Northeast Ohio Regional Sewer District

2019 Rocky River West Branch Environmental Monitoring Biological, Water Quality, and Habitat Study

Rocky River West Branch RM 0.45

Water Quality and Industrial Surveillance
Environmental Assessment Division
March 2020

Introduction

The Rocky River is located just west of Cleveland, flowing northward from its headwaters near Hinkley (East Branch) and Medina (West Branch) until its confluence with Lake Erie. In 2019, the Northeast Ohio Regional Sewer District (NEORSD) conducted a full water quality assessment, consisting of water chemistry sampling, stream habitat assessment, and fish and macroinvertebrate community assessments on the Rocky River for general watershed monitoring. The objective of this study was to evaluate the attainment of Ohio's Water Quality Standards and determine any spatial and temporal trends in the watershed. Data from this study may also be used to perform regulatory tasks by the Ohio Environmental Protection Agency (EPA) under the credible data program (Ohio Revised Code 6111.52). This report will focus on the West Branch of the Rocky River within the NEORSD service area, including the tributaries Baker Creek, Blodgett Creek, Plum Creek, and Minnie Creek.

Sampling was conducted by NEORSD Level 3 Qualified Data Collectors certified by the Ohio EPA in Fish Community Biology, Benthic Macroinvertebrate Biology, Chemical Water Quality, and Stream Habitat Assessment as explained in the *2019 Rocky River Environmental Monitoring study plan* which was approved by Ohio EPA on May 15, 2019. All sampling and bioassessments occurred between June 15, 2019 and September 30, 2019 (through October 15 for fish community assessments), as required in the Ohio EPA *Biological Criteria for the Protection of Aquatic Life Volume III* (1987b). The results gathered from these assessments were evaluated using the Ohio EPA's Qualitative Habitat Evaluation Index (QHEI), Index of Biotic Integrity (IBI), Modified Index of Well-Being (MIwb), and the Invertebrate Community Index (ICI). Water chemistry data was validated per the methods outlined by the Ohio EPA (2018a) and compared to the Ohio Water Quality Standards for their designated use to determine attainment (Ohio EPA 2018b). An examination of the individual metrics that comprise the IBI, MIwb, and ICI was used in conjunction with the water chemistry data and QHEI results to assess the health of the stream.

Table 1 indicates the sampling locations with respect to river mile (RM), latitude and longitude, site description, and the types of surveys conducted. Figure 1 is a study area map, noting the location of each sampling location evaluated during the 2019 study. A digital photo catalog of the sampling locations is available upon request by contacting the NEORSD WQIS Division.

The NEORSD manages sewage conveyance and treatment through its major interceptor sewers and three wastewater treatment plants. The NEORSD also manages local stormwater runoff, flooding, and erosion issues through its Regional Stormwater Management Program. Cities that participate in the Regional Stormwater Management Program in the Rocky River West Branch watershed include Berea, Columbia Township, Olmsted Falls, Olmsted Township, and Strongsville. Sections, or all these cities, also have wastewater services provided by the NEORSD which are all tributary to Southerly Wastewater Treatment Center via the Southwest Interceptor.

Table 1. Rocky River West Branch Sampling Locations

Site Location	Lat	Long	River Mile	Description	River Code	Station ID	Sample Type
Rocky River W. Branch	41.4036°	-81.8912°	0.45	Upstream of confluence with East Branch	13-200-000	501850	F, M, C
Rocky River W. Branch	41.3623°	-81.8945°	4.30	Downstream of I-80	13-200-000	T01K06	F, M, C
Baker Creek	41.3526°	-81.9002°	0.15	Downstream of Sprague Road	13-202-000	T01S13	M, C
Blodgett Creek	41.3489°	-81.8728°	1.50	Upstream of Marks Road	13-200-003	T01A17	F, M, C
Plum Creek	41.3589°	-81.9214°	2.84	Adjacent to Usher Road	13-201-000	T01G03	F, M, C
Minnie Creek (Rocky River W. Br. Trib at RM 1.80)	41.3900°	-81.8969°	0.20	At Hope Community Church	13-200-001	T01A15	F, M, C

F = Fish community biology (includes habitat assessment)
M = Macroinvertebrate community biology
C = Water column chemistry

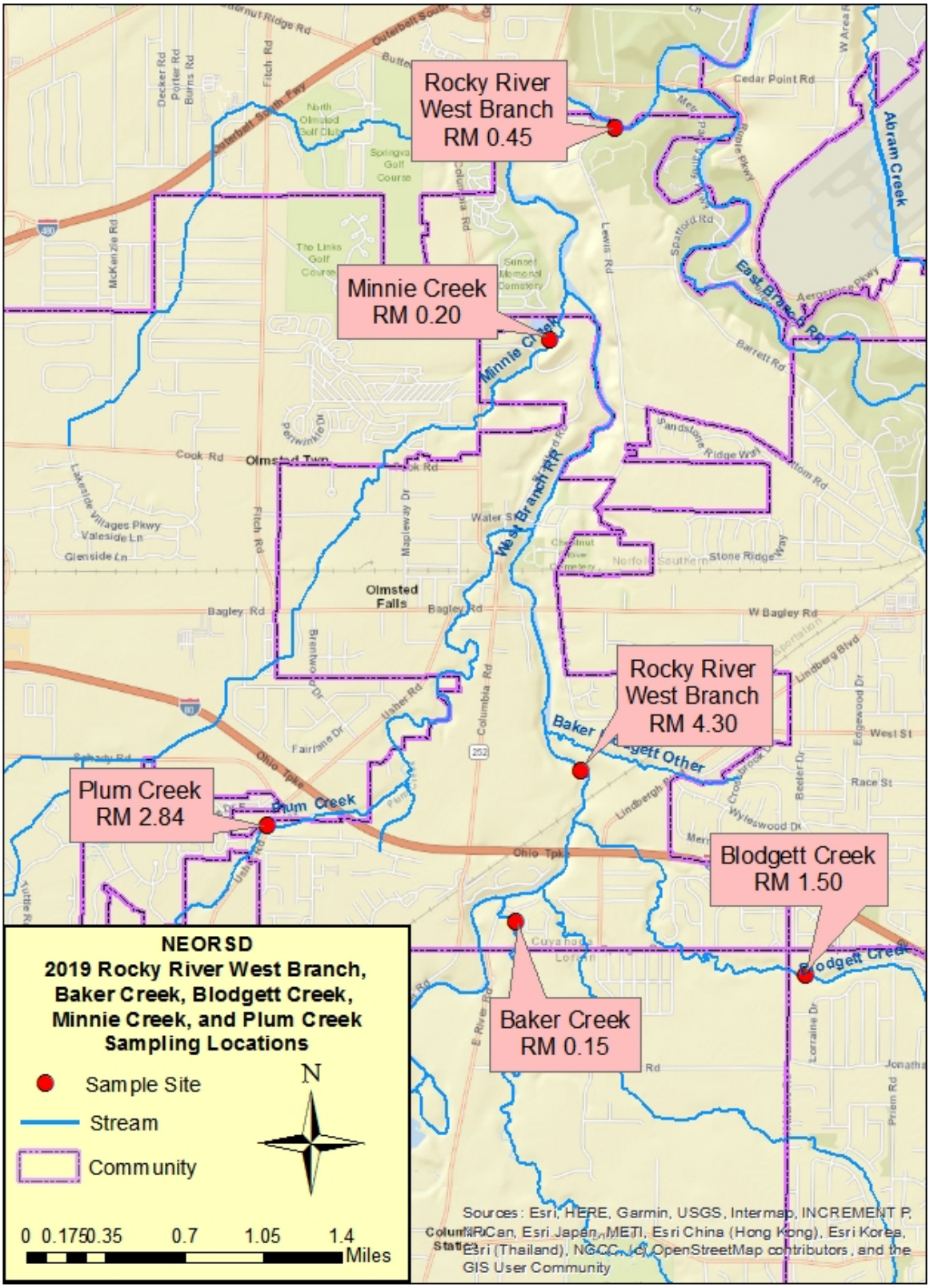


Figure 1. 2019 Rocky River West Branch and Tributaries Sampling Locations

The Ohio EPA assigns designated uses to establish minimum water quality requirements for surface waters in Ohio. These requirements represent measurable criteria for assessing the chemical, physical, and biological integrity of Ohio's surface waters consistent with Clean Water Act requirements. The beneficial use designations for the Rocky River West Branch and its tributaries are listed below in Table 2 (Ohio EPA, 2018b). Minnie Creek has not been assigned a beneficial use designation by the Ohio EPA at the time of this study.

Table 2. Use Designations for the Rocky River West Branch and Selected Tributaries

Stream	Beneficial Use Designation												
	Aquatic Life Habitat (ALU)							Water Supply			Recreation		
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR
Rocky River West Branch		+							+	+		+	
Plum Creek		+							+	+		+	
Blodgett Creek		+							+	+		+	
Baker Creek		+							+	+		+	

SRW = state resource water; WWH = warmwater habitat; EWH = exceptional warmwater habitat; MWH = modified warmwater habitat; SSH = seasonal salmonid habitat; CWH = coldwater habitat; LRW = limited resource water
PWS = public water supply; AWS = agricultural water supply; IWS = Industrial water supply
BW = bathing water; PCR = primary contact recreation; SCR = Secondary contact recreation.

The Ohio EPA regulates wastewater pollutants discharged from point sources through the National Pollutant Discharge Elimination System (NPDES) and if necessary, establishes a Total Maximum Daily Load (TMDL) for the watershed. A draft TMDL report for the Rocky River was released in 2005 stating the Rocky River is impaired for recreational use due to elevated bacteria densities (Ohio EPA, 2005). A TMDL for Plum Creek was also approved in 2001 to help alleviate organic enrichment and over-enriched nutrient concentrations. A list of NPDES permits within the Rocky River West Branch watershed are listed in Table 3 (Ohio EPA, n.d.).

Table 3. NPDES Permits tributary to the Rocky River West Branch

Facility	NPDES Permit #	Type[a]	Class[b]	Receiving Stream	RM	County	Address
Town & Country Co-op Inc.	3IG00087	I	Minor	West Br. Rocky River Tributary at RM 31.40	5.00-5.20	Medina	901 W. Smith Rd. Medina
RPM International Inc.	3PR00395, 3PK00255	P	Minor	West Br. Rocky River Tributary at RM 24.50	1.00	Medina	2628 Pearl Rd. Medina
Medina County Sewer District no. 500 Liverpool WWTP	3PK00004	P	Major	West Br. Rocky River Tributary at RM 14.80	0.20	Medina	89 Columbia Rd. Valley City
Columbia Hills Country Club	3PR00277	P	Minor	West Br. Rocky River	10.90	Lorain	State Rt. 252 Columbia Station
Sundaes in the Park WWTP	3PR00339	P	Minor	West Br. Rocky River	9.60	Lorain	25145 Royalton Rd. Columbia Station

Table 3. NPDES Permits tributary to the Rocky River West Branch

Facility	NPDES Permit #	Type[a]	Class[b]	Receiving Stream	RM	County	Address
Columbia School	3PT00087	P	Minor	West Br. Rocky River	9.60	Lorain	25796 Royalton Rd. Columbia Station
Cuyahoga Landmark Inc.	3IN00104	I	Minor	West Br. Rocky River Tributary at RM 4.90	3.90	Cuyahoga	12966 Prospect Rd. Strongsville
Columbia Park Water System MHP	3PV00013	P	Minor	West Br. Rocky River Tributary at RM 1.78	0.30	Cuyahoga	7100 Columbia Rd. Olmsted Falls
Plum Creek WWTP	3PG00052	P	Minor	Plum Creek, Rocky River West Branch	6.78	Lorain	Eddie Ln. Columbia
Centerra Co-op	3IG00087	I	Minor	West Br. Tributary at RM 31.47	--	Medina	901 West Smith Rd. Medina
Columba Gas Transmission Corp	3IN00301	I	Minor	Mallet Creek Tributary at RM 0.10	1.50	Medina	2834 Stiegler Rd. Medina
Highland High School	3PT00111	P	Minor	Granger Ditch	1.60	Medina	3880 Ridge Rd. Medina
Medina County Sewer District No. 11	3PG00043	P	Minor	Granger Ditch Tributary at RM 1.00	3.10	Medina	2404 Weymouth Rd. Hinkley Twp.

a – Publicly Owned Treatment Works (POTW) = P; Private industrial entity = I
b – Class characterized by flow: <1MGD = Minor and ≥1MGD = Major
WWTP = Wastewater Treatment Plant

Water Chemistry Sampling

Methods

Water chemistry and bacteriological sampling was conducted five times on the Rocky River West Branch and tributaries between July 24 and August 21, 2019, at the six sites listed in Table 1. Techniques used for sampling and analyses followed the Ohio EPA Surface Water Field Sampling Manual for water quality parameters and flows (2018a). Chemical water quality samples from each site were collected with a 4-liter disposable polyethylene cubitainer with a disposable polypropylene lid, three 473-mL plastic bottles and one 125-mL plastic bottle. The first 473-mL plastic bottle was field preserved with trace nitric acid, the second was field preserved with trace sulfuric acid and the third bottle received no preservative. The sample collected in the 125-mL plastic bottle (dissolved reactive phosphorus) was filtered using a 0.45-µm PVDF syringe filter. All water quality samples were collected as grab samples. Bacteriological samples were collected in sterilized plastic bottles and preserved with sodium thiosulfate. At the time of sampling, measurements for dissolved oxygen, dissolved oxygen percent, pH, temperature, specific conductivity, and conductivity were collected using either a YSI 600XL or EXO1 sonde. Duplicate samples and field blanks were each collected at randomly selected sites, at a frequency not less than 5% of the total samples collected. Relative percent difference (RPD) was used to determine the degree of discrepancy between the primary and duplicate sample (Formula 1).

Formula 1: $$RPD = \left(\frac{|X-Y|}{((X+Y)/2)} \right) * 100$$

X= is the concentration of the parameter in the primary sample
Y= is the concentration of the parameter in the duplicate sample

The acceptable percent RPD is based on the ratio of the sample concentration and detection limit (Formula 2) (Ohio EPA, 2018a).

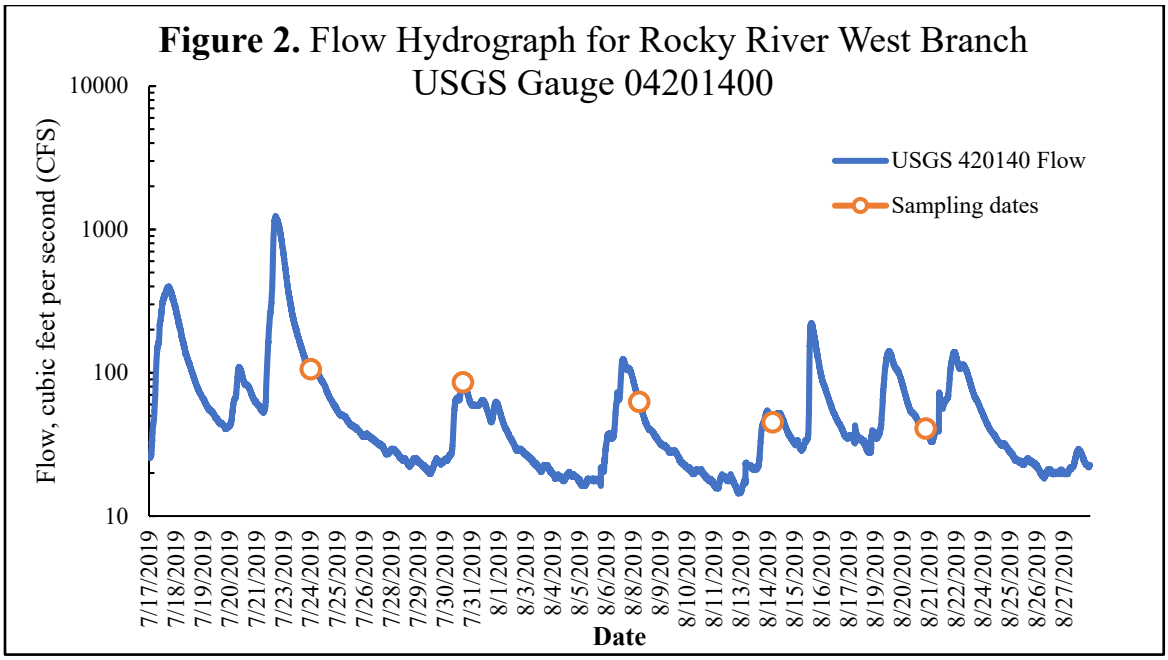
Formula 2: $$\text{Acceptable \% RPD} = [(0.9465X^{-0.344})*100] + 5$$

X = sample/detection limit ratio

Those RPDs that were higher than acceptable may indicate potential problems with sample collection and as a result, the data was not used for comparison to the water quality standards.

Mercury analysis for all sampling events was done using EPA Method 245.1. Because the detection limit for this method is above the criteria for the Human Health Nondrinking and Protection of Wildlife Outside Mixing Zone Averages (OMZA), this type of mercury sampling was used as a screening tool to determine whether contamination was present above those levels typically found in the river.

Dates of water chemistry sampling compared to Rocky River West Branch flow data (USGS 04201400) are shown below in Figure 2. Water chemistry analysis sheets for each site are available upon request from the NEORSD WQIS Division.



Results and Discussion

Over the course of five sampling events in 2019, one field blank and three duplicates were collected as part of this study. Zinc was the only parameter that showed possible contamination in the field blank. It is unclear how the field blank may have become contaminated and may be due to inappropriate sample collection, handling, and/or contaminated blank water. Zinc was then rejected based on Ohio EPA data validation protocols. Of the three duplicate samples collected, the August 21 duplicate sample contained four parameters which were rejected because the acceptable RPD was exceeded (Table 4). Potential reasons for this discrepancy include lack of precision and consistency in sample collection and/or analytical procedures, environmental heterogeneity, and/or improper handling of samples.

Table 4. Duplicate Samples with RPDs Greater than Acceptable

Location	Date	Parameter	Acceptable RPD	Actual RPD
Baker Ck. RM 0.15	8/21/2019	Al	27.6	97.6
		Fe	27.0	44.7
		Mn	21.7	39.9
		Ti	48.7	69.3

Paired parameters were evaluated for QA/QC purposes on all samples where one parameter is a subset of another. No paired parameters exceeded the relative percent difference threshold; therefore, all paired parameters were accepted as valid. However, total dissolved solids and total suspended solids both yielded a higher numeric value than the parent parameter total solids on multiple instances. Therefore, these parameters were downgraded to estimated values.

Exceedances of the recreational bacteriological criteria occurred at all six sites during the 2019 sampling season. The recreational criteria for *Escherichia coli* (*E. coli)* consist of two components: a 90-day geometric mean and a value not to be exceeded in more than 10% of the samples collected during a 90-day period (statistical threshold value). For streams designated as primary contact recreation, these criteria are 126 colony counts/100mL or most-probable number (MPN)/100mL and 410 colony counts/100mL or MPN/100mL, respectively. These calculations are formulated when there are at least five samples collected within a rolling 90-day period. When duplicate samples were collected at a sample location, the results were reported as an average.

Both criteria were exceeded at all sample locations for the 90-day periods beginning on July 24, 2019 (Table 5). These exceedances may have been attributed to wet-weather events which occurred on four of the five sampling dates (Figure 2 and Table 5). The wet-weather events were measured at the NEORSD Olmsted Falls rain gauge. Potential sources of bacteria inputs may include stormwater runoff, illicit discharges, sanitary sewer overflows, inadequate wastewater treatment systems, and failing household sewage treatment systems (HSTS), the last of which are quite common in the Rocky River West Branch watershed.

Table 5. 2019 Rocky River West Branch *E. coli* Densities (MPN/100mL)

Date	Rocky River W. Br. RM 0.45	Rocky River W. Br. RM 4.30	Baker Creek RM 0.15	Blodgett Creek RM 1.50	Plum Creek RM 2.84	Minnie Creek RM 0.20
7/24/2019*	644	512	534	64,880	7,430	736
7/31/2019	330	213	438	6,700	980	604
8/8/2019*	582	328	980	>2,650	654	1,350
8/14/2019*	534	378	2,960	1,950	1,820	1,040
8/21/2019*	272	225	225	1,040	710	658
90-day Geomean	462	314	908	5,449	1,438	837

Exceeds statistical threshold value
Exceeds geometric mean criterion for 90-day period

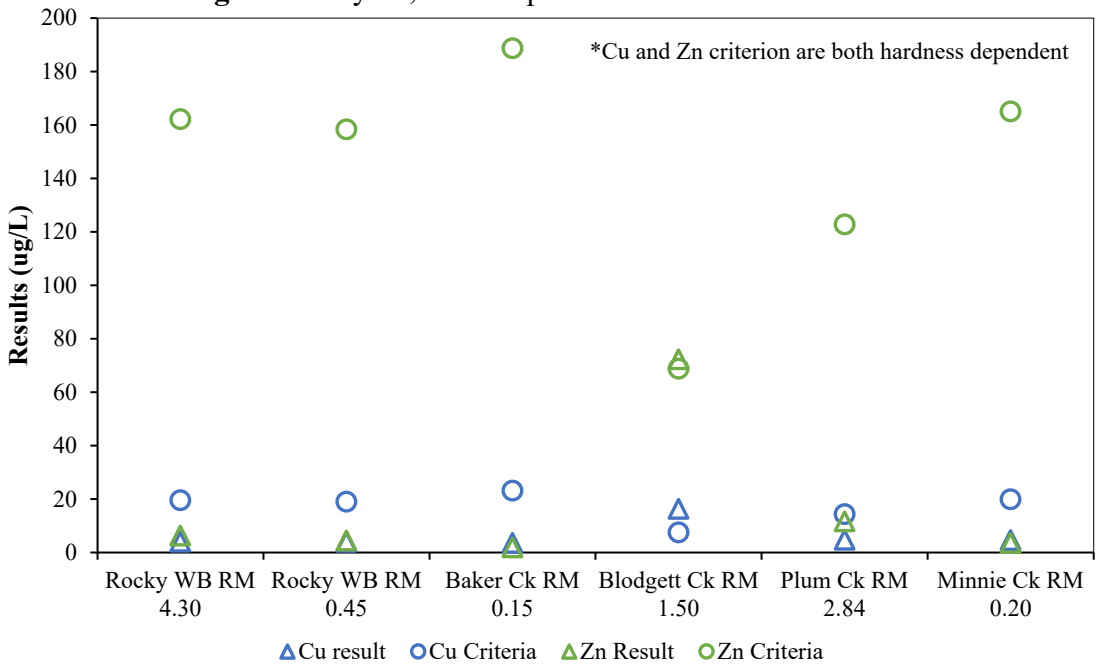
*Wet-weather event: greater than 0.10 inches of rain, but less than 0.25 inches, samples collected that day and the following day are considered wet-weather samples; greater than 0.25 inches, the samples collected that day and the following two days are considered wet-weather samples.

Mercury concentrations at all five sites were not detectable using EPA method 245.1 (MDL=0.022 µg/L). Since the detection limit for this method is above the criteria for the Human Health Nondrinking OMZA (0.0031 ug/L) and Protection of Wildlife OMZA (0.0013 µg/L), it generally cannot be determined if the Rocky River West Branch was in attainment of those criteria. Blodgett Creek experienced an exceedance for the Aquatic Life outside mixing zone maximum (OMZM) & Tier I OMZM for copper on July 24, 2019. Zinc also showed the potential to exceed the OMZM criterion, but can not be classified as a true exceedance since it was detected in the field blank and therefore rejected following Ohio EPA validation protocols.

The hydrograph in Figure 2, as well as precipitation data from the NEORSD North Olmsted rain gauge, characterize the sampling event on July 24, 2019 as a significant wet-weather event. Urban and industrial runoff from upstream land uses within the Blodgett Creek watershed may be the cause of toxic metal exceedances. Figure 3 displays copper (Cu) and zinc (Zn) concentrations

compared to their repective hardness-based criterion. The decrease in hardness and increased Cu and Zn concentrations obeserved in Blodgett Creek may have caused these exceedances. Concentrations above the hardness-based criterion display signs of acute toxicity in Blodgett Creek during significant wet-weather events. No other sample location displayed these characteristics during the same wet-weather sampling event, as Cu and Zn concentrations were near or below their laboratory detection limits.

Figure 3. July 24, 2019 Aquatic Life OMZM Exceedances



In 2015, the Ohio EPA Nutrients Technical Advisory Group released a proposed Stream Nutrient Assessment Procedure (SNAP) designed to determine the degree of impairment in a stream due to nutrient enrichment. The SNAP assigns designations for quality of surface waters based on factors including dissolved oxygen (DO) swings, benthic chlorophyll α, total phosphorous (TP), and dissolved inorganic nitrogen (DIN) (Ohio EPA, 2015). NEORSD did not collect data on benthic chlorophyll α or DO swings in 2019; however, nutrient concentrations were collected and analyzed for general watershed monitoring purposes. When all necessary data is not available to perform a full SNAP assessment, provisional targets of 0.40 mg/L total phosphorus and 3.6 mg/L DIN are used as water quality target concentrations (WQTC).

Table 6 shows nutrient concentration results for the six Rocky River West Branch sites. The results of DIN and TP were compared to Table 2 listed in the SNAP document (Figure 4). Both Rocky River West Branch and Minnie Creek displayed *enriched condition; generally high risk to beneficial uses; often co-occurring with multiple stressors; increased risk to ecological conditions with poor habitat*. Blodgett Creek and Baker Creek displayed *levels typical of developed lands; little to no risk to beneficial uses*. Plum Creek displayed l*evels typical of enriched conditions, low risk to beneficial use if allied responses are within normal ranges*.

Table 6. Rocky River West Branch Nutrient Analysis

Sample Location	*Geomean DIN (mg/L)	*Geomean TP (mg/L)	Geomean DRP (mg/L)	Geomean Nitrate-Nitrite (mg/L)
Rocky River W. Branch RM 0.45	2.694	0.092	0.048	*2.672*
Rocky River W. Branch RM 4.30	3.191	0.113	0.061	*3.163*
Baker Creek RM 0.15	0.304	0.040	0.015	0.284
Blodgett Creek RM 1.50	0.513	0.059	0.023	0.474
Plum Creek RM 2.84	0.823	0.141	0.074	0.778
Minnie Creek RM 0.20	2.489	***0.528***	0.446	*2.227*

* Data used in Table 2 of SNAP (Ohio EPA, 2015)
Bold: Exceeds provisional WQTC
Italics = Exceeds the 2001 Rocky River Nutrient TMDL Target Concentrations: 1.3 mg/L Nitrate-Nitrite & 0.19 mg/L TP
Exceeds Median TP for IBI scores ≥ 40 = 0.05 mg/L - HW; 0.07 mg/L – Wade
Exceeds Nitrate-nitrite reference sites median = 0.42 mg/L - HW; 0.43 mg/L – Wade
Exceeds Nitrate-nitrite reference sites 75th percentile = 1.00 mg/L - HW; 1.05 mg/L – Wade

Minnie Creek exhibited a TP geomean concentration of 0.528 mg/L, which exceeded the provisional WQTC of 0.40 mg/L. However, the SNAP considers sampling for nutrients during *stable, baseflow conditions*. The one sample collected during dry-weather conditions also yielded a result above the 0.40 mg/L TP WQTC. A TMDL for the Rocky River West Branch between Plum Creek (RM 3.06) and the confluence with the East Branch was not necessary in 1997 as results met biological attainment goals. Concentrations of nitrate-nitrite at both Rocky River West Branch sites, and both TP and nitrate-nitrite at Minnie Creek exceeded the nutrient target concentrations outlined in the 2001 Ohio EPA TMDL report (Table 6). Three dry-weather samples reported as a geomean are required to assign a narrative rating using the SNAP. Further sampling during stable, baseflow conditions is required to determine whether, and to what degree, nutrients are impacting each stream segment.

		← DECREASING RISK				
	TP Conc. (mg/l)	DIN Concentration (mg/l)				
		<0.44	0.44 < 1.10	1.10 < 3.60	3.60 < 6.70	≥6.70
DECREASING RISK →	<0.040	background levels typical of least disturbed conditions	levels typical of developed lands; little or no risk to beneficial uses	levels typical of modestly enriched condition in phosphorus limited systems; low risk to beneficial use if allied responses are within normal ranges	levels typical of enriched condition in phosphorus limited systems; moderate risk to beneficial use if allied responses are elevated	characteristic of tile-drained lands; otherwise atypical condition with moderate risk to beneficial use if allied responses are elevated (1.1% of observations)
	0.040-<0.080	levels typical of developed lands; little or no risk to beneficial uses	levels typical of developed lands; little or no risk to beneficial uses	levels typical of working landscapes; low risk to beneficial use if allied responses are within normal ranges	levels typical of enriched condition in phosphorus limited systems; moderate risk to beneficial use if allied responses are elevated	characteristic of tile-drained lands; moderate risk to beneficial use if allied responses are elevated (1.1% of observations)
	0.080-<0.131	levels typical of modestly enriched condition in nitrogen limited systems; low risk to beneficial use if allied responses are within normal ranges	levels typical of working landscapes; low risk to beneficial use if allied responses are within normal ranges	levels typical of working landscapes; low risk to beneficial use if allied responses are within normal ranges	characteristic of tile-drained lands; moderate risk to beneficial use if allied responses are elevated; increased risk with poor habitat	characteristic of tile-drained lands; moderate risk to beneficial use if allied responses are elevated (1.0% of observations)
	0.131-<0.400	levels typical of modestly enriched condition in nitrogen limited systems; low risk to beneficial use if allied responses are within normal ranges	levels typical of enriched condition; low risk to beneficial use if allied responses are within normal ranges	levels typical of enriched condition; low risk to beneficial use if allied responses are within normal ranges; increased risk with poor habitat	enriched condition; generally high risk to beneficial uses; often co-occurring with multiple stressors; increased risk with poor habitat	enriched condition; generally high risk to beneficial uses; often co-occurring with multiple stressors
	≥0.400	atypical condition (1.3% of observations)	atypical condition (1% of observations);	enriched condition; generally high risk to beneficial uses; often co-occurring with multiple stressors; increased risk with poor habitat	enriched condition; generally high risk to beneficial uses; often co-occurring with multiple stressors ; increased risk with poor habitat	enriched condition; generally high risk to beneficial uses; often co-occurring with multiple stressors

"allied responses" = allied response indicators (24-hour DO swing, benthic chlorophyll)

Figure 4. Table 2 of the Stream Nutrient Assessment Procedure (Ohio EPA, 2015b)

Columbia Mobile Home Park (MHP) East, LLC manages its own wastewater treatment system in Olmsted Township and discharges its treated wastewater (0.250 MGD design flow) to Minnie Creek at RM 0.41. Since October of 2016, Columbia MHP East, LLC has been in *significant/category 1 noncompliance* with the Ohio EPA, consistently violating its nitrogen-ammonia ($N\text{-}NH_3$), *E. coli*, and total suspended solids (TSS) NPDES permit limits (USEPA ECHO). Ohio EPA has yet to renew their NPDES permit, which expired on June 30, 2018. Total phosphorus is not a permit required limit, but monitoring is required. Table 7 displays Columbia MHP's effluent nutrient and TSS data, exceeding NPDES permit limits. Data in Table 7 used NPDES reporting data, obtained from the Ohio EPA through a public request. The Columbia MHP wastewater effluent is likely significantly contributing to the elevated nutrient concentrations observed downstream in Minnie Creek and in the Rocky River West Branch. The Ohio EPA should continue to work with the Columbia MHP WWTP to remediate their poor wastewater treatment system and work towards renewal and compliance of their NPDES permit.

Table 7. Columbia MHP NPDES Permit # 3PV00013*ED final effluent data – 6/11/2019-10/15/2019					
TP median (mg/L)	TP NPDES limit (mg/L)	N-NH_3 median (mg/L)	N-NH_3 summer NPDES limit (mg/L)	TSS median (mg/L)	TSS NPDES limit (mg/L)
1.28	Monitoring only	21.0	2.3/1.5*	40.0	18/12*
*NPDES Limits: Weekly/Monthly					

Biological responses (IBI and ICI scores) have shown to have a negative effect with increasing nutrient loadings (Ohio EPA, 1999a). When compared to Ohio EPA reference sites, the highest IBI scores were associated with TP concentrations below median state values (0.12 mg/L) and not necessarily influenced by nitrate-nitrite concentrations at concentrations below 3-4 mg/L. In streams that met WWH criteria within the Erie-Ontario Lake Plains (EOLP) ecoregion (IBI scores ≥ 40), median TP concentrations are 0.05 mg/L for headwater sites and 0.07 mg/L for wading sites.

Comparing 2019 data to Ohio EPA EOLP ecoregion reference sites, the Rocky River West Branch and its tributaries displayed above median nitrate-nitrite concentrations at all sites with the exception of Baker Creek (Table 6). Three sites also exceeded the 75th percentile nitrate-nitrite concentrations. TP concentrations exceeded the median concentration all sites but Baker Creek. Elevated nutrients in the Rocky River West Branch tributaries may be attributable to the abundance of HSTSs in the watershed, rural agricultural landscape, inadequate wastewater treatment systems (Minnie Creek, Rocky River West Branch, and Plum Creek), and other upstream influences.

Habitat Assessment

Methods

Instream habitat assessments were conducted using the QHEI at each site listed in Table 1 except for Baker Creek, where access permission was unable to be obtained from all landowners needed to perform a fish community and habitat assessment. The QHEI was developed by the Ohio EPA to assess aquatic habitat conditions that may influence the presence or absence of fish species by evaluating the physical attributes of a stream. The index is based on six metrics: stream substrate, instream cover, channel morphology, riparian zone and bank condition, pool and riffle quality, and stream gradient (Ohio EPA, 1989). The QHEI has a maximum score of 100, and a score greater than 60 at wading sites and 55 at headwater sites suggests that sufficient habitat exists to support a warmwater fish assemblage (Ohio EPA, 2006a). Scores greater than 75 frequently demonstrate habitat conditions that support exceptional warmwater fish communities. A more detailed description of the QHEI can be found in Ohio EPA's Methods for Assessing Habitat in Flowing Waters: Using the QHEI (2006a). QHEI field sheets for each site are available upon request from the NEORSD WQIS Division.

Individual components of the QHEI can also be used to evaluate whether a site is capable of meeting its WWH designated use. This is done by categorizing specific attributes as indicative of either a WWH or modified warmwater habitat (MWH) (Rankin, 1995). Attributes that are

considered characteristic of MWH are further classified as being a moderate or high influence on fish communities. As modified habitat attributes increase to an (MWH+1)/(WWH+1) ratio at or greater than 1.0-1.5, the likelihood of achieving WWH attainment of the IBI scores declines (Yoder and Rankin, 1996).

Results and Discussion

Rocky River West Branch

The two Rocky River West Branch sites exhibited *good* to *excellent* instream habitat (Table 8). High quality WWH attributes included fast currents, sufficient pool depth, and normal riffle embeddedness. Moderate influence habitat attributes included moderate silt cover, low sinuosity, and a normal/moderate overall embeddedness at RM 4.30. A distinct sub-ecoregion transition was evident between the RM 4.30 site, where the substrate consists of sandstone bedrock and glacial till washout, downstream to RM 0.45 where the river cuts through shale bedrock. The late season second electrofishing assessment on the two Rocky River sampling locations had thick benthic green filamentous alga growing, displaying the longevity of low river conditions and inability of the river to flush the algae downstream.

Table 8. 2019 Qualitative Habitat Evaluation Index scores and physical attributes

				MWH Attributes																																	
				WWH Attributes												High Influence						Moderate Influence																
Stream	River Mile	QHEI Score	Narrative Rating	No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Development	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max. Depth >40 cm	Low-Normal Riffle Embeddedness	**Total WWH Attributes**	Channelized or no Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth < 40 cm (WD, HW sites)	**Total High Influence Attributes**	Recovering Channel	Heavy/Moderate Silt Cover	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Attributes**	**(MWH-H.I.+1) / (WWH+1) Ratio**	**(MWH M.I.+1) / (WWH+1) Ratio**
Rocky River	4.30	74.50	*Good*	X			X		X	X		X	X	**6**						**0**		X		X	X				X	X		**5**	0.1	0.9
W. Branch	0.45	76.50	*Excellent*	X	X		X			X	X	X	X	**7**				X		**1**		X		X	X							**3**	0.3	0.5
Plum Ck.	2.84	70.00	*Excellent*	X	X		X			X	X	X		**6**				X		**1**		X			X				X	X		**4**	0.3	0.7
Blodgett Ck.	1.50	65.75	*Good*	X	X		X		X	X		X		**6**				X		**1**				X	X				X	X		**4**	0.3	0.7
Minnie Ck.	0.20	68.75	*Good*	X	X		X	X	X			X		**6**						**0**		X						X	X	X		**4**	0.1	0.7

Plum Creek

Plum Creek at RM 2.84 displayed *excellent* stream habitat. Normal to moderate embeddedness was observed and silt covered cobble and gravel substrates. The limited instream cover consisted of shallows, deep pools, boulders, and woody debris. On the second fish assessment pass, stream conditions were significantly lower and exhibited near intermittent riffles between pools. WWH attributes outnumbered the MWH attributes with a ratio of 0.7. Historical data from Ohio EPA shows scores consistently in the *good* to *excellent* narrative range throughout the lower 3 miles of Plum Creek.

Blodgett Creek

Blodgett Creek displayed habitat suitable for a warmwater fish community, receiving a 65.75 QHEI score. High quality WWH attributes included cobble substrates, good overall development, and moderate sinuosity and instream cover. The river riparian width on river right

has previously been developed into a park, with only a small buffer zone of un-mowed grass near the river, resulting in a slightly incised section of stream. Moderate riffle and pool quality were noted, as the zone had no deep pools, and sand and small gravel substrates displayed moderate stability in the riffle habitat.

Minnie Creek

Minnie Creek also displayed *good* stream habitat. The diverse substrate types dominated by gravel and sand were moderately silted and embedded. Instream cover was diverse with five types, the best being rootwads, woody debris and aquatic macrophytes. The excellent channel morphology was characterized by high sinuosity, wide to moderate riparian width, and moderate channel stability. Negative MWH attributes included no fast currents and moderate embeddedness and silt cover. Overall, Minnie Creek displays physical stream habitat characteristics of a WWH stream.

Fish Community Biology Assessment

Methods

Two electrofishing passes were conducted at all sites listed in Table 1, except for Baker Creek, where access permission was unable to be obtained from all landowners needed to perform an electrofishing assessment. A list of the dates when the surveys were completed, along with flow measurements from United States Geological Survey gauge stations are shown in Table 9. Wading electrofishing methods were used at all sample sites and followed Ohio EPA methods as detailed in the Biological Criteria for the Protection of Aquatic Life, Volumes II (1987a) and III (1987b). Fish collected during the surveys were identified, weighed (wading sites only), and examined for the presence of DELT anomalies (deformities, eroded fins, lesions, and tumors). All fish were then released to the waters from which they were collected, except for vouchers and those that could not be easily identified in the field.

Table 9. Sampling Dates and River Flows

Date	Sampling Location	Daily Mean Flow (CFS)
7/1/19	Blodgett Creek RM 1.50	1.53
7/9/19	Rocky River W. Branch RM 0.45	114
7/10/19	Rocky River W. Branch RM 4.30	97
7/19/19	Minnie Creek RM 0.20	2.78
7/26/19	Plum Creek RM 2.84	1.71
9/3/19	Blodgett Creek RM 1.50	1.12
10/1/19	Rocky River W. Branch RM 0.45	15.9
	Plum Creek RM 2.84	0.14
10/2/19	Rocky River W. Branch RM 4.30	15.4
	Minnie Creek RM 0.20	0.02

Rocky River West Branch sites measured at USGS 04201500
Blodgett Creek measured at USGS 04201409
Plum Creek measured at USGS 04201423
Minnie Creek measured at USGS 04201429
Note: Flow data was provisional at time of publication

The electrofishing results were compiled and utilized to evaluate fish community health through the application of two Ohio EPA indices, the Index of Biotic Integrity (IBI) and the Modified Index of Well-Being (MIwb) at wading sites. The IBI incorporates twelve community metrics representing structural and functional attributes. The structural attributes are based upon fish community aspects such as fish abundance and diversity. Functional attributes are based upon fish community aspects such as feeding strategies, environmental tolerances, and disease symptoms. These metrics are individually scored by comparing the data collected at the survey site with values expected at reference sites located in a similar geographical region. The maximum possible IBI score is 60 and the minimum possible score is 12. The summation of the 12 individual metrics scores provides a single-value IBI score, which corresponds to a narrative rating of *Exceptional, Good, Marginally Good, Fair, Poor,* or *Very Poor*. The 12 metrics utilized for wading and headwater sites are listed in Table 10.

The second fish index utilized by Ohio EPA, is the Modified Index of Well-being (MIwb). The MIwb, Formula 1 below, incorporates four fish community measures: numbers of individuals, biomass, and the Shannon Diversity Index (H) (Formula 2 below) based on numbers and weight of fish. The MIwb is a result of a mathematical calculation based upon the formula.

Formula 1: $$MIwb = 0.5\ lnN + 0.5\ lnB + \overline{H}(No.) + \overline{H}(Wt.)$$

N = Relative numbers of all species excluding species designated as highly tolerant, hybrids, or exotics

B = Relative weights of all species excluding species designated as highly tolerant, hybrids, or exotics

$\overline{H}(No.)$ = Shannon Diversity Index based on numbers

$\overline{H}(Wt.)$ = Shannon Diversity Index based on weight

Formula 2: $$\overline{H} = -\sum\left[\left(\frac{n_i}{N}\right)log_e\left(\frac{n_i}{N}\right)\right]$$

n_i = Relative numbers or weight of species

N = Total number or weight of the sample

The Rocky River is located completely within the EOLP ecoregion and follows the EOLP IBI metric scoring. The WWH IBI scoring criterion in the EOLP is 40 for headwater streams and 38 for wading streams. The WWH MIwb scoring criterion in the EOLP is 7.9 for wading sites. The MIwb is not applicable for headwater sites where drainage areas are less than 20 mi^2. A site is considered to be within nonsignificant departure (NSD) if the score falls within 4 IBI units or 0.5 MIwb units of the criterion (Table 11).

Table 10. IBI Metrics	
Wading sites	Headwater sites (<20 sq. miles)
Number of indigenous fish species	Number of indigenous fish species
Number of darter species	Number of darter species
Number of sunfish species	Number of headwater species
Number of sucker species	Number of minnow species
Number of intolerant species	Number of sensitive species
Percent tolerant species	Percent tolerant species
Percent omnivore species	Percent omnivore species
Percent insectivore species	Percent insectivore species
Percent of top carnivore species	Percent pioneering species
Number of individuals (minus tolerants)	Number of individuals (minus tolerants)
Percent of simple lithophilic spawners	Number of simple lithophilic species
Percent DELT anomalies	Percent DELT anomalies

Table 11. Fish Community Biology Scores in the EOLP Ecoregion							
Ohio EPA Narrative	Very Poor	Poor	Fair	Marginally Good	Good	Very Good	Exceptional
IBI Score - Headwater	12-17	18-27	28-35	36-39	40-45	46-49	50-60
IBI Score - Wading	12-17	18-27	28-33	34-37	38-45	46-49	50-60
MIwb Score (Wading only)	0-4.4	4.5-5.8	5.9-7.3	7.4-7.8	7.9-8.8	8.9-9.3	≥9.4
Ohio EPA Narrative	Non-Attainment			NSD	Attainment		
NSD – Non-Significant Departure of WWH attainment							

Results and Discussion

Rocky River West Branch

The fish community in the Rocky River West Branch indicates good water quality conditions, although an impairment at RM 4.30 was observed. Both Rocky River West Branch sites were calculated to be in full aquatic life attainment for the IBI (Table 12), with the MIwb at RM 4.30 scoring below the WWH criterion. At both sites, adequate habitat and water quality conditions supported a fish assemblage with moderate to high species richness and insectivorous species, and moderate to low numbers of tolerant fish and DELT anomalies. Although achieving WWH attainment, low to moderate abundance of pollution intolerant fishes and simple lithophilic spawning species were observed.

Table 12. 2019 Fish Community Biology Scores							
Location	River Mile	1st Pass		2nd Pass		Average	
		IBI	MIwb	IBI	MIwb	IBI	MIwb
West Branch Rocky River	4.30	36[ns]	6.7*	46	7.7[ns]	41	7.2*
	0.45	42	7.9	42	9.5[E]	42	8.7
Blodgett Creek	0.15	26*	--	26*	--	26*	--
Plum Creek	2.84	26*	--	30*	--	28*	--
Minnie Creek	0.20	36[ns]	--	40	--	38[ns]	--

*Significant departure from biocriterion (>4IBI; >0.5 MIwb units). Underlined scores are in the *Poor* or *Very Poor* narrative range
[ns] non-significant departure from biocriterion (≤4IBI; ≤0.5 MIwb units)
[E] Exceptional WWH score

The Rocky River has historically been monitored by the Ohio EPA since 1981. Improvements to the Rocky River fish community have been noted, as fish community scores struggled to meet WWH attainment prior to 1997 (Figures 5 & 6) (Ohio EPA, 1993, 1999b) and are now in partial or full attainment along most Rocky River sites. Significant improvements and elimination of several WWTPs discharging to the Rocky River have resulted in declines in ammonia concentrations, although nutrient concentrations are still elevated compared to Ohio reference sites. However, bacteria densities still indicate sewage contamination throughout the watershed. Biological index scores in the Rocky River West Branch improved in the late 1990s as toxic releases were remediated from the Montville Landfill (RM ~ 34.0) when the facility shut down. These remediation efforts have resulted in improved water quality and a more robust fish community in the Rocky River West Branch, historically.

Figure 5. Rocky River W. Branch Historical IBI Scores

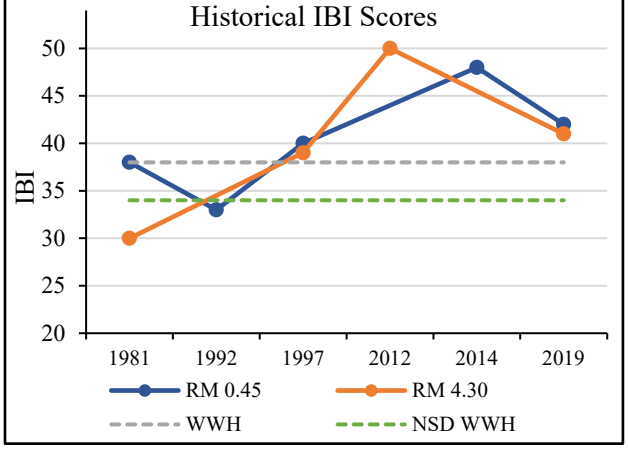
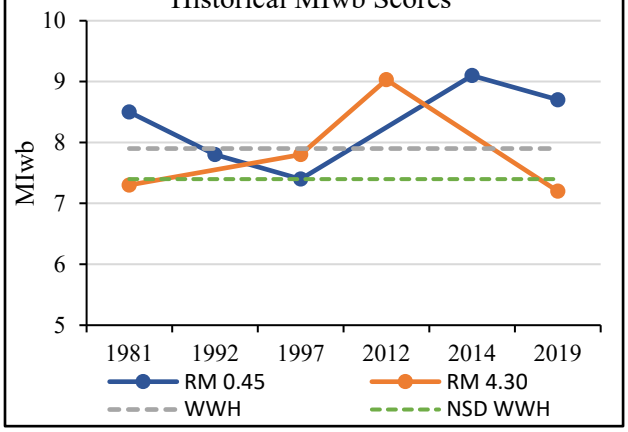


Figure 6. Rocky River W. Branch Historical MIwb Scores



Blodgett Creek

Despite adequate fish habitat (QHEI=56.75), Blodgett Creek exhibited a poor fish community. Six total species were collected in Blodgett Creek in 2019, with pollution tolerant fish accounting for nearly 88% and 95% of the first and second electrofishing passes, respectively. The depauperate fish community consisted of zero darter species, sensitive species, and insectivorous species, indicating a significant impairment. Of the six species collected, five

species have feed guilds classified as either generalists, herbivores, or omnivores (Ohio EPA, 2006b), suggesting a disruption of the food base. This may be due to nutrient enrichment or other water quality impairments from upstream sources. Ohio EPA historical data displays similar results as Blodgett Creek upstream of RM 0.90 has never achieved WWH attainment (Figure 7). Only one sample location on Blodgett Creek upstream of the West Branch of the Rocky River (RM 0.10) has scored in attainment (Ohio EPA, 1999b) and is likely due to the local recolonization of fish from the Rocky River West Branch and not because of adequate long-term water quality.

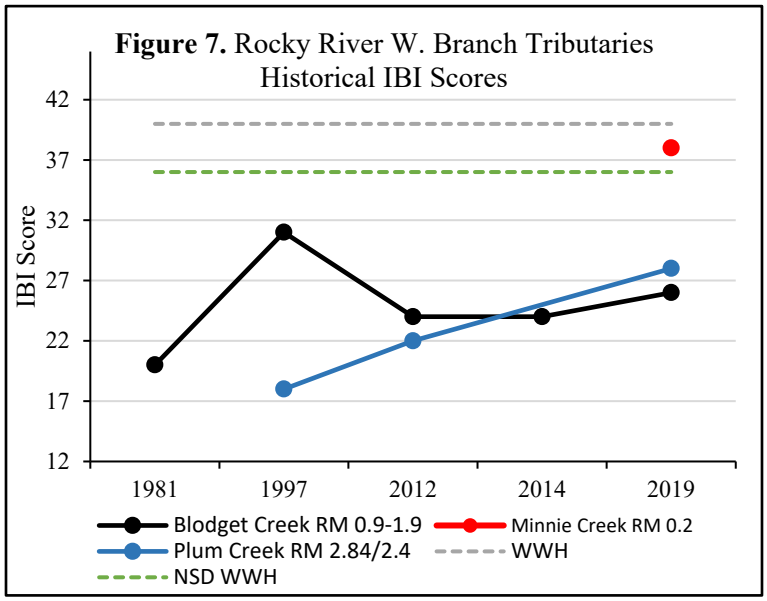


Figure 7. Rocky River W. Branch Tributaries Historical IBI Scores

The Strongsville A WWTP and the Olmsted Falls Versailles WWTP ceased discharge to Blodgett Creek in 1995 and redirected flows to the NEORSD Southwest interceptor. Improvements in chemical water quality have been observed since the decommissioning of these two WWTPs; however, the fish community has yet to improve. With no apparent fish barrier in the lower two miles of Blodgett Creek, the long-term observations of poor fish communities in Blodgett Creek display signs of acute toxicity from heavy metals during wet-weather events, as evidence from water chemistry sampling. Other water quality impacts may include failing HSTSs, and urban, industrial, and agricultural stormwater runoff.

Plum Creek

Plum Creek fish community scores once again displayed poor water quality, although a slight improvement in the fish community has been observed. At RMs 2.40-2.84, IBI scores of 18 (*Poor*, 1997) and 24 (*Poor*, 2014) were calculated by the Ohio EPA, while an average IBI score of 28 (*Fair*) was calculated by NEORSD in 2019 (Figure 7). Proportion of tolerant fish has decreased from greater than 85% in 1997 (Ohio EPA, 1999b) to less than 57% in 2019. Only one darter species, one headwater species, and one simple lithophilic spawning species were collected in 2019. Two wetland species, the brook stickleback and the central mudminnow were collected in 2019, suggesting wetland connectivity to Plum Creek. Once again, no pollution-sensitive species were collected.

Figure 8. Plum Creek Waterfalls (The Waterfall Record)

A natural waterfall acts as a physical barrier to fish migration into Plum Creek at the confluence with the Rocky River West Branch (Figure 8). Plum Creek displayed elevated bacteria densities on every sampling event, which seems common throughout the entire Rocky River watershed, but no other water quality exceedance was observed. Chronic low dissolved oxygen concentrations from organic enrichment were observed by the Ohio EPA prior to 1997. Dissolved oxygen concentrations have now improved as no exceedances were measured in 2019. Reductions in organic enrichment are most likely due to the removal of the Brentwood and Western Ohio Utility WWTPs in 1997.

The removal of two WWTPs and increased NPDES effluent monitoring at the Plum Creek WWTP (RM 6.78) also had a positive impact decreasing nutrient concentrations. The 2019 Plum Creek median TP and Nitrate-Nitrite concentrations at RM 2.84 both met TMDL nutrient target concentrations (Table 6) that were established in the 2001 Ohio EPA TMDL report. However, even with these water quality improvements, the natural fish barrier virtually eliminates fish from re-colonizing the upper reaches of Plum Creek from the Rocky River West Branch, hindering its WWH attainment.

Minnie Creek

Minnie Creek's water quality has not previously been assessed by the Ohio EPA and has not been designated a specific water quality standard ALU designation. Fish community scores indicate good water quality and reflects that of a warmwater habitat stream. A diverse species richness, minnow species richness, and moderate numbers of sensitive species were identified during both assessments. Community structure and function varied slightly between the two sampling events, with the first event exhibiting far fewer fish collected, a higher proportion of tolerant fish, and a lower proportion of insectivorous fish. This shift in community may reflect seasonal recolonization of fish into Minnie Creek from the Rocky River West Branch or indicate potential water quality issues related to the upstream Columbia Park Water System MHP. Overall, habitat and fish community scores reflect that of a WWH stream.

Baker Creek

Landowner permission was not granted for a continuous 150 meters of Baker Creek; therefore, no fish community or habitat assessments were performed. Baker Creek was assessed by the Ohio EPA in 2014 and received an IBI score of 40, indicating good water quality and attainment of its WWH designated use. Land use within the watershed has experienced moderate development since the 2014 assessment, with more development planned to take place over the next several years. No point sources of pollution are identified within the Baker Creek watershed.

Macroinvertebrate Community Biology Assessment

Methods

Macroinvertebrates were sampled quantitatively using modified Hester-Dendy (HD) samplers in conjunction with a qualitative assessment of Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly), also referred to as EPT taxa, inhabiting available habitats at the time of HD retrieval. Sampling was conducted at all locations listed in Table 1. Methods for sampling followed the Ohio *EPA's Biological Criteria for the Protection of Aquatic Life*, Volumes II (1987a) and III (1987b). The recommended period for HDs to be installed is six weeks.

The collected macroinvertebrate specimens were sent to *EA Engineering, Science, and Technology, Inc.* for identification and enumeration. Specimens were identified to the lowest practical taxonomic level as defined by the Ohio EPA (1987b). Lists of the species collected during the quantitative and qualitative sampling at each site are available upon request from NEORSD WQIS Division.

The overall aquatic macroinvertebrate community in the stream was evaluated using Ohio EPA's Invertebrate Community Index (ICI). The ICI consists of ten community metrics (Table 13), each with four scoring categories. Metrics 1-9 are based on the quantitative sample, while Metric 10 is based on the qualitative EPT taxa collected. The sum of the individual metric scores result in the overall ICI score. This scoring evaluates the macroinvertebrate community against Ohio EPA's reference sites for each specific eco-region. The WWH ICI criterion in the EOLP ecoregion is 34 (Table 14) and a site is considered within NSD if the score falls within 4 ICI units.

Table 13. ICI Metrics
Total Number of Taxa
Number of Mayfly taxa
Number of Caddisfly taxa
Number of Dipteran taxa
Percent Mayflies
Percent Caddisflies
Percent Tanytarsini Midges
Percent Other Diptera and Non-Insects
Percent Tolerant Organisms (as defined)
Number of Qualitative EPT Taxa

Table 14. Invertebrate Community Index (ICI) Range for EOLP Ecoregion							
Ohio EPA Narrative	Very Poor	Poor	Fair	Marginally Good	Good	Very Good	Exceptional
ICI Score	0-6	8-12	14-28	30-32	34-40	42-44	46-60
Ohio EPA Status	Non-Attainment			NSD	Attainment		
NSD – Non-Significant Departure of WWH attainment							

Results and Discussion

Rocky River West Branch

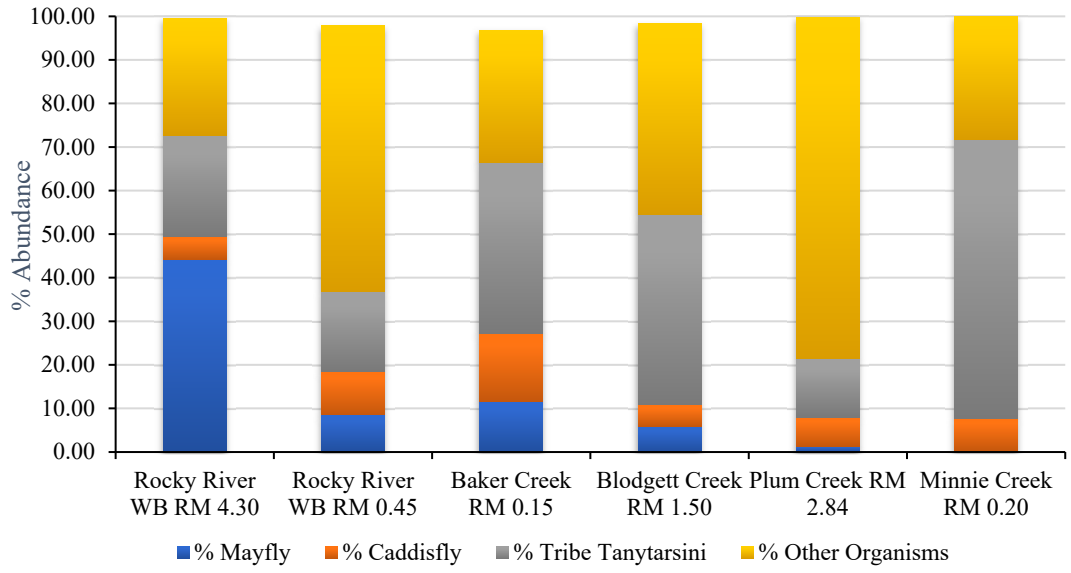
The Rocky River West Branch macroinvertebrate scores varied as RM 4.30 scored a 34 (*Good*) and RM 0.45 scored a 24 (*Fair*) (Table 15). An evenly distributed macroinvertebrate community was observed at RM 4.30 in 2019, with mayflies comprising 44.3% of the HD and 26.8% non-EPT taxa (Figure 9). A shift in community structure was noted between RM 4.30 and 0.45; the proportion of mayfly taxa fell to 8.9% and non-EPT taxa comprised >60% of the HD. No tolerant macroinvertebrates were collected at RM 4.30, increasing to 13.9% at RM 0.45. Sensitive species also seemed to decrease in abundance in the Rocky River West Branch, as 28.3% of the HD sample were sensitive at RM 4.30, falling to only to 10.0% at RM 0.45. None of the ten ICI metrics at RM 0.45 scored a 6, with two receiving a score of zero, yielding its non-attainment *Fair* narrative. RM 4.30, however, did meet WWH attainment, as all metrics scored two or greater, displaying a functional macroinvertebrate community.

Table 15. 2019 Rocky River West Branch and Select Tributaries Results

Location	RM	ICI Score	Density Qt. (ft^2) /Ql.	Ql./ Total Taxa	Ql. EPT Taxa	Qt. % Tolerant/ Sensitive taxa	Predominant Organism on natural substrates
Rocky River West Br.	4.30	34	1213/M	35/43	10	0.0/28.3	Flathead mayflies, baetid mayflies
	0.45	24*	777/M-H	29/48	10	13.9/10.0	Chironomids / hydropsychid caddisflies
Baker Creek	0.15	44	688/M	23/38	9	2.9/11.8	Flathead mayflies, isopods, philipotid mayflies, hydropsychid caddisflies
Blodgett Creek	0.15	36	1761/M	21/41	6	18.8/1.6	Midges, baetid mayflies
Plum Creek	2.84	26*	1434/M-L	28/40	6	26.0/0.5	Flatworm, heptageniid mayflies
Minnie Creek	0.20	42	2165/L	14/32	4	3.9/52.0	Flatworms, isopods

*Significant departure from biocriterion (score >4 ICI units)
Qt. Quantitative sample collected on Hester-Dendy artificial substrates
Ql. Qualitative sample collected from natural stream substrates
Qualitative sample relative density: L=Low, M=Moderate, H=High
Sensitive Taxa: Taxa listed on the Ohio EPA Macroinvertebrate Taxa List (2019) as MI (*Moderately Intolerant*) or I (*Intolerant*)

Figure 9. 2019 Rocky River W. Branch & Tribs Macroinvertebrate Community Composition



The physical habitat at RM 4.30 displayed embedded, yet good riffle quality, as the substrate consisted of course sandstone rock, fractured shale, and glacial till deposits. Fair margin habitat at RM 4.30 displayed functional root mats, tree roots, and woody debris. At RM 0.45, unembedded substrates included fractured shale, boulder, cobble, and sand, with shale bedrock encompassing most of the riffle and run habitat.

Both Rocky River West Branch sites both saw a decline in ICI scores when compared to Ohio EPA scores in 2012 (RM 4.30) and 2014 (RM 0.45) (Figure 10). At RM 4.30, the decline in ICI score was only four units with both years achieving WWH attainment. However, RM 0.45 saw a decrease from a score of 46 (*Exceptional*) in 2014 to 24 (*Fair*) in 2019. Ohio EPA narrative ratings that are not included in Figure 10 include *Good* at RM 0.45 (1992), *Marginally Good* at RM 4.30 (1992), and *Exceptional* at RM 0.45 (1997). The 2019 RM 0.45 ICI score is the only score not to achieve WWH attainment on the Rocky River West Branch since 1981. With bacteria densities the only measurable chemical parameter exceeding aquatic life or recreational criteria, the poor macroinvertebrate habitat complexity at RM 0.45 is likely limiting its community performance.

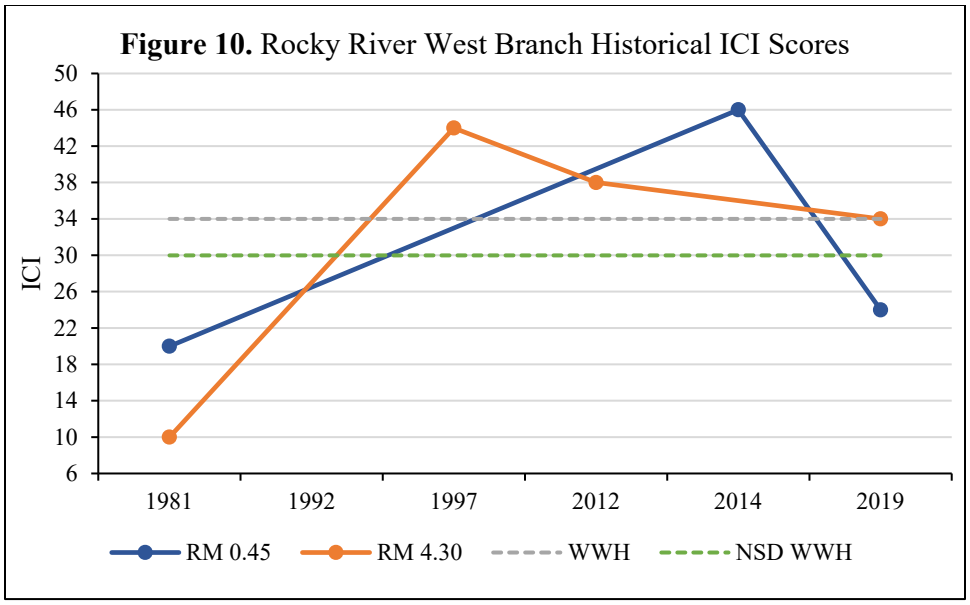


Figure 10. Rocky River West Branch Historical ICI Scores

Baker Creek

The macroinvertebrate community in Baker Creek scored *Very Good* with a score of 44. EPT taxa were well represented, making up 9 of the 23 total qualitative taxa. Community structure seemed to be fully intact as EPT and non-EPT taxa displayed evenness across groups. Less than 3% of all organisms collected in the HD were classified as tolerant species, compared to nearly 12% classified as sensitive. High quality EPT taxa were the predominant organisms on natural substrates during qualitative sampling. Improvements to water quality in 2019 are noted, as Ohio EPA monitoring in 1993 indicated a *Fair* macroinvertebrate community predominated by pollution-tolerant midges, displaying significant organic degradation.

Since no fish community assessment or QHEI was performed on Baker Creek in 2019, all habitat data is derived from the macroinvertebrate crew field sheets. The riparian zone on river right has been eliminated as an urban housing development has completely encroached on the stream. Substrate within the reach consisted of moderate to fine sized, unembedded substrates, promoting a well suited macrohabitat. The sampling reach consisted of riffle and runs with no pool present. Margins quality was fair, with root mats and aquatic macrophytes present. Moving forward, attention should be paid to the impact of development in the Baker Creek watershed, which poses the risk of causing excessive erosion and sedimentation and may jeopardize attainment of the stream's biota.

Blodgett Creek

Blodgett Creek displayed a *Good* macroinvertebrate community and met its ALU designation. Caddisflies, mayflies, and tribe tanytarsini midges were all well represented, although mayflies displayed poor diversity among taxa. Although in attainment, a high proportion of tolerant taxa (18.8%) and low proportion sensitive taxa were collected (1.2%), indicating lingering water quality issues. The fine benthic substrates in this section of Blodgett Creek do not necessarily promote adequate interstitial spaces for macroinvertebrates to colonize. No pools were present in the reach, with good riffle and margin habitat quality consisting mostly of overhanging grasses and rootmats.

Vast improvements to water quality in Blodgett Creek have been observed over the last 30 years. The Ohio EPA noted in 1993; "during low flow conditions, Blodgett Creek appeared to be comprised entirely of WWTP effluent." Results from the 1993 sampling on lower Blodgett Creek displayed a community predominated by pollution-tolerant midges and a low taxa diversity. Since the removal of the two WWTPs in 1995, moderate taxa diversity and improved biological scores are now observed, although pollution-tolerant midges are still one of the most common taxa collected during qualitative sampling.

Plum Creek

Plum Creek displayed a *Fair* macroinvertebrate community assemblage in 2019 and failed to meet its WWH designation. The organism density from natural substrates was moderate-low and the HD yielded a community with very high proportions of non-EPT taxa (Figure 9) and tolerant organisms. Six EPT taxa were collected in the qualitative sample with a total of 40 taxa collected between the two methods. Plum Creek displayed the highest proportion tolerant taxa (26.0%) and the lowest proportion sensitive taxa (0.54%) of any site assessed in this report, indicating a significant impairment of the macroinvertebrate community.

Historical data retrieved from Ohio EPA shows similar macroinvertebrate scores, ranging from *Fair* to *Marginally Good*. Moderate to heavy silt and solids were deposited around the HD upon retrieval, indicating high sediment loading, commonly found in developing watersheds. As stated in the Ohio EPA Rocky River Report (1999b), sediment from construction site runoff and changes in flow regime and stormwater runoff will present ongoing threats to the biota of this stream. The physical waterfall at the mouth of Plum Creek should not limit the performance of the macroinvertebrate community, as they can migrate upstream in their terrestrial life form, suggesting other water quality issues may be negatively impacting the benthic community.

Minnie Creek

Minnie Creek at RM 0.20 supported a *Very Good* macroinvertebrate community, receiving an ICI score of 42. Fourteen taxa were collected in the qualitative sample, four of which are classified as EPT taxa. Sensitive species comprised greater than 52% of the community and greatly outnumbered tolerant taxa. A well represented tribe tanytarsini group (facultative to moderately intolerant) comprised 63.9% of the community, while mayflies were nearly absent at 0.19%. Overall, macrohabitat displayed poor riffle and margin habitat as moderate and fine substrates were noted and the riffles were moderately embedded. Even with the waste loads allocated to Minnie Creek by the Columbia Park Water System MHP, it seems this stream has the ability to assimilate the gross water pollution as both the fish and macroinvertebrate community reflect warmwater communities.

Conclusions

During the 2019 field sampling season, Baker Creek displayed full attainment of its existing ALU designation given available data (macroinvertebrate assessment only). An Ohio EPA fish community assessment performed in 2014 supports full WWH attainment, as it received a score of 40 (*Good*). Given the performance of the IBI, QHEI, and ICI scores in Minnie Creek, this stream appears to be an ideal candidate, and is recommended for WWH ALU designation.

The Rocky River West Branch met WWH attainment in at least one of the three metrics, but the ICI score at RM 0.45 and MIwb score at RM 4.30 did not meet their WWH criterion goals (Table 16).

Table 16. 2019 Rocky River West Branch and Tributaries Biomonitoring Results

RM	IBI	MIwb	ICI	QHEI	Attainment Status	Cause(s)	Source(s)
Rocky River West Branch (WWH Existing)							
4.30	41	7.2*	34	74.50	PARTIAL	Nutrient enrichment	HSTS, urban stormwater runoff
0.45	42	8.7	24*	76.50	PARTIAL	Nutrient enrichment	HSTSs, poorly treated wastewater
Baker Creek (WWH Existing)							
0.15	--	--	44	--	(FULL)		
Blodgett Creek (WWH Existing)							
1.50	26*	--	36	65.75	NON	Unknown toxicity, nutrient enrichment	Industrial and urban stormwater runoff, HSTSs
Plum Creek (WWH Existing)							
2.84	28*	--	26*	70.00	NON	Bacteria, nutrient enrichment, natural sources	HSTS, Plum Creek WWTP, physical stream barrier
Minnie Creek (WWH Recommended)							
0.20	38[ns]	--	42	68.75	WWH Recommended	Nutrient enrichment	Columbia Park Water Systems MHP, HSTSs

*Significant departure from biocriterion (> 4ICI; > 4IBI; > 0.5 MIwb units). Underlined scores are in the *Poor* or *Very Poor* narrative range
[ns] non-significant departure from biocriterion (≤4IBI; ≤0.5 MIwb units)
() Not all bioassessment methods were performed

The two Rocky River West Branch locations averaged a QHEI score of 75.5 while the three tributaries averaged a score of 68.2, both exceeding Ohio EPA's QHEI target scores and suggest sufficient reach-based habitat exists to support warmwater fish communities. Benthic aggradation was observed at Plum Creek, Blodgett Creek, and Minnie Creek as evidence of the moderate-high substrate embeddedness and moderate-heavy silt cover, which is common in urban streams. Past hydromodifications to Blodgett Creek within the sampling reach to accommodate a recreation field (river right) and a gravel access road (river left) has incised the stream and reduced streamside buffer area and connectivity to available floodplain. Baker Creek experiences riparian encroachment attributable to streamside urban development, where single family homes border the river right streambank. All sites displayed good riffle/run/pool development, adequate pool depth, and low ratios (<1.0) of MWH+1 / WWH+1 attributes. Except for the Rocky River West Branch RM 0.45, all locations displayed four or more MWH moderate influence attributes, with three sites displaying the high influence attribute of sparse/no cover. Although numerous MWH attributes were observed, QHEI scores > 60 (Table 8) display that the urban landscape is not significantly impacting available fish habitat.

Both Rocky River West Branch sites displayed sound structural and functional components as IBI scores met WWH attainment (Table 12). However, RM 4.30 did not meet its ALU attainment for the MIwb component. Daily mean flows were higher on the first electrofishing pass (Table 9), with lower fish community scores correlating to the seasonally higher flow conditions. Historical daily median flow values for early July are between 30-50 CFS. The Ohio EPA Biocriteria Manual (1987b) states electrofishing should be conducted during normal summer flow and clarity, which can vary from year to year. With the unusually wet early summer conditions, these slightly elevated stream conditions were considered *normal low flow conditions* but may have negatively affected fish community scores. The second electrofishing events, both taken during below median flow conditions, yielded attainment of their ALU designations, with RM 0.45 receiving an *Exceptional* score for the MIwb component. Flow in the Rocky River West Branch may account for up to 23 CFS based off design flow from upstream WWTPs and may make up a significant proportion of the flow during extended drought conditions. Pollution stresses are potentially the greatest during these low flow conditions. Since the second pass electrofishing events both yielded attainment of their ALU designation during below median flows, it appears adequate water quality and WWH attainment of the fish community scores are being achieved in the Rocky River West Branch at these two sample locations.

The macroinvertebrate community in the Rocky River West Branch achieved WWH attainment only at RM 4.30, as RM 0.45 received a *Fair* narrative. The RM 0.45 sample location has eroded down to bedrock throughout nearly the entire reach. Poor margin quality, riffle habitat, lack of pool habitat, and the predominately bedrock substrate composition pose limitations to macroinvertebrate community performance at this site.

Of the tributaries, Minnie Creek is the only stream to achieve a score in full attainment of WWH criterion, with Baker Creek likely to achieve attainment if fish data were collected. All tributaries displayed excessive bacteriological loading, which is likely human sewage, as evident from the high *E. coli* densities. The Blodgett Creek macroinvertebrate community seems to have re-established a viable population throughout the stream, as macroinvertebrate assessments in recent years have scored 42 *(Very Good)* in 2012, *Marginally Good* in 2014, and 36 *(Good)* in 2019. However, no specialized insectivore feeding fish species were collected in either survey. Along with the high proportion of tolerant fish and the absence of intolerant fish, either periods of toxicity, as evident from the copper OMZM exceedance, or the inability of fish to re-colonize this section of Blodgett Creek appear to be influencing the performance of fish community scores.

Plum Creek has historically been degraded, as the 1997 Ohio EPA report outlined organic and nutrient enrichment as the main cause of non-attainment, resulting in the development of a TMDL in 2001. Nutrient sampling during the 2019 season displayed results below the TMDL target concentrations with no exceedance of DO minimum during the five sampling events. Although improved measurable chemical water quality has been observed, neither the fish nor macroinvertebrate communities are achieving ALU attainment. The waterfall near the confluence of the Rocky River West Branch will continue to prevent fish from re-colonizing a historically polluted stream, but the macroinvertebrate community should improve with water quality.

Two former golf courses in which Baker Creek intersects (Riverside Golf Course ≈ 86 acres and Emerald Woods Golf Course ≈ 300 acres) have been bought by developers and are

planned to be developed into single family homes with sanitary sewer connections. Along with the parceling and sales of old farm field properties, increased development will vastly change the impervious surface landscape in the Baker Creek watershed. Development within the Baker Creek, Plum Creek, and the Rocky River West Branch watersheds is ongoing and attention to the impacts that land use changes will have on both flow regime and water quality is needed to prevent deterioration of its biota.

The NEORSD has recently completed pre-monitoring for septic tank to sanitary sewer conversions in Olmsted Falls (Rocky River West Branch and Minnie Creek watersheds) and Strongsville (Baker Creek watershed). In addition to these projects, NEORSD has recently completed sampling for the Southwest Interceptor Local Sanitary Sewer Evaluation Study. This study will evaluate and prioritize potential water quality problems including excessive peak wet-weather flows to district facilities, sanitary sewer overflows, urban stormwater runoff, illicit discharges to storm sewers, and failing septic systems. As NEORSD and local municipalities work together to reduce sewage and control urban stormwater runoff to the environment, a reduction in pollutants entering the streams and an improved overall water quality will likely follow.

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References:

Ohio Environmental Protection Agency. (1987a). *Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters* (Updated January 1988; September 1989; November 2006; August 2008). Columbus, OH: Division of Water Quality Monitoring and Assessment.

Ohio Environmental Protection Agency. (1987b). *Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities* (Updated September 1989; March 2001; November 2006; and August 2008, June 2015). Columbus, OH: Division of Water Quality Monitoring and Assessment.

Ohio Environmental Protection Agency. (1989). *The Qualitative Habitat Evaluation Index [QHEI]: Rationale, Methods, and Application.* Columbus, Ohio: Ecological Assessment Section Division of Water Quality Planning & Assessment

Ohio Environmental Protection Agency. (1993). *Biological and Water Quality Study of the Rocky River and Selected Tributaries*. Columbus, OH: Division of Surface Water.

Ohio Environmental Protection Agency. (1999a). *Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams*. Columbus, OH: Ohio EPA Technical Bulletin.

Ohio Environmental Protection Agency. (1999b). *Biological and Water Quality Study of the Rocky River and Selected Tributaries*. Columbus, OH: Division of Surface Water.

Ohio Environmental Protection Agency. (2001). *Total Maximum Daily Loads for the Rocky River Basin.* Columbus, OH: Division of Surface Water

Ohio Environmental Protection Agency. (2005). *Total Maximum Daily Loads for Bacteria in the Rocky River Watershed*. Columbus, OH: Division of Surface Water.

Ohio Environmental Protection Agency. (2006a). *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)* (Ohio EPA Technical Bulletin EAS/2006-06-1). Columbus, OH: Division of Surface Water, Ecological Assessment Section.

Ohio Environmental Protection Agency. (2006b). *2006 Updates to Biological Criteria for the Protection of Aquatic Life: Volume II and Volume II Addendum. Users Manual for Biological Field Assessment of Ohio Surface Waters.* Columbus, OH: Division of Surface Water.

Ohio Environmental Protection Agency. (2015). *Proposed Stream Nutrient Assessment Procedure*. Columbus, OH: Division of Surface Water, Ohio EPA Nutrients Technical Advisory Group.

Ohio Environmental Protection Agency. (2018a). *Surface Water Field Sampling Manual for water quality parameters and flows.* Columbus, OH: Division of Surface Water.

Ohio Environmental Protection Agency. (2018b). *State of Ohio Water Quality Standards Ohio Administrative Code Chapter 3745-1* (Effective January 2, 2018). Columbus, OH: Division of Surface Water, Standards and Technical Support Section.

Ohio Environmental Protection Agency. (2019) *Ohio EPA Macroinvertebrate Taxa List*. Columbus, OH: Division of Surface Water.

Ohio Environmental Protection Agency (n.d.). *List Individual NPDES Permits by County.* Division of Surface Water.

Rankin, E.T. (1995). *Habitat indices in water resource quality assessments.* In W.S. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Risk-based Planning and Decision Making (pp. 181-208). Boca Raton, FL: Lewis Publishers.

U.S. Environmental Protection Agency. *Enforcement and Compliance History Online* (ECHO). Detailed Facility Report - Columbia MHP.

The Waterfall Record. *Plum Creek Falls, Ohio*. https://waterfallrecord.com/2009/08/19/plum-creek-falls-ohio/

Yoder, C.O. and E.T. Rankin. (1996). *Assessing the condition and status of aquatic life designated uses in urban and suburban watersheds*, pp. 201-227. In Roesner, L.A. (ed.). Effects of Watershed Development and Management on Aquatic Ecosystems, American Society of Civil Engineers, New York, NY.