS/cm[c]), continuous depth and discrete samples from April 19, 2013 to November 7, 2013.

Specific Conductance:

2014 Statistics - Average: 206 µS/cm[c]; Maximum: 284 µS/cm[c]; Minimum: 111 µS/cm[c].

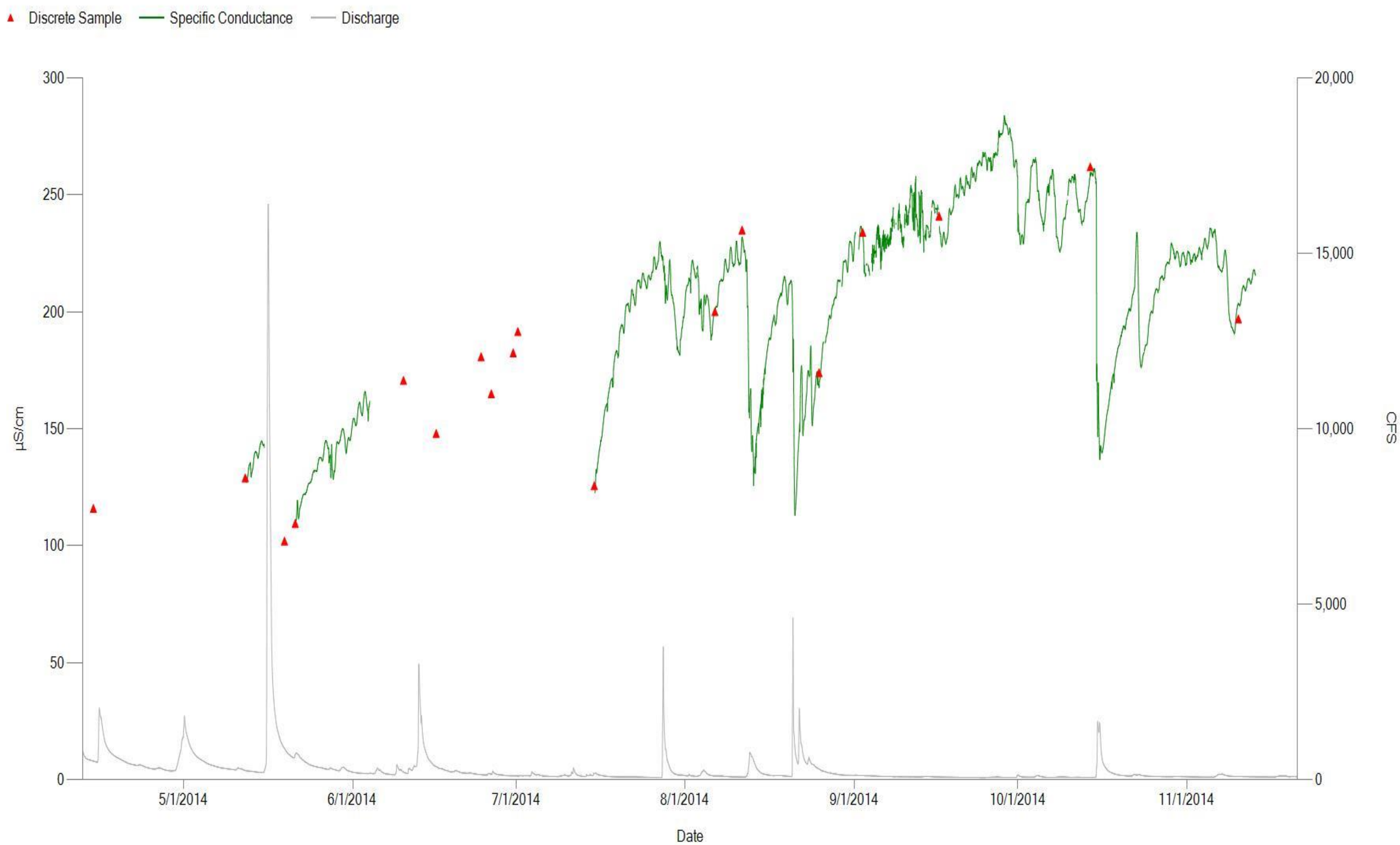

Figure 9. Continuous specific conductance (µS/cm[c]), continuous discharge (Shermans Creek) and discrete samples from April 14, 2014 to November 13, 2014. The data gaps are due to equipment failure.

pH:

2013 Statistics - Average: 7.9 units; Maximum: 8.8 units; Minimum: 7.0 units.

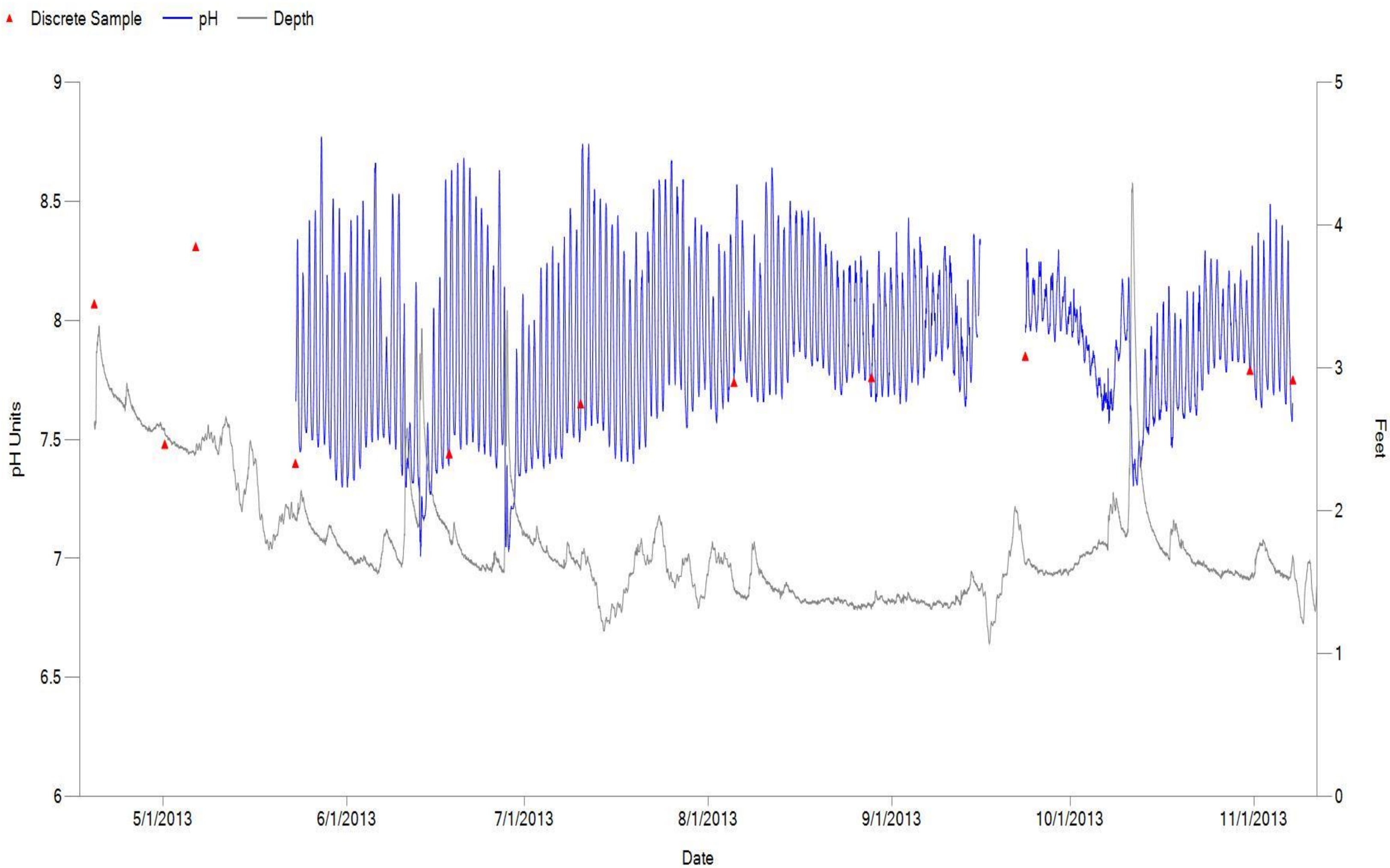

Figure 10. Continuous pH, continuous depth and discrete samples from April 19, 2013 to November 7, 2013. The data gap at the beginning of the sampling period is due to a large undocumented fouling event.

pH:

2014 Statistics - Average: 7.9 units; Maximum: 8.9 units; Minimum: 7.2 units.

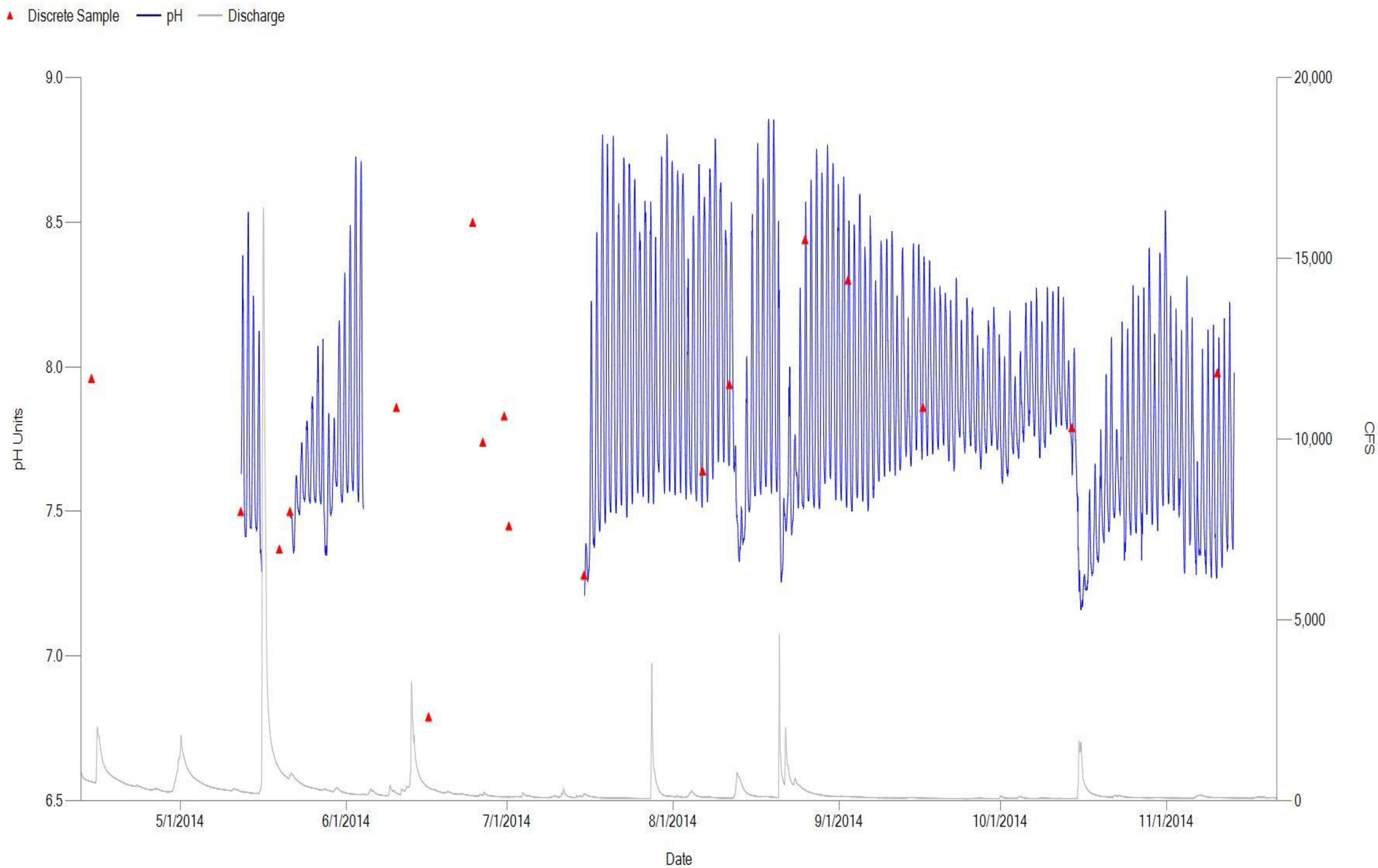

Figure 11. Continuous pH, continuous discharge (Shermans Creek) and discrete samples from April 14, 2014 to November 13, 2014. The data gaps are due to equipment failure.

Dissolved Oxygen:

2013 Statistics - Average: 8.9 mg/L; Maximum: 14.2 mg/L; Minimum: 3.7 mg/L.

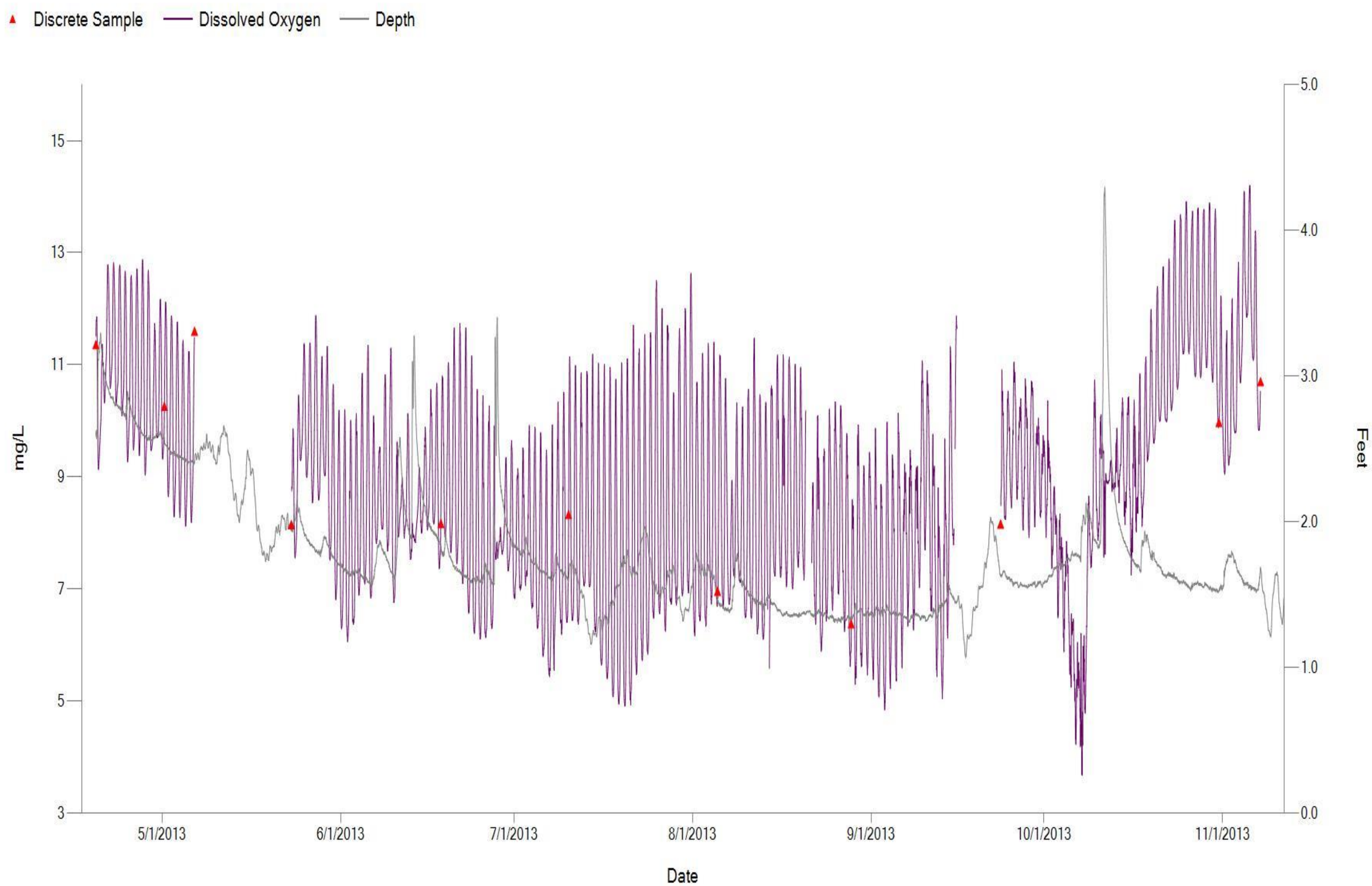

Figure 12. Continuous dissolved oxygen, continuous depth and discrete samples from April 19, 2013 to November 7, 2013.

Dissolved Oxygen:

2014 Statistics - Average: 9.6 mg/L; Maximum: 14.2 mg/L; Minimum: 6.3 mg/L.

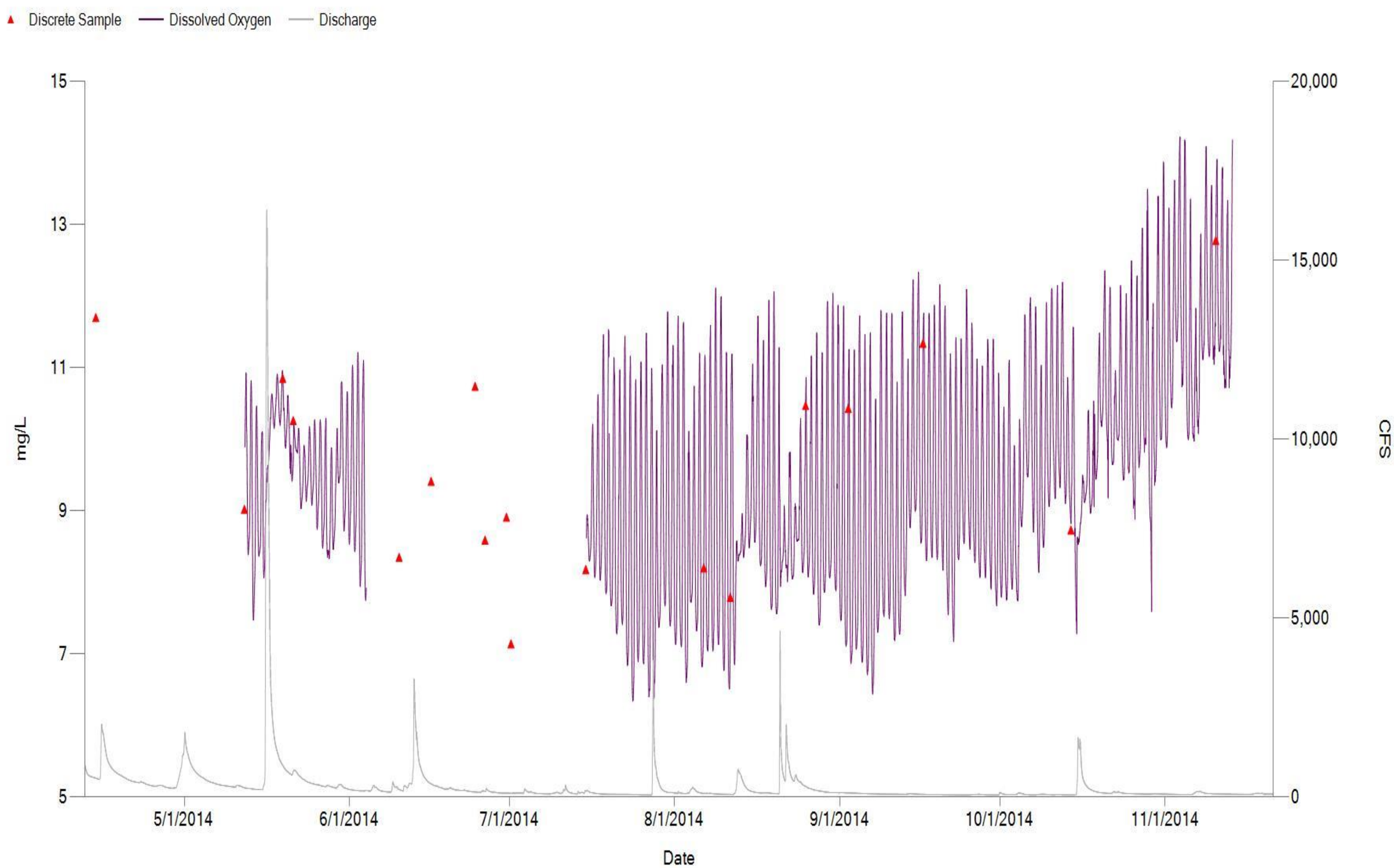

Figure 13. Continuous dissolved oxygen, continuous discharge (Shermans Creek) and discrete samples from April 14, 2014 to November 13, 2014. The data gaps are due to equipment failure.

In-situ Water Chemistry: In 2013 water chemistry samples were collected seven times using standard analysis code (SAC) 612. Samples were collected seven times in 2014 using SAC 612 with additional dissolved metal concentration analyses. Measurements with "<" indicate concentrations below the reporting limit.

Table 1. 2013 Chemical grab sample results.

Parameters	Units	5/1/2013	5/6/2013	5/23/2013	6/18/2013	8/5/2013	9/23/2013	10/31/2013
		7:30	13:15	8:00	8:30	8:25	11:00	8:15
ALKALINITY	MG/L	40.8	47	47	51.6	91.4	111	79.4
ALUMINUM T	UG/L	60	59	249	191	120	112	15
BARIUM T	UG/L	36	30	42	48	54	58	52
BORON T	UG/L	30	20	<19.1058	30	<19.1058	20	30
BROMIDE	UG/L	<7.03284	<7.03284	<7.03284	9.993	<7.03284	<7.03284	<7.03284
CALCIUM T	MG/L	13.6	14.4	14.5	16.8	30.4	34.3	30.564
CHLORIDE T	MG/L	8.892	7.735	8.466	12.118	8.525	10.357	14
COPPER T	UG/L	0.45	0.368	1.31	1.14	1.74	0.729	0.604
IRON T	UG/L	148	151	421	348	247	213	119
LEAD T	UG/L	0.125	0.126	0.476	0.294	0.385	0.167	<0.07258
MAGNESIUM T	MG/L	3.514	3.595	3.69	4.514	6.959	8.244	6.634
MANGANESE T	UG/L	17	21	45	36	54	34	16
NICKEL T	UG/L	<13.7856	<13.7856	<13.7856	<13.7856	<13.7856	<13.7856	<13.7856
SELENIUM T	UG/L	<0.32605	<0.32605	<0.32605	<0.32605	<0.32605	0.633	<0.32605
SODIUM T	MG/L	5.042	4.466	4.746	6.45	5.496	4.88	7.434
STRONTIUM T	UG/L	153	170	183	203	406	550	408
ZINC T	UG/L	71	6	149	30	<5.1325	<5.1325	9
SULFATE T	MG/L	8.665	8.724	8.633	9.449	11.682	13.986	13.939
HARDNESS T	MG/L	48	51	51	61	105	120	104
OSMOTIC PRESSURE	MOSM	4	5	3	3	4	36	3
pH	pH units	7.8	8.1	7.9	7.7	8	8	8

Table 1 (continued). 2013 Chemical grab sample results.

Parameters	Units	5/1/2013	5/6/2013	5/23/2013	6/18/2013	8/5/2013	9/23/2013	10/31/2013
		7:30	13:15	8:00	8:30	8:25	11:00	8:15
SPECIFIC CONDUCTIVITY	umhos/cm	133.7	142.1	142.2	--	233	266	236
TDS	MG/L	84	90	92	100	132	168	116
TOC	MG/L	1.722	1.742	2.436	2.094	2.561	2.761	2.018
TSS	MG/L	<5	<5	8	<5	12	14	<5
AMMONIA D	MG/L	<0.00672	0.014	0.042	0.034	0.044	0.026	0.017
AMMONIA T	MG/L	0.115	0.011	0.048	0.031	0.041	0.044	0.01
NITRATE & NITRITE T	MG/L	0.903	0.834	0.965	1.795	0.717	0.725	1.172
NITRATE & NITRITE D	MG/L	0.903	0.832	0.963	--	0.721	0.723	1.159
NITROGEN T	MG/L	1.052	1.036	1.251	1.824	1.049	1.057	1.306
NITROGEN D	MG/L	1.024	1.011	1.158	--	1.095	0.946	1.352
ORTHO PHOSPHORUS T	MG/L	0.007	0.005	0.013	0.021	0.01	0.011	0.006
ORTHO PHOSPHORUS D	MG/L	0.006	0.005	0.011	--	0.012	0.007	0.003
PHOSPHORUS T	MG/L	0.015	0.016	0.038	0.034	0.032	0.024	0.007
PHOSPHORUS D	MG/L	0.009	0.011	0.017	0.018	0.017	0.014	<0.00305

Table 2. 2014 Chemical grab sample results.

Parameters	Units	4/1/2014	5/19/2014	6/16/2014	6/24/2014	8/6/2014	9/2/2014	11/10/2014
		8:34	11:21	7:24	13:20	10:44	13:18	11:47
ALKALINITY	MG/L	23.4	25.8	39.6	61.6	68.4	81.4	68.2
ALUMINUM D	UG/L	--	--	<200.0	<200.0	<200.0	<200.0	9
ALUMINUM T	UG/L	238	277	72	56	132	60	22
BARIUM T	UG/L	31	32	39	39	48	46	40
BORON T	UG/L	20	<19.1058	20	<19.1058	20	<19.1058	<19.1058
BROMIDE	UG/L	<6.677	<6.677	<6.677	7.492	7.221	<7.127	<7.127
CALCIUM T	MG/L	10.68	10.4	14.7	23.24	23.7	27.8	25
CHLORIDE T	MG/L	9.315	5.219	7.995	8.92	10.976	8.918	n/a
COPPER D	UG/L	--	--	<4	<4	<4	<4	0.665
COPPER T	UG/L	2.95	0.77	0.394	0.946	1.03	0.64	0.532
IRON D	UG/L	--	--	46	35	43	36	56
IRON T	UG/L	364	332	147	108	230	127	82
LEAD D	UG/L	--	--	<1.0	<1.0	<1.0	<1.0	<.101
LEAD T	UG/L	0.412	0.525	0.141	0.115	0.242	0.111	<0.101
MAGNESIUM T	MG/L	2.681	2.712	3.883	4.807	5.137	6.146	5.372
MANGANESE D	UG/L	--	--	<10	<10	23	12	6
MANGANESE T	UG/L	23	17	12	14	33	18	6
NICKEL T	UG/L	<13.7856	<13.7856	<13.7856	<13.7856	<13.7856	<13.7856	<12
SELENIUM T	UG/L	0.824	1.27	0.331	0.461	<0.32605	<0.32605	<.763
SODIUM T	MG/L	5.403	3.714	5.632	5.016	6.31	6.183	6.097
STRONTIUM T	UG/L	84	93	150	241	282	370	304
ZINC D	UG/L	--	--	<10.0	10	<10.0	<10.0	6
ZINC T	UG/L	10	6	<5.1325	<5.1325	<5.1325	<5.1325	5
GLYPHOSATE	UG/L	--	--	nd*	nd*	nd*	--	--
SULFATE T	MG/L	8.778	8.278	9.223	9.82	9.558	11.439	--

*nd = not detected

Table 2 (continued). 2014 Chemical grab sample results.

Parameters	Units	4/1/2014	5/19/2014	6/16/2014	6/24/2014	8/6/2014	9/2/2014	11/10/2014
		8:34	11:21	7:24	13:20	10:44	13:18	11:47
HARDNESS T	MG/L	38	37	53	78	80	95	85
OSMOTIC PRESSURE	MOSM	<1	<1	5	5	3	4	2
pH	pH units	6.9	7.4	7.7	8.6	8.1	8.3	7.9
SPECIFIC CONDUCTIVITY	umhos/cm	107.8	100.2	145.9	180.4	197	231	204
TDS	MG/L	80	78	456	120	120	134	124
TOC	MG/L	2.309	1.984	1.896	1.922	2.789	2.028	2.394
TSS	MG/L	16	8	<5	<5	<5	<5	<5
AMMONIA D	MG/L	0.009	<0.008	0.016	0.021	0.029	0.025	--
AMMONIA T	MG/L	0.011	<0.008	0.013	0.021	0.033	0.018	--
NITRATE & NITRITE T	MG/L	1.857	1.515	2.083	1.464	0.849	1.554	0.892
NITRATE & NITRITE D	MG/L	1.882	1.515	2.099	1.472	0.857	1.568	0.922
NITROGEN T	MG/L	2.122	1.674	2.242	1.606	1.086	1.771	--
NITROGEN D	MG/L	2.269	1.672	2.346	1.57	1.071	1.697	--
ORTHO PHOSPHORUS T	MG/L	0.012	0.017	0.012	0.005	0.01	0.009	0.004
ORTHO PHOSPHORUS D	MG/L	0.01	0.013	0.011	0.004	0.007	0.008	0.005
PHOSPHORUS T	MG/L	0.024	0.024	0.016	0.013	0.019	0.019	0.008
PHOSPHORUS D	MG/L	0.013	0.014	0.012	0.007	0.011	0.012	0.006

Biology: The indigenous aquatic community is an excellent indicator of long-term conditions and is used as a measure of water quality. Benthic macroinvertebrates (Table 2) were collected on January 14, 2013, August 8, 2013, November 11, 2013, and November 12, 2014. Fishes were collected on July 11, 2013 and July 1, 2014 (Table 3).

Table 2. Taxa list for benthic macroinvertebrate surveys.

		20130114-1245-mlookenbil	20130828-1315-mbrickner	20131107-1430-dushull	20141110-1530-mhoger
Baetidae	*Acerpenna*	1		2	7
Baetidae	*Baetis*		13		
Ephemerellidae	*Serratella*				4
Ephemerellidae	*Ephemerella*				1
Ephemerellidae	*Eurylophella*	1			
Ephemeridae	*Ephemera*		1		2
Heptageniidae	*Epeorus*			1	15
Heptageniidae	*Leucrocuta*	2	1	4	15
Heptageniidae	*Maccaffertium*	13	33	28	35
Isonychiidae	*Isonychia*	7	17	15	34
Leptophlebiidae	*Leptophlebia*	4			
Leptophlebiidae	*Paraleptophlebia*	7		12	14
Capniidae	*Allocapnia*	68			3
Capniidae	*Paracapnia*				5
Chloroperlidae	*Haploperla*	1			
Nemouridae	*Prostoia*	4			
Perlidae	*Acroneuria*	2	2	3	1
Perlidae	*Agnetina*	2	3	2	1
Perlodidae	*Isoperla*	4			3
Taeniopterygidae	*Strophopteryx*	3			
Taeniopterygidae	*Taeniopteryx*	15		12	15
Hydropsychidae	*Ceratopsyche*	3	14	4	4
Hydropsychidae	*Cheumatopsyche*	9	16	36	35
Hydropsychidae	*Hydropsyche*		1		
Hydroptilidae	*Leucotrichia*		1		
Limnephilidae	*Hydatophylax*				3
Philopotamidae	*Chimarra*	1	6	15	13
Psychomyiidae	*Psychomyia*		1		1
Uenoidae	*Neophylax*	5			4
Empididae	*Clinocera*	2			
Elmidae	*Microcylloepus*		2		
Elmidae	*Optioservus*	2	7	10	3
Elmidae	*Stenelmis*	12	75	37	17
Athericidae	*Atherix*				

Table 2 (continued). Taxa list for benthic macroinvertebrate surveys.

		20130114-1245-mlookenbil	20130828-1315-mbrickner	20131107-1430-dushull	20141110-1530-mhoger
Coenagrionidae	*Argia*	1	4	1	
Corydalidae	*Nigronia*	1			
Corydalidae	*Corydalus*		3		1
Limoniidae	*Hexatoma*	1			
Psephenidae	*Psephenus*	3	3		2
Sialidae	*Sialis*			1	1
Simuliidae	*Prosimulium*	12			
Simuliidae	*Simulium*	3			
Tipulidae	*Antocha*	1		1	
Tipulidae	*Dicranota*			1	
Tipulidae	*Tipula*	1			
Chironomidae		50	12	9	13
Oligochaeta			2		

Table 3. Taxa list for fish surveys.

Family	Scientific Name	Common Name	20130711-1330-twertz	20140701-0800-twertz
Catostomidae	*Catostomus commersonii*	White Sucker	15	25
Catostomidae	*Hypentelium nigricans*	Northern Hogsucker	1	
Catostomidae	*Erimyzon oblongus*	Creek Chub	1	
Cyprinidae	*Campostoma anomalum*	Central Stoneroller	42	202
Cyprinidae	*Semotilus atromaculatus*	Creek Chub	5	3
Cyprinidae	*Luxilus cornutus*	Common Shiner	5	8
Cyprinidae	*Semotilus corporalis*	Fallfish	26	16
Cyprinidae	*Notemigonus crysoleucas*	Golden Shiner	1	
Cyprinidae	*Exoglossum maxillingua*	Cutlip Minnow	5	
Cyprinidae	*Nocomis micropogon*	River Chub	8	7
Cyprinidae	*Pimephales notatus*	Bluntnose Minnow	19	17
Cyprinidae	*Notropis rubellus*	Rosyface Shiner	53	10
Cyprinidae	*Notropis volucellus*	Mimic Shiner	67	221
Cyprinidae	*Rhinichthys cataractae*	Longnose Dace		16
Cyprinidae	*Rhinichthys atratulus*	Blacknose Dace		1
Centrarchidae	*Lepomis auritus*	Redbreast Sunfish	22	10
Centrarchidae	*Lepomis cyanellus*	Green Sunfish	1	6
Centrarchidae	*Micropterus dolomieu*	Smallmouth Bass	25	22
Centrarchidae	*Lepomis gibbosus*	Pumpkinseed	1	13
Centrarchidae	*Lepomis macrochirus*	Bluegill	1	28
Centrarchidae	*Ambloplites rupestris*	Rock Bass	20	41

Table 3 (continued). Taxa list for fish surveys.

Family	Scientific Name	Common Name	20130711-1330-twertz	20140701-0800-twertz
Cottidae	*Cottus bairdii*	Mottled Sculpic	1	2
Ictaluridae	*Noturus insignis*	Margined Madtom	28	9
Percidae	*Etheostoma blennioides*	Greenside Darter	22	43
Percidae	*Etheostoma olmstedi*	Tessellated Darter		4
Percidae	*Etheostoma zonale*	Banded Darter	5	13
Percidae	*Percina peltata*	Shield Darter		1

ASSESSMENT:

Continuous: Continuous instream monitors (CIMs) record instream parameters that have defined water quality standards (WQS) in 25 Pa Code §93.7 (temperature, pH and DO). Certain conditions must be met in order to properly assess data from CIMs. Any readings that do not comply with the applicable numeric WQS criteria are considered exceedances and are reviewed to determine if representative of the stream segment and if representative of natural quality as stated in 25 Pa Code §93.7(d). All data reviews are consistent with requirements as described in 25 Pa Code §96.3 which includes the 99 percent frequency measurement rule.

Defining Criteria Exceedance

The WQS criteria for pH and DO are expressed as either a discrete minimum, discrete maximum, or as a daily average (continuous 24-hour period, §93.1) concentration. The individual recordings exceeding the listed criteria are summed and the percent of the year (%Y) that those readings represent is calculated using the following equation:

$$\%Y = 100 * [n / (525{,}600 / i)]$$

Where

n = number of exceedances
i = recording interval in minutes
The constant (525,600) is the number of minutes in a year (365 days * 24 hrs/day * 60 min/hr)

If %Y > 1, then the criterion is not achieved 99% of the time as required by §96.3(c), and the waterbody is considered in violation of water quality standards. A period of one year is applied as a rolling year to avoid arbitrary divides as with a calendar year or water year. The 99 percent frequency measurement calculation is based on one continuous 365-day period.

Sampling Critical Time Periods

Temperature, pH and DO are all affected by seasonal change and can, therefore, be predicted to a certain degree. For example, CIMs may be deployed during the growing season when increases in instream production and respiration occur. The Department's CIM efforts have documented increases in pH values, increases in diel pH fluctuation, corresponding decreases in DO values, and increases in diel DO fluctuation beginning in early spring and persisting through the fall. This correlates with increased photoperiod and increased air and surface water temperatures. The effect of increased temperature and photoperiod to increased instream production and respiration are well documented (Odum 1956, Strickland et al. 1970, Neori and Holm-Hansen 1982, Raven and Geider 1988). Diel fluctuation is the difference of minimum and maximum values over a 24-hour period. This is caused by both plant photosynthetic activity and respiration throughout the day and community respiration at night (Odum 1956, White et al. 1991, Wurts 2003). An increased photoperiod with adequate nutrition will increase the standing biomass of photosynthetic organisms (Valenti et al. 2011). Phosphorus has been documented to be the limiting factor of standing biomass in freshwater systems (Stevenson 2006), however other studies indicate increased nitrogen and phosphorus can produce higher biomass than nitrogen or phosphorus alone, suggesting co-limitation (Carrick and Price 2011). During the growing season, pH is most likely to exceed maximum criteria (9.0) and DO to fall below the minimum criteria or 7-day average as described in §93.7, for each critical use. Sampling during critical periods may give sufficient information to make an assessment decision and greatly reduce the amount of resources needed to conduct the survey.

The Department must also recognize that critical or limiting conditions may not be consistent year-to-year, and a single year of data may not accurately represent conditions that water quality standards were developed to protect. Typically, this is driven by the amount and timing of precipitation for a given period or year. Elevated precipitation will result in increased surface water discharge, which moderates limiting conditions characterized by temperature, pH and DO. The Department has documented in past surveys that elevated discharge can reduce daily DO, pH, and temperature fluctuations and increase daily minimum DO values and decrease maximum pH and temperature values. It is imperative to characterize conditions that drive critical or limiting conditions, and reference those conditions as part of the protected use assessment and subsequent reassessments.

CIM, Temperature

Temperature criteria in §93.7 are applied to heated waste sources regulated under 25 Pa Code Chapters 92a and 96. Temperature limits apply to other sources when they are needed to protect designated and existing uses. An appropriate thermal evaluation includes a biological assessment based on instream flora and fauna to determine whether the biological community is affected by the thermal regime. Typically, fish community evaluations have the best resolution in characterizing a waterbody's thermal regime due to the effects to physiology and distribution patterns (Shuter et al. 1980, Ridgeway and Shuter 1991, Azevedo et al. 1998, Wehrly and Wiley 2003, Lyons et al. 2009). CIM temperature data is not typically used to assess critical uses. However, High Quality criterion in § 93.4b (a)(1)(i), "The water has long-term water quality, based on at least one year of data which exceeds levels….at least 99% of the time…" for a list of parameters including temperature may be applied to qualify as a High Quality Water.

CIM temperature data was compared to temperature CWF criteria found in Table 3 of §93.7. Criterion was not achieved 99% of the time defined by the rolling year. Water temperatures were above CWF criterion 41% of the time. These exceedances occurred in the months of April – November in 2013 and May – November 2014. Average water temperature in 2013 was close to the maximum temperature CWF criterion, 18.9 °C, and averages in 2014 were well below the maximum temperature CWF criterion (refer to Figure 6 – 7 for yearly water temperature averages).

CIM, Specific Conductance

Specific conductance measurements from Buffalo Creek showed a relatively consistent pattern throughout the sampling period in both 2013 and 2014. Mean specific conductance were similar between years with a slight decrease in 2014, 225 μS/cm^c (2013) and 206 μS/cm^c (2014). Specific conductance responded typically with major flow events in both years. A few anomalies in late September and early October were observed until the last major flow event during the sampling period. (Figure 8 – 9).

CIM, pH

CIM pH data collected from Buffalo Creek was below the criteria maximum (9.0) and above the criteria minimum (6.0) found at §93.7 at least 99% of the time. Flow events caused depressions in pH but were not atypical. No pH values recorded less than the criteria minimum (6.0) or more than the criteria maximum (9.0). Summary statistics for daily pH fluctuations in a given year were similar. Daily pH fluctuations greater than the 95% quantile value most frequently occurred in May, June and July 2013 and July and August 2014 (Table 4; Figure 10 –11).

Table 4. Daily pH fluctuations summary statistics. Means, maximums, minimums and the 95th quantile (q95) values reported as ranges in pH units. Counts of daily ranges over the q95 also reported.

Year	Mean	Max	Min	q95	q95Count
2013	0.66577	1.30000	0.12855	1.15900	9
2014	0.75555	1.36916	0.07348	1.21978	8

CIM, Dissolved Oxygen

CIM DO data collected at the Buffalo Creek met the criteria minimum (5.0 mg/l) found at §93.7. While DO concentrations achieved a minimum of 3.7 mg/L in 2013, rolling year exceedances of the criteria minimum only occurred 0.3% of the time. Average daily DO fluctuations were similar in each year; however, the maximum daily fluctuation was larger in 2013. Daily DO fluctuations greater than the 95th quantile value in a given year occurred on nine consecutive days in mid-July 2013, two consecutive days in July 2014 and September 2014, and on four occurrences in August 2014 (Table 5). Late summer fluctuations in both years are most likely a function of increased productivity during the growing season (Figures 12 – 13).

Table 5. Daily DO fluctuations summary statistics. Means, maximums, minimums and the 95th quantile (q95) values reported as ranges in mg/L. Counts of daily ranges over the q95 also reported.

Year	Mean	Max	Min	q95	q95Count
2013	3.44763	6.77307	0.55000	5.56267	9
2014	3.04046	5.07000	0.17000	4.58789	8

CIM, Ammonia Toxicity (derived)

The toxicity of ammonia in an aquatic environment varies with respect to the temperature and pH of the water. The ammonia concentrations measured from grab samples were compared to acute and chronic criteria derived from continuous temperature and pH data and formulas in Table 3 of §93.7(a). Measured values were well below these calculated toxicity values (Table 6; Figures 14 – 15).

Table 6. Grab sample ammonia concentrations and calculated toxicity values in mg/L.

Date	Time	Ammonia Concentration	Calculated Acute Toxicity	Calculated Chronic Toxicity
2013 Samples				
5/1/2013	7:30	0.115	7.209	1.983
5/6/2013	13:15	0.011	3.179	0.766
5/23/2013	8:00	0.048	3.088	0.805
6/18/2013	8:30	0.031	4.683	1.372
8/5/2013	8:25	0.041	2.719	0.679
9/23/2013	11:00	0.044	3.741	0.935
10/31/2013	8:15	0.01	5.473	1.368
2014 Samples				
4/1/2014	8:34	0.011	--	--
5/19/2014	11:21	<0.008	12.218	2.79
6/16/2014	7:24	0.013	5.949	1.743
6/24/2014	13:20	0.021	0.720	0.157
8/6/2014	10:44	0.033	2.077	0.501
9/2/2014	13:18	0.018	1.273	0.291
11/10/2014	11:47	--	6.572	1.715

2013 Ammonia Toxicity Comparison

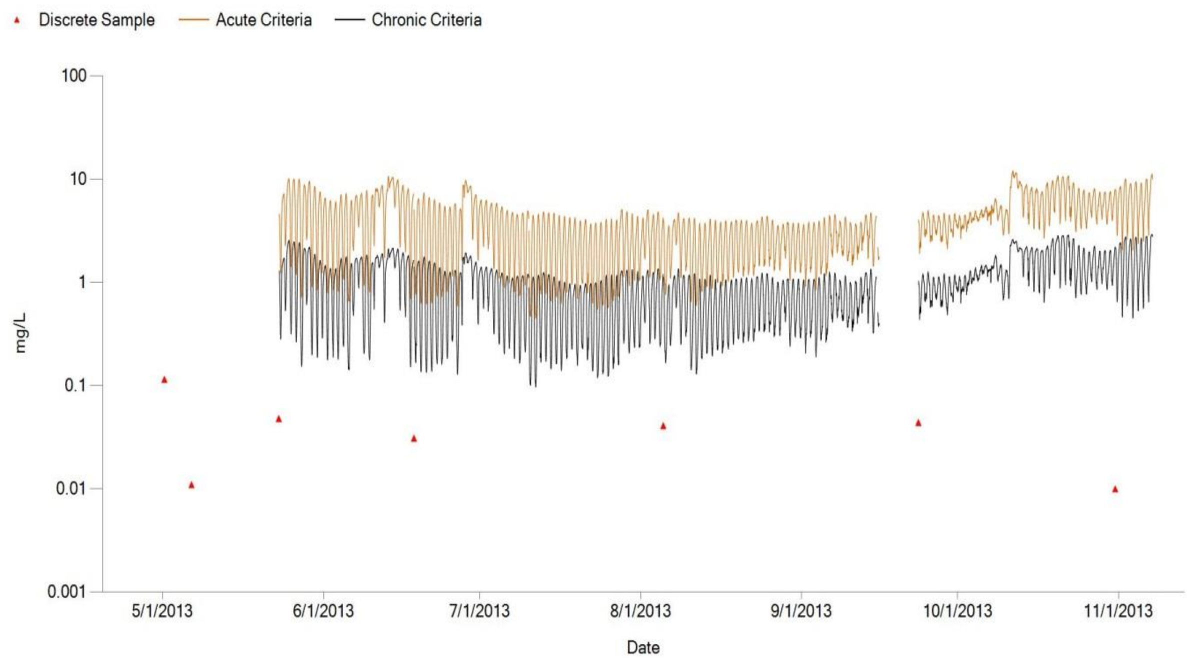

Figure 14. Calculated acute ammonia toxicity, calculated chronic ammonia toxicity, and measured ammonia concentrations from April 19, 2013 to November 7, 2013.

2014 Ammonia Toxicity Comparison

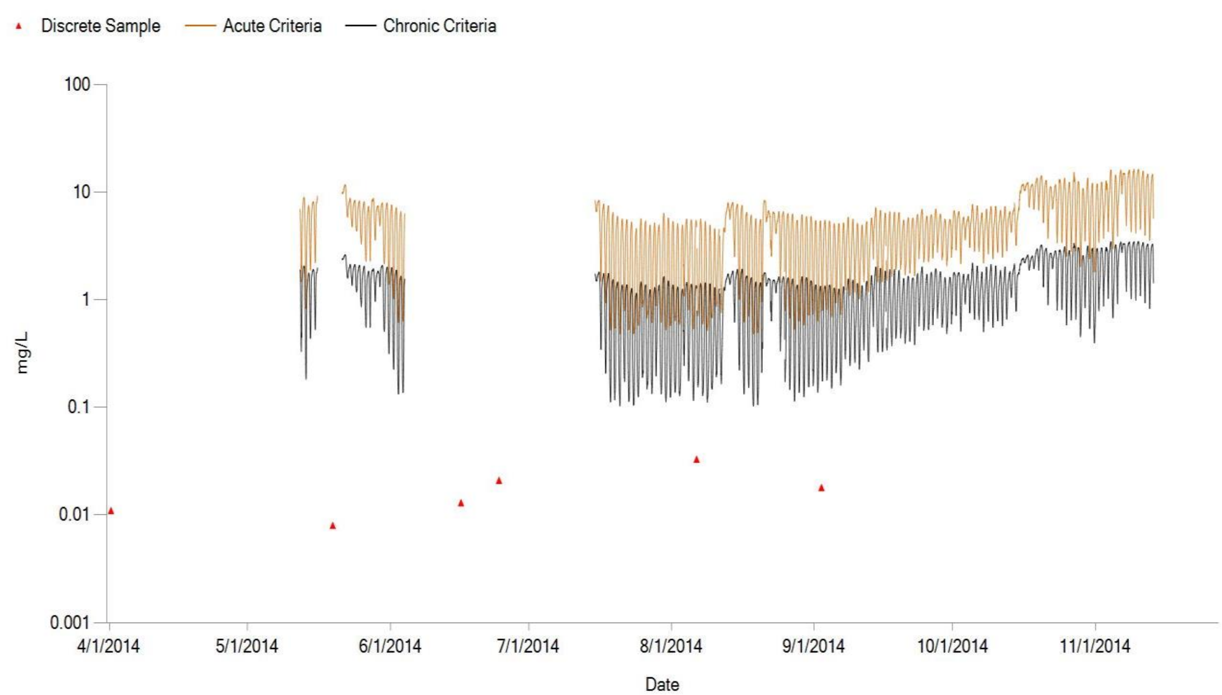

Figure 15. Calculated acute ammonia toxicity, calculated chronic ammonia toxicity, and measured ammonia concentrations from April 14, 2014 to November 13, 2014.

Chemistry: In both years grab samples were collected in May, June, August, and September. Means were calculated from those four months and were used as a basis for highlighting chemistry parameters showing the most change between 2013 and 2014. Manganese and strontium concentrations were greater in 2013 (Figure 16). All other analytes were similar in both the 2013 and 2014 sampling periods (Table 7).

Table 7. Analytes grouped with means and standard deviations calculated as described above. Parameters in red text were further compared.

Nutrients	Year	Mean (mg/L)	SD (mg/L)	Metals	Year	Mean (µg/L)	SD (µg/L)
AMMONIA T	2013	0.044	0.011	ALUMINUM T	2013	136.417	36.670
	2014	0.023	0.013		2014	133.250	101.369
NITRATE & NITRITE T	2013	1.034	0.514	BARIUM T	2013	49.000	9.592
	2014	1.423	0.399		2014	41.250	7.274
NITROGEN T	2013	1.261	0.377	BORON T	2013	--	--
	2014	1.614	0.367		2014	--	--
ORTHO PHOSPHORUS T	2013	0.013	0.006	COPPER T	2013	1.080	0.483
	2014	0.011	0.004		2014	0.778	0.177
PHOSPHORUS T	2013	0.028	0.006	IRON T	2013	262.000	59.178
	2014	0.019	0.004		2014	204.125	98.050
				LEAD T	2013	0.272	0.092
Salts		Mean (mg/L)	SD (mg/L)		2014	0.253	0.190
CALCIUM T	2013	23.917	9.926	BROMIDE	2013	--	--
	2014	20.218	7.474		2014	--	--
SODIUM T	2013	5.394	0.775	MAGNESIUM T*	2013	5.829	2.145
	2014	5.383	1.196		2014	4.585	1.450
CHLORIDE T	2013	9.841	1.767	MANGANESE T	2013	37.917	11.295
	2014	8.393	2.382		2014	20.250	8.770
SULFATE T	2013	10.948	2.393	NICKEL T	2013	--	--
	2014	9.699	1.304		2014	--	--
TDS @ 180 C	2013	122.167	35.642	SELENIUM T	2013	--	--
	2014	155.000	91.804		2014	--	--
TOC	2013	1.720	0.995	STRONTIUM T	2013	331.917	179.182
	2014	1.878	1.101		2014	235.125	118.544
TSS	2013	--	--	ZINC T	2013	--	--
	2014	--	--		2014	--	--

*magnesium reported in mg/L

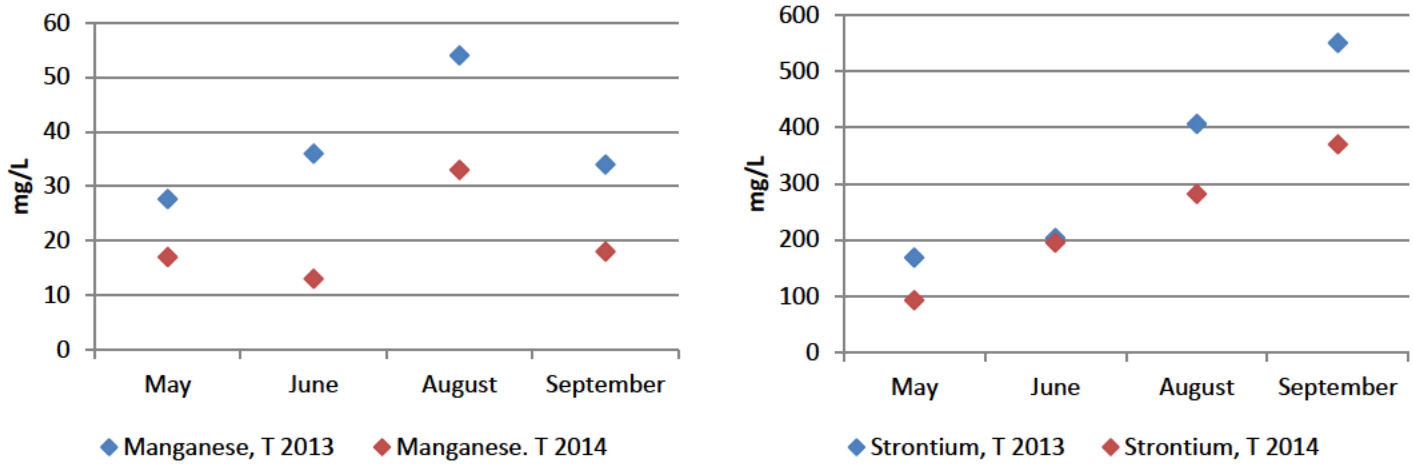

Figure 16. A visual comparison of metal concentrations resulting in noticeable change between sampling years.

Biological: Overall, the macroinvertebrate surveys conducted in 2013 indicated good water quality. IBI scores for macroinvertebrates were calculated according to An Index of Biotic Integrity for Benthic Macroinvertebrate Communities in Pennsylvania protocol (PA DEP, 2015). While the January 2013 sample scored higher than the other 2013 samples, an elevated IBI score could be the result of the subsample size of 241 individuals being out of range for the calculated metrics (Table 8). Looking at percent Ephemeroptera, Plecoptera & Trichoptera (EPT) taxa, however, values were consistent amongst the samples. The January 2013 sample consisted of 63% EPT taxa, the August 2013 sample consisted of 58% EPT taxa, and the November 2013 sample consisted of 68% EPT. The most dominant taxa in 2013 were *Maccaffertium Stenelmis*, *Allocapnia*, and Chironomidae, a mayfly, beetle, stonefly, and family of midges all somewhat tolerant to pollution.

The 2014 macroinvertebrate survey also indicated good water quality. The IBI score seemed somewhat elevated from previous scores, but again could be the result of the subsample size of 254 individuals being out of range for the calculated metrics. Approximately 85% of the sample consisted of EPT taxa. The most dominant taxa were *Maccaffertium, Isonychia,* and *Cheumatopsyche,* mayflies and a caddisfly somewhat tolerant to pollution.

Table 8. Benthic macroinvertebrate metric calculations.

Date	IBI	Richness	Mod EPT	HBI	% Dom	% Mod May	Beck3	Shannon Div
January 14, 2013	91.5	31	16	3.72	28.2	14.1	17	2.55
August 28, 2013	61.1	22	8	4.54	34.4	23.9	10	2.28
November 7, 2013	67.8	20	9	4.01	18.7	30.3	12	2.45
November 10, 2014	95.2	28	18	3.35	13.8	47.2	21	2.79

On the surface, the fish assemblage data from the two years appears to have significant differences in species richness and relative abundances. There are eight species collected that were not represented in both years and total abundance between 2013 and 2014 was 374 to 725 respectively. However, when viewing the assemblage based on their traits and normalizing effort, similarities become almost uncanny. The percent tolerant species decreased by only one percent in 2014 and the percent tolerant individuals remained stable at 11%. The percent insectivores also remained stable at 51%, but in 2014 the piscivores decreased by 7% and the omnivores decreased by 8% which can be attributed to an increase in herbivores, specifically the Central Stoneroller. There was an increase in opportunistic individuals and a decrease in both periodic and equilibrium individuals, which has been shown to be a possible indicator of environmental stochasticity or hydrologic variability (Winemiller and Rose, 1992) but in this case, was more likely attributed to an increase in the non-native Mimic Shiner from 2013 to 2014. The thermal community, as measured from the weighted average of the thermal preference and relative abundance was within the expected range for freestone streams of this size. The catch per unit effort (CPUE), as normalized to catch per probe-hour, remained nearly identical between the 2013 and 2014 at 231 and 233 respectively. Overall, the fish assemblage in Buffalo Creek is within the expected normal range for streams of this size and location for both years. Native and non-native conditions should continue to be monitored.

SUMMARY:

Continuous instream monitor (CIM), chemistry, and biological data suggest minimal impacts to this forest dominated watershed. A few inconsistencies were observed in the CIM specific conductance, pH, and dissolved oxygen in late September and early October of both 2013 and 2014; otherwise measurements were consistent with expected trends. Evaluating continuous data for the 99 percent frequency measurement rule outlined in 25 Pa Code §96.3, water temperature throughout the recording period violated the 99 percent rule for Buffalo Creek's designated use, CWF; however, biology of the stream does not appear to be impacted by the thermal regime. CIM pH and DO met criteria found at §93.7. Water chemistry remained relatively constant between 2013 and 2014 indicating a stable system. Furthermore, the macroinvertebrate surveys conducted in 2013 and 2014 resulted in attaining communities, further supporting minimal impacts to the watershed, and the fish assemblage represents a relatively stable community.

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