

Trout Brook Watershed Water Quality Assessment 2019

FINAL REPORT

Prepared By
Cortland County Soil and Water Conservation District
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Introduction

The Trout Brook watershed has historically been one of the most affected by flooding, stream bank erosion and instability within Cortland County. Water quality chemistry data have been collected periodically between 1970 and 2017 by the U.S. Geological Survey (USGS), the Susquehanna River Basin Commission (SRBC) and the Cortland County Soil and Water Conservation District (SWCD) at two sites on Trout Brook. In addition, macroinvertebrate water quality data have been collected multiple times from 1984 to 2013 from two sites on Trout Brook by the SRBC. In 2017, the SWCD completed an in-depth stream channel assessment project within the Trout Brook watershed. This effort focused on identification of potential stream management projects for erosion reduction and channel connectivity for aquatic organism passage, water quality improvement and community engagement and education. However, relatively few water quality data are available for tributaries within the Trout Brook watershed other than a small unnamed tributary that originates on the Cortland County landfill property.

Examination of existing data for lower Trout Brook indicates that in general water quality has been good over the period of record as no major problems have been identified. In 1970, nitrate (NO_3) appeared to be somewhat elevated when compared to the SRBC NO_3 level of concern (1.0 mg/L; Buda 2007); there is no NYSDEC water quality standard for nitrate for Class C waters (NYSDEC 1998). Comparison of the 1970 and 2016 USGS data suggests that road salt may be affecting water quality of lower Trout Brook. Conductivity, hardness, and especially chloride appear elevated in the 2016 samples relative to the earlier data. Comparing SWCD data from 2000-01 and 2017 to the USGS 1970s data also indicates increases in chloride, hardness and conductivity in 2000-01 but do not increase between 2000-01 and 2017.

The present study was conducted to: 1) provide data complementary to the 2017 channel assessment project, 2) address the relative lack of tributary water quality data, 3) examine trends in water quality by comparing historical data to those collected in this study and 4) examine water quality of the unnamed tributary draining from the Cortland County Landfill. Water samples were collected from Trout Brook and 6 of its tributaries and analyzed for a standard suite of water quality parameters. A focus on the Cortland County landfill tributary was included to address concerns expressed by members of the public.

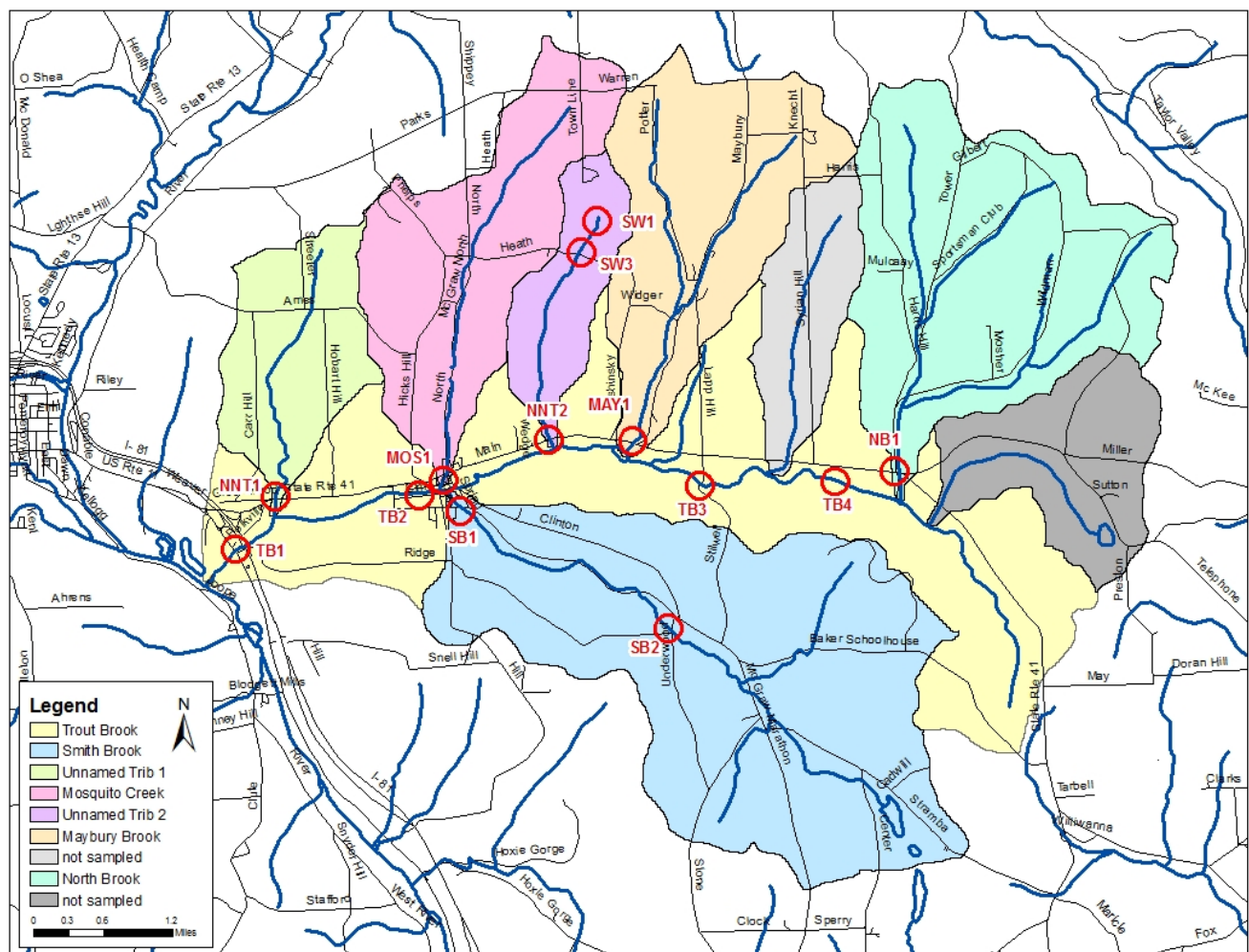
This project was supported by State Aid Part B funding to the Cortland County Soil and Water Conservation District.

Methods

Sample Sites

Samples were collected from 4 sites on Trout Brook and 7 sites on tributaries to Trout Brook (Figure 1). Sites were selected to obtain representative water quality samples from the mainstem Trout Brook, its largest tributary, Smith Brook (2 sites), and 5 smaller tributaries (1 site each) throughout the watershed. When possible, bridges were utilized for collection and in general, samples were collected upstream of bridges.

Figure 1. Water quality sampling sites in this study. Sites SW1 and SW3 were not sampled in this study but data are available at these sites for comparison. Tributary subwatersheds in gray shades were not sampled.



Sample Collection

Dry-weather grab samples were collected on August 22-23, 2019. Dry weather samples represent baseflow conditions consisting primarily of groundwater. Dry weather conditions were defined as having no significant precipitation during the 48 hours prior to sampling.

Samples were collected from each site at a riffle location with relatively high water velocity where water depth was sufficient to avoid substrate disturbance. After sample retrieval, the collected volume was distributed among individual bottles provided by the analytical laboratory for analysis of specific parameters (Figure 2). All sample bottles were kept on ice until they could be delivered to the laboratory for analysis. Standard sample hold times, holding procedures and chain of custody procedures were followed.

During water sample collection, a YSI Professional Plus Multimeter sonde was used to measure the field parameters temperature, oxidation-reduction potential (ORP), pH, dissolved oxygen and conductivity. The sonde was calibrated according to manufacturer's instructions immediately prior to the first sampling day.



Figure 2. Materials used for sample collection, including collection beaker, sample bottles, YSI sonde for field parameter measurements.

Table 1. Laboratory-analyzed parameters and detection limits. All units are mg/L except color, which is in platinum-cobalt standardized color units.

	Detection Limit
Metals (Total)	
Aluminum	0.2
Cadmium	0.002
Calcium	0.5
Copper	0.01
Iron	0.05
Lead	0.01
Magnesium	0.2
Manganese	0.003
Nickel	0.01
Sodium	1
Zinc	0.01
Conventionals	
Color	5
Alkalinity, Total	10
Hardness	0.5
BOD	2
COD	10
TOC	1
Total Dissolved Solids	10
Total Suspended Solids	4
Chloride	1
Sulfate	5
TKN	0.2
Ammonia	0.02
Phosphorus, Total	0.01
Nitrogen, Nitrate (As N)	0.05
Cyanide	0.01
Organics	
Total Phenolics	0.01

Sample Analysis

Samples were analyzed for a suite of standard water quality parameters including conventional pollutants, metals and phenolics (Table 1). Samples were analyzed by Eurofins TestAmerica Laboratories, Amherst, NY (NYELAP #10026).

For parameters and sites for which historic data exist, data were summarized and examined for temporal trends. Data for comparison exist at Trout Brook sites TB1 and TB2 and the unnamed tributary NNT2. Site location for TB2 changed slightly between 2011-2017 sampling and 2019 sampling. Sampling during the earlier period was approximately 1 km downstream the 2019 TB2 site. NNT2 is the tributary originating within the Cortland County Landfill property, where SW1 is the most upstream site within the landfill and SW3 is immediately downstream of the landfill boundary and 2.8 km upstream of the NNT2 site sampled in this study.

Results

Results are organized to address three questions: 1) what is the current status of water quality across the watershed, 2) how do water quality data collected in this study from Trout Brook sites TB1 and TB2 compare to historic data, and 3) is the Cortland County Landfill affecting water quality of the unnamed tributary?

Watershed Sampling 2019

Most field-measured water quality parameter values were within typical ranges for flowing surface water sites (Table 2). Water temperature was somewhat higher at TB3 and somewhat lower at TB4 than at the remaining sites in the watershed. ORP, a measure of redox potential, was somewhat lower than typical for stream sites at SB2 and TB4 and to a lesser extent MAY1. A low ORP value tends to be associated with low dissolved oxygen (DO) or high organic content, or both. Total organic carbon (TOC) was also somewhat higher at these sites than most other sites sampled (see below and Table 3). TB4 is immediately downstream of a long reach that is beaver ponded into a wetland complex that may be releasing stored nutrients. The cause of the somewhat low ORP at the other two sites is unknown. No sites had pH values beyond the NYS DEC water quality standards limits for surface waters, although SB1 was close to exceeding the upper limit of 8.5 and TB4 was just within the lower limit of 6.5. DO at TB1

was unexpectedly low and approached the minimum NYS Water Quality Standard (WQS of 5 mg/L, especially considering that water temperature was not high at this site.

Table 2. Field parameter values for 11 sites sampled in the Trout Brook watershed, August 22-23, 2019. Sites are ordered approximately downstream to upstream; see Figure 1 and Appendix 1 for site location details.

Parameter	Unit	NY WQS Standard	Sample Site										
			TB1	NNT1	TB2	MOS1	SB1	SB2	NNT2	MAY1	TB3	TB4	NB1
Temperature	°C	--	17.5	17.6	18.6	18.5	19.3	20.1	17.6	18.2	21.3	15.1	19.6
ORP	mV	--	143.8	147.3	128.2	125.1	120.1	85.4	137.7	109.7	116.1	86.3	130.4
pH	pH units	6.5 - 8.5	7.12	7.65	7.69	8.05	8.36	7.66	7.62	7.72	7.87	6.54	8.1
Conductivity	mS/cm	--	251	212.9	215.6	291.4	260.5	177.9	130	206.3	155.6	138.7	108.9
Dissolved Oxygen	mg/L	>5	5.79	8.79	9.17	8.76	9.68	8.74	8.74	8.96	9.6	8.05	9.23

Ten of the 16 conventional pollutant parameters were undetected or detected at very low concentrations (Table 3). Color, alkalinity, hardness, biological oxygen demand (BOD), total cyanide, sulfate, chemical oxygen demand (COD), total organic carbon (TOC), total suspended solids (TSS) and total phenolics values were below the detection limit or at low concentrations within the range expected for natural stream systems. In general, all nutrients (total phosphorus, NH₃ (ammonia), TKN (total Kjeldahl nitrogen) and NO₃) were low or undetected at all sites (Table 3). Total P, TKN and NH₃ were undetected or at very low concentrations at all sites. Only NO₃ was at detected at concentrations of concern at any sites. NO₃ concentrations greater than 10 mg/L have the potential to harm aquatic life and natural concentrations are generally less than 1 mg/L. NO₃ did not exceed 10 mg/L at any site but was highest, approaching or exceeding 1 mg/L, at four sites: TB1, MOS1, TB3 and TB4. Chloride (Cl) concentrations are increasing nationwide associated with winter road salt application and therefore correlated with urbanization and road density. Cl below 100 mg/L in freshwater is considered within a normal range; no sites exceeded this range (Table 3). Highest Cl concentrations were generally found at sites lower in the watershed, including TB1, TB2, NNT1, MOS1 and SB1. Total Dissolved Solids (TDS) includes Cl as well as other dissolved inorganic elements and compounds and was closely correlated with Cl.

With several exceptions, all metals concentrations were low at all sites (Table 4). Aluminum exceeded the WQS of 0.1 mg/L at NNT2. Sodium (Na) exceeded the NYS Na guidelines for people on a severely restricted sodium diet of 20 mg/L at TB1 and MOS1.

Table 3. Conventional pollutants parameter values for 11 sites sampled in the Trout Brook watershed, August 22-23, 2019. Sites are ordered approximately downstream to upstream; see Figure 1 and Appendix 1 for site location details.

Parameter	Unit	NY WQS ¹ Standard	Sample Site											
			TB1	NNT1	TB2	MOS1	SB1	SB2	NNT2	MAY1	TB3	TB4	NB1	
Color	cu	--	<5H	<5H	<5H	<5H	<5H	<5H	15	5H	<5	15	15	<5
Alkalinity, Total	mg/L	--	90.1	84.1	85.3	101	118	83	71.3	75.6	57	56.7	49.7	
Hardness as CaCO ₃	mg/L	--	99.7	95.9	93.3	109	126	80	72	83.4	60.5	61.3	47.6	
TDS	mg/L	<500	143	127	<10	169	145	98	62	125	90	81	63	
TSS	mg/L	--	6.4	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	
Chloride	mg/L	--	38.8	35.3	27.3	45.9	26.3	16.1	3.4	30.9	17.7	20.1	9.3	
Sulfate	mg/L	--	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	
Phosphorus, Total	mg/L	--	<0.01	<0.01	<0.01	0.012	<0.01	0.012	0.018	<0.01	<0.01	<0.01	<0.01	
Nitrate	mg/L	--	0.98H	0.46H	0.6H	1.1H	0.37H	0.091H	0.52H	0.46H	0.76	1H	0.21	
Ammonia	mg/L	<0.035-0.040*	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02F1	
TKN	mg/L	--	0.29F1	<0.2	<0.2F1	0.31	0.47	0.39	0.27	<0.2	0.73	0.45	0.37F1	
COD	mg/L	--	<10	12.3	<10	13	<10	<10	<10	12	<10	<10	<10	
BOD	mg/L	--	<2H	<2H	<2H	<2H	<2H	<2H	<2H	<2H	<2H	<2H	<2H	
TOC	mg/L	--	<1	1.45	<1	1.1	<1	2.25	1.1	1.1	1.5	1.35	1.1	
Cyanide, Total	mg/L	<9	<0.01	<0.01	<0.01F1	<0.01	<0.01	<0.01	<0.01	<0.01F1	<0.01	<0.01	<0.01	
Phenolics	mg/L	--	<0.01	<0.01	<0.01F1	<0.01	<0.01F1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01F1	

H=Sample was prepped or analyzed beyond the specified holding time according to QAQC protocols

F1=Matrix Spike (MS) and/or MS Duplicate recovery is outside acceptance limits according to standard QAQC protocols

* WQS varies with waterbody class, pH and temperature, these values appropriate to sampling conditions

1 - for Class B and C waters

Comparison to Historic Data – Trout Brook Sites TB1 and TB2

Examining data for temporal trends must be conducted carefully because multiple factors can affect the data, including seasonal and weather conditions and meters and other equipment used for measuring. Thus, any apparent trends must be confirmed by additional sampling.

No clear trends over time in field parameters are apparent at TB1 or TB2, with the exception of increasing conductivity at TB2 (Table 5). Dissolved oxygen concentrations are low at both sites in 2019; establishing the presence of a definitive trend would require additional sampling. Dissolved oxygen and temperature are dependent on season and time of day measured, which likely varies across the data record.

The conventional parameters NH₃, total P, SO₄, TDS (TB2 only), TOC and TSS (TB2 only) have been consistently detected in the past at TD1 and TD2. These parameters were not generally detected during 2019 sampling and appear to be declining over time (Table 6). No trend was apparent in chloride, hardness, NO₃, TDS, TKN (data available only for TB1), or TSS. Alkalinity was higher in 2019 at both sites than during any previous sampling; establishing the presence of a definitive trend would require additional sampling.

Table 4. Metals concentration (mg/L) at 11 sites sampled in the Trout Brook watershed during August 22-23, 2019. Sites are ordered approximately downstream to upstream; see Figure 1 and Appendix 1 for site location details.

Parameter	NY WQS ¹ Standard	Sample Site										
		TB1	NNT1	TB2	MOS1	SB1	SB2	NNT2	MAY1	TB3	TB4	NB1
Aluminum	<0.1	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.3	<0.2	<0.2	<0.2	<0.2
Cadmium	<0.0021*	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Calcium	--	32.3	30.6	29.9	35.4	40.7	25.3	22.8	27.3	18.9	19.2	15.2
Copper	<0.009*	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Iron	--	<0.05	0.056	0.057	<0.05	<0.05	0.5	0.28	<0.05	0.32	0.58	<0.05
Lead	<0.004*	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Magnesium	<35	4.7	4.7	4.5	5.1	6	4.1	3.6	3.7	3.2	3.2	2.4
Manganese	<0.3	0.014	0.0039	0.0053	<0.003	0.0039	0.19	0.0077	<0.003	0.054	0.15	0.0031
Nickel	<0.052*	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	<20	21.4	19.3	15.2	26.9	12.9	10.5	3.9	16	10.4	11.8	6.2
Zinc	<0.083*	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

* WQS varies with hardness, stated value assumes hardness = 100 mg/l

X.XX indicates a contravention of a water quality standard

1 - for Class B and C waters

Table 5. Available field parameter data over time at Trout Brook sites TB1 and TB2. See Figure 1 and Appendix 1 for site location details.

Year	Conductivity (µmhos/cm)		DO (mg/L)		EH/ORP (mV)	pH		Temperature (°C)	
	TB1	TB2	TB1	TB2	TB1	TB1	TB2	TB1	TB2
1970	207					7.4			
1972	154					7.7		20.0	
1984	240		9.4			7.7		20.5	
1998	285		7.4			7.1		16.5	
2000	154		10.0					17.1	
2001	203		9.7			7.4		13.1	
2007	305		10.1			7.1		16.2	
2010		84					7.2		
2011		171		11.6			8.1		9.8
2012		189		11.6			8.2		12.8
2013	204	153	11.0	12.1		8.6	7.9	24.6	9.3
2014		166		11.1			7.9		11.2
2015		184		12.1			7.9		10.1
2016		207		10.9			8.0		11.1
2017	110	174	13.0	12.1	160.0	8.1	8.0	5.6	11.0
2019	251	216	5.8	9.2	143.8	7.1	7.7	17.5	18.6

Four metals, Cd, Cu, Pb and Ni, have always been undetected or detected at very low concentrations at TB1, including in 2019 (Table 7). Thus, no trends are apparent for these metals at this site. No data for these metals are available at TB2. Although consistently

detected, no trends are apparent for Ca or Mn at either site or Zn at TB1 (no Zn data are available at TB2). Al and Fe appear to be decreasing at both sites. Mg and Na appear to be increasing at TB2 but no trend for these metals is apparent at TB1.

Unnamed Tributary NNT2 - Comparison to Historic Data and Adjacent Tributaries

As addressed above, examining data for temporal trends must be conducted carefully because changes in sampling conditions or data collection or analysis can affect the validity of apparent trends.

Examination of water quality indicates differences between SW1 and SW3 on and downstream of the landfill, respectively, and NNT2 downstream of the landfill at Route 41 (Tables 8-10). Conductivity and conventional pollutant concentrations including alkalinity, hardness, TDS, TSS, TOC, COD, Cl and color are lower at NNT2 than at upstream sites. SO_4 is lower at NNT2, but appears to be decreasing at the upstream sites over time. BOD is lower at NNT2 but is generally low at the upstream sites as well. NH_3 , TKN and total phenols are low and do not appear to differ among the three sites. NO_3 is higher at NNT2 than at the upstream sites. Metals including Ca, Fe, Mg, Mn, Na and Zn are lower at NNT2 than at upstream sites. Al is lower at NNT2 and appears to be rising at the upstream sites. Lead is generally not detected at the upstream sites and was also not detected at NNT2.

Water quality at NNT2 is similar to adjacent tributaries Mosquito Creek to the east and Mayberry Creek to the west (Tables 2-4), and NNT2 parameter values are average relative to the other tributaries in the watershed for most parameters. When compared to water quality is fairly similar among the three tributaries for most parameters. Concentrations of three metals, Al, Fe and Mn, are higher in NNT2 than in the adjacent tributaries, and hardness, TDS, Cl, Na, and conductivity are lower in this tributary when compared to the adjacent tributaries.

Table 6. Available conventional parameter concentration data over time (mg/L) at Trout Brook sites TB1 and TB2. Individual non-detect values were changed to zero to facilitate averaging; a value of ND indicates that all values were non-detect for that year. See Figure 1 and Appendix 1 for site location details.

Year	Alkalinity		Cl		Hardness		NH ₃		NO ₃		P, Total		SO ₄		TDS		TKN	TOC		TSS		
	TB1	TB2	TB1	TB2	TB1	TB2	TB1	TB2	TB1	TB2	TB1	TB2	TB1	TB2	TB1	TB2	TB1	TB1	TB2	TB1	TB2	
1970			12.0		82				2.82													
1972			7.5		66				1.90													
1984																						
1998			30.0		91		0.02		1.22		0.020		11.0						1.5		10.0	
2000	63		14.3		106		ND		0.57		0.051						0.253		2.8		10.0	
2001	33		15.3		61		0.01		0.89		0.025						0.201				21.0	
2007			39.2		96				0.94		0.011		9.2						1.5			
2010		41		14.5						0.58			6.9		108					1.8		
2011		56		20.2						0.63			6.5		97					1.8		3.3
2012		62		20.4						0.35		0.018	6.5		112					1.9		4.7
2013	64	54	20.4	16.9					0.53	0.51		0.027	5.8	8.4	150	108			2.5	2.3		3.5
2014		51		17.7						0.64		0.020		5.6		103				2.5		4.5
2015		54		18.3						0.58		0.032		5.2		103				3.1		14.3
2016		54		23.0		113		ND		0.83		0.014		18.9		104				2.7		1.4
2017	58	58	15.0	20.4	61		ND	ND	0.62	0.44	ND	0.017		5.3		102	0.240			2.3	0.0	1.7
2019	90	85	38.8	27.3	100	93	ND	ND	0.98	0.60	ND	ND	ND	ND	143	ND	0.290	ND	ND	6.4	ND	

Table 7. Available average dissolved metals concentration data over time (mg/L) at Trout Brook sites TB1 and TB2. Individual non-detect values were changed to zero to facilitate averaging; a value of ND indicates that all values were non-detect for that year. See Figure 1 and Appendix 1 for site location details.

Year	Aluminum		Calcium		Cd	Cu	Iron		Lead	Magnesium		Manganese		Ni	Sodium		Zinc
	TB1	TB2	TB1	TB2			TB1	TB1		TB1	TB2	TB1	TB2		TB1	TB2	
1970																	
1972																	
1984																	
1998	0.010		33.9			ND	0.02		0.001	4.2		0.010		ND	18.0		0.005
2000	0.186				ND	0.01			ND					ND			0.036
2001			14.0														
2007			30.6							4.7					17.6		
2010				16.6							2.5					9.4	
2011				19.3							2.7					10.3	
2012		0.111		19.9							3.0					9.8	
2013	0.057	0.067	25.1	27.9			0.09	0.09		3.5	2.8	0.004	0.004		13.2	10.1	
2014		0.098		19.3				0.17			2.9		0.008			10.3	
2015		0.525		18.7				0.68			2.9		0.023			10.4	
2016		0.099		26.6				0.09			3.8		0.006			14.0	
2017	ND	0.087		20.3	ND	ND		0.13	ND		3.1		0.006	ND		13.2	0.020
2019	ND	ND	32.3	29.9	ND	ND	ND	0.06	ND	4.7	4.5	0.014	0.005	ND	21.4	15.2	ND

Cd = cadmium, Cu = copper, Ni = nickel

Table 8. Available field parameter data over time at three sites on NNT2, the unnamed tributary originating on the Cortland County Landfill property (see Figure 1 and Appendix 1 for site location details). Average data values per year and across all existing data (2003-2019) for sites SW1 (most upstream within landfill) and SW3 (immediately downstream of the landfill) are provided; annual sampling of these sites by Cortland County is required under NYS DEC Solid Waste regulations.

Year	Conductivity ($\mu\text{mhos/cm}$)			Eh/ORP (mV)			DO (mg/L)			pH			Temperature ($^{\circ}\text{C}$)		
	SW1	SW3	NNT2	SW1	SW3	NNT2	SW1	SW3	NNT2	SW1	SW3	NNT2	SW1	SW3	NNT2
2003	419	316		73	143		8.65	8.70		7.45	7.48		11.1	11.9	
2004	374	299		148	335		8.55	9.69		7.59	6.94		13.1	10.0	
2005	394	382		75	125		8.00	8.43		7.50	7.17		13.6	12.1	
2006	372	261		160	227		8.11	8.58		7.50	6.75		13.7	12.0	
2007	330	249		-94	-102		9.76	9.36		7.98	8.08		17.4	16.8	
2008	269	287		-59	-73		8.72	8.71		8.02	8.31		15.0	13.7	
2009	1552	1331		112	113		7.60	8.39		8.07	8.21		12.8	12.1	
2010	204	216		203	218		8.07	7.86		8.27	7.68		17.1	13.9	
2011	275	301		61	98		10.53	10.40		7.98	8.17		15.3	16.1	
2012	339	370		117	157					8.29	7.45		14.7	15.9	
2013	388	380		119	247		10.58	11.11		8.03	8.02		13.3	11.3	
2014	353	1476		72.6	29.0		7.28	7.08		7.74	8.21		12.1	10.6	
2015	282	257		114.9	119.7		8.18	9.65		7.94	7.79		15.7	13.2	
2016	324	371		225.7	213.9		5.81	8.09		7.60	7.45		9.0	7.5	
2017	283	309		35.7	26.8		9.39	11.27		7.66	7.78		9.8	9.2	
2018	280	319		93.9	142.2		6.65	8.18		7.72	7.79		8.5	7.3	
2019	553	172	130	122.3	194.0	137.7	4.72	6.72	8.74	7.60	8.13	7.62	15.6	13.5	17.6
Average	411	429		93.0	130.2		8.16	8.89		7.82	7.73		13.4	12.2	

Data Quality

In addition to providing analytical data, the laboratory that conducted sample analyses also provides a Uniform Data System (UDS) Level 2 analysis and quality assurance report, which is available from the Cortland County SWCD upon request. As part of the quality assurance process undertaken by the laboratory, data are “flagged” if they fail to meet performance limits. Of the 352 reporting results provided by the laboratory, 34 (9.6%) were flagged by the laboratory as failing some internal quality control test. While this percentage is higher than desired, flagged data are not necessarily invalid. Most flagged data were associated with holding time exceedances of color, nitrate and biological oxygen demand (BOD) analyses. Flagged data values are indicated in data tables.

Table 9. Available conventional parameter data over time at three sites on NNT2, the unnamed tributary originating on the Cortland County Landfill property (see Figure 1 and Appendix 1 for site location details). Average data values per year and across all existing data for sites SW1 (most upstream within landfill) and SW3 (immediately downstream of the landfill) are provided; annual sampling of these sites by Cortland County is required under NYS DEC Solid Waste regulations. All units are in mg/L except color, which is in platinum-cobalt standardized color units.

Year	Alkalinity			Hardness			TDS			Cl			SO ₄			True Color			TSS		
	SW1	SW3	NNT2	SW1	SW3	NNT2	SW1	SW3	NNT2	SW1	SW3	NNT2	SW1	SW3	NNT2	SW1	SW3	NNT2	SW1	SW3	NNT2
2003	129	140		116	148		260	222		47.2	3.6		8.1	18.1		0	0				
2004	142	114		123	118		230	226		24.3	8.1		5.5	21.4		0	0				
2005	112	110		265	236		239	209		21.1	9.2		21.3	14.0		0	0				
2006	141	105		133	104		225	153		28.3	12.8		4.1	7.1		0	0				
2007	147	247		139	153		256	346		73.9	19.9		1.7	24.5		20	18		5.0	16.0	
2008	104	113		99	144		252	291		22.8	7.8		0.0	25.8		58	48		17.0	51.0	
2009	127	92		138	149		170	167		23.0	4.6		7.0	29.1		12	10		5.0	5.0	
2010	120	123		127	157		250	177		24.1	4.5		0.0	20.8		10	8				
2011	125	127		120	145		173	180		12.0	5.4		0.0	18.0		28	20				
2012	130	173		122	185		155	240		20.8	1.8		2.9	18.8		10	0				
2013	103	231		127	134		212	134		9.9	9.4		3.8	4.1		30	0				
2014	132	138		122	141		169	197		21.3	14.1		0.0	0.0		20	20				
2015	117	113		114	111		156	134		15.3	12.3		0.0	0.0		25	30				
2016	133	119		112	123		150	157		18.2	14.0		1.8	12.4		20	10				
2017	125	123		111	126		165	169		13.2	17.5		0.0	0.0		20	10				
2018	128	123		130	120		159	143		13.2	14.4		0.0	0.0		25	20				
2019	106	90	71	118	101	72	134	114	62	9.2	7.4	3.4	0.0	0.0	0.0	25	30	5			0.0
Average	125	134		130	141		197	192		23.4	9.8		3.3	12.6		18	13		9.0	24.0	

Table 9 (Cont'd).

Year	NH ₃			NO ₃			TKN			TOC			BOD			COD			Phenols		
	SW1	SW3	NNT2	SW1	SW3	NNT2	SW1	SW3	NNT2	SW1	SW3	NNT2	SW1	SW3	NNT2	SW1	SW3	NNT2	SW1	SW3	NNT2
2003	0.09	0.04		0.22	0.23		0.9	0.3		6.6	2.5		0.00	0.00		13.0	2.8		0.002	0.001	
2004	0.05	0.09		0.23	0.22		0.7	0.4		6.7	2.3		1.20	1.40		20.8	4.3		0.011	0.024	
2005	0.03	0.00		0.14	0.51		0.7	0.4		5.2	3.3		0.00	0.00		14.5	4.8		0.001	0.006	
2006	0.16	0.08		0.29	0.22		0.7	0.3		5.6	3.5		0.00	0.00		11.3	3.0		0.001	0.000	
2007	0.00	0.74		0.25	0.00		0.6	1.5		4.3	9.7		0.00	10.33		16.0	16.7		0.005	0.006	
2008	0.00	0.00		0.00	0.18		0.2	0.5		4.1	2.7		0.00	0.00		9.7	0.0		0.000	0.000	
2009	0.00	0.00		0.00	0.63		0.3	0.8		6.0	2.5		0.00	0.00		18.3	12.0		0.000	0.002	
2010	0.00	0.00		0.15	0.27		0.7	0.3		6.0	4.1		0.00	0.00		0.0	0.0		0.000	0.003	
2011	0.00	0.00		0.11	0.33		0.0	0.0		4.7	1.3		0.00	0.00		18.0	0.0		0.000	0.000	
2012	0.00	0.00		0.20	0.04		0.0	0.0		2.7	1.1		0.00	0.00		0.0	7.7		0.000	0.000	
2013				0.10	0.17		0.0	0.5		7.2	7.5		1.33	2.00		7.3	12.0		0.078	0.003	
2014	0.05	0.00		0.13	0.39		0.6	0.2		5.5	3.2		1.43	0.90		10.5	5.7		0.000	0.000	
2015	0.00	0.00		0.09	0.22		0.6	0.3		5.6	4.5		0.67	0.00		5.5	5.4		0.000	0.009	
2016	0.09	0.00		0.25	0.27		0.7	0.3		5.3	3.5		6.57	0.00		13.0	13.2		0.000	0.004	
2017	0.00	0.01		0.09	0.29		0.5	0.4		6.1	4.0		0.00	0.00		0.0	0.0		0.000	0.000	
2018	0.10	0.00		0.34	0.25		0.4	0.3		3.9	4.2		0.00	0.00		5.1	17.2		0.000	0.000	
2019	0.03	0.00	0.00	0.06	0.13	0.52	0.6	0.4	0.3	6.3	4.5	1.1	0.00	0.00	0.00	28.2	23.5	0.0	0.010	0.011	0.000
Average	0.04	0.06		0.16	0.26		0.5	0.4		5.4	3.8		0.66	0.86		11.2	7.5		0.01	0.00	

Table 10. Available dissolved metals data (mg/L) over time at three sites on NNT2, the unnamed tributary originating on the Cortland County Landfill property (see Figure 1 and Appendix 1 for site location details). Average data values per year and across all existing data for sites SW1 (most upstream within landfill) and SW3 (immediately downstream of the landfill) are provided; annual sampling of these sites by Cortland County is required under NYS DEC Solid Waste regulations.

Year	Aluminum			Calcium			Iron			Lead			Magnesium			Manganese			Sodium			Zinc		
	SW1	SW3	NNT2	SW1	SW3	NNT2	SW1	SW3	NNT2	SW1	SW3	NNT2	SW1	SW3	NNT2	SW1	SW3	NNT2	SW1	SW3	NNT2	SW1	SW3	NNT2
2003	0.09	0.73		35.3	48.3		0.26	0.82		0.001	0.000		6.8	6.6		0.20	0.33		27.6	4.1		0.057	0.039	
2004	0.08	0.12		37.6	37.8		0.25	1.04		0.002	0.001		7.1	5.7		0.19	0.22		17.6	6.3		0.057	0.047	
2005	0.07	0.17		39.3	41.2		0.75	0.17		0.000	0.002		7.1	6.4		0.22	0.00		8.6	9.8		0.004	0.009	
2006	0.03	0.06		42.1	33.6		0.27	0.22		0.003	0.001		6.8	5.0		0.32	0.05		21.1	9.7		0.007	0.006	
2007	0.12	0.77		42.2	48.0		0.54	0.89		0.001	0.004		8.2	8.1		0.52	0.22		40.2	12.8		0.037	0.060	
2008	0.00	0.00		28.0	46.7		0.28	0.77		0.002	0.002		6.9	6.7		0.23	0.12		18.2	5.5		0.000	0.000	
2009	0.11	0.12		38.7	44.4		0.57	19.90		0.000	0.004		10.0	9.3		0.22	0.44		19.1	1.6		0.018	0.021	
2010	0.19	0.11		37.0	51.6		0.31	0.36		0.000	0.000		8.5	6.9		0.19	0.29		18.1	0.0		0.000	0.000	
2011	0.00	0.00		36.7	47.5		0.24	0.32		0.000	0.000		6.9	6.5		0.09	0.12		10.7	4.0		0.000	0.000	
2012	0.00	0.00		33.2	60.7		0.98	0.76		0.000	0.000		9.4	8.1		0.37	0.59		17.1	0.0		0.000	0.000	
2013	0.20	0.00		38.9	42.0		0.16	1.99		0.000	0.005		7.3	7.1		0.08	1.73		10.5	9.4		0.000	0.000	
2014	1.00	0.71		33.8	43.6		0.74	0.59		0.000	0.000		9.0	7.6		0.25	0.01		17.3	10.8		0.010	0.011	
2015	0.00	0.36		34.3	34.7		0.43	0.74		0.000	0.000		6.9	5.9		0.12	0.04		11.1	8.1		0.000	0.000	
2016	0.23	0.34		31.0	38.5		1.29	0.83		0.000	0.000		8.4	6.4		0.68	0.04		23.2	9.9		0.000	0.000	
2017	0.64	0.29		32.2	39.6		0.58	0.72		0.000	0.000		7.5	6.4		0.25	0.06		11.4	11.5		0.000	0.026	
2018				40.7	36.3		0.33	0.32		0.000	0.000		6.9	7.2		0.06	0.19		9.4	11.2				
2019	0.20	0.42	0.30	34.1	31.6	22.8	0.69	0.50	0.28	0.000	0.000	0.000	8.0	5.4	3.6	0.16	0.04	0.01	10.2	7.3	3.9	0.000	0.000	0.000
Average	0.18	0.26		36.2	42.7		0.51	1.82		0.001	0.001		7.7	6.8		0.24	0.26		17.1	7.2		0.012	0.014	

Conclusions

Overall water quality remains high within the Trout Brook watershed. Very few water quality standards exceedances were detected and concentrations of those parameters were relatively low. MOS1 and TB3 appear to have the highest nutrient concentrations, with higher than average phosphorus and nitrogen (multiple forms) than the other sites. However, nutrients were low at all sites, including MOS1 and TB3. NNT1, TB2 and SB1 appear to have the lowest overall concentrations of nutrients. NNT2, the landfill tributary, appeared to have elevated concentrations of several metals relative to other tributaries (see below).

No definite temporal trends were observed at the lowermost Trout Brook sites TB1 or TB2, for any parameter or family of parameters, although both sodium (Na) and chloride (Cl) concentrations were higher at both sites in 2019 than generally observed in previous sampling. NaCl (salt) concentrations are increasing in many regions of the United States in surface and groundwater associated with winter road treatment.

Landfill sampling data indicate that the sites SW1 and SW3 on the landfill tributary stream (NNT2) have at times exceeded water quality standards for some parameters, including dissolved oxygen, phenolics, color, manganese, iron and aluminum. Of these, aluminum, iron and manganese are also elevated in this tributary relative to adjacent tributaries, suggesting that the landfill is affecting water quality somewhat in NNT2. However, elevated concentrations of these metals are not seen at the next downstream site sampled, TB2 on Trout Brook. Most common leachate indicators such as nitrate, ammonia, Kjeldahl nitrogen (TKN), and chemical and biological oxygen demand (COD, BOD) were not elevated and the leachate indicator hardness was somewhat lower in NNT2 than in adjacent tributaries.

This study provides valuable updated information on the status of water quality in Trout Brook as well as data previously unavailable for Trout Brook tributaries. Continued periodic water quality sampling across the watershed will provide additional spatial and temporal trend data for the watershed.

References Cited

Buda, S.C. 2007. Upper Susquehanna Subbasin Year-1 Survey. Susquehanna River Basin Commission. Publication 260. Harrisburg, PA. 8 pp.

NYSDEC. 1998. Division of Water Technical and Operational Guidance Series (1.1.1). Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations. Albany, NY.

Data Sources

SRBC macroinvertebrate and water quality: <https://mdw.srbc.net/waterqualityportal>

USGS water quality:

https://nwis.waterdata.usgs.gov/nwis/qwdata?pm_cd_compare=Greater%20than&radio_parm_cd_s=all_parm_cds&site_no=01509020&agency_cd=USGS&format=por_table

<https://www.waterqualitydata.us/provider/NWIS/USGS-NY/USGS-423533076062101/>

https://nwis.waterdata.usgs.gov/nwis/qwdata/?site_no=423533076062101

SWCD water quality and channel assessment data: available upon request

Glossary of Terms

Term	Description
BOD	Biological oxygen demand
COD	Chemical oxygen demand
DO	Dissolved oxygen
Eh	Reduction potential
F1	Matrix spike and/or MS Duplicate recovery is outside acceptance limits according to standard QAQC protocols
H	Sample was prepped or analyzed beyond the specified holding time according to QAQC protocols
MS	Matrix spike
MSD	Matrix spike duplicate
NH ₃	Ammonia, a source of N
NNT	Unnamed tributary
NO ₃	Nitrate, a source of N
QAQC	Quality Assessment/Quality Control
ORP	Oxidation-reduction potential
pH	H ⁺ concentration on a logarithmic scale, a measure of acidity
SO ₄	Sulfate
TDS	Total dissolved solids
TKN	Total Kjeldahl nitrogen, the sum of NH ₃ and organic N
TOC	Total organic carbon
TSS	Total suspended solids
WQS	Water quality standards

Appendix 1 Sample site codes and location descriptions

Site Code	Location
TB1	Trout Brook @ Route 11
NNT1	Unnamed Tributary @ Route 41
TB2	Trout Brook @ South Rd, McGraw
MOS1	Mosquito Creek @ Highland Avenue, McGraw
SB1	Smith Brook @ East Academy Street, McGraw
SB2	Smith Brook @ Underwood Hill Road
NNT2	Unnamed Tributary @ Route 41 Xendocha Farm
MAY1	Maybury Creek @ Route 41
TB3	Trout Brook @ Stillwell Road
TB4	Trout Brook upstream of Syrian Hill Road
NB1	North Brook @ Route 41/Tower Road, Solon
SW1	NNT2 Surface Water Site upstream of landfill
SW3	NNT2 Surface Water Site @ Heath Rd downstream of landfill