

NORTHEAST OHIO REGIONAL SEWER DISTRICT

2015-2016 Mill Creek Environmental Monitoring: Biological, Water Quality, and Habitat Survey Results

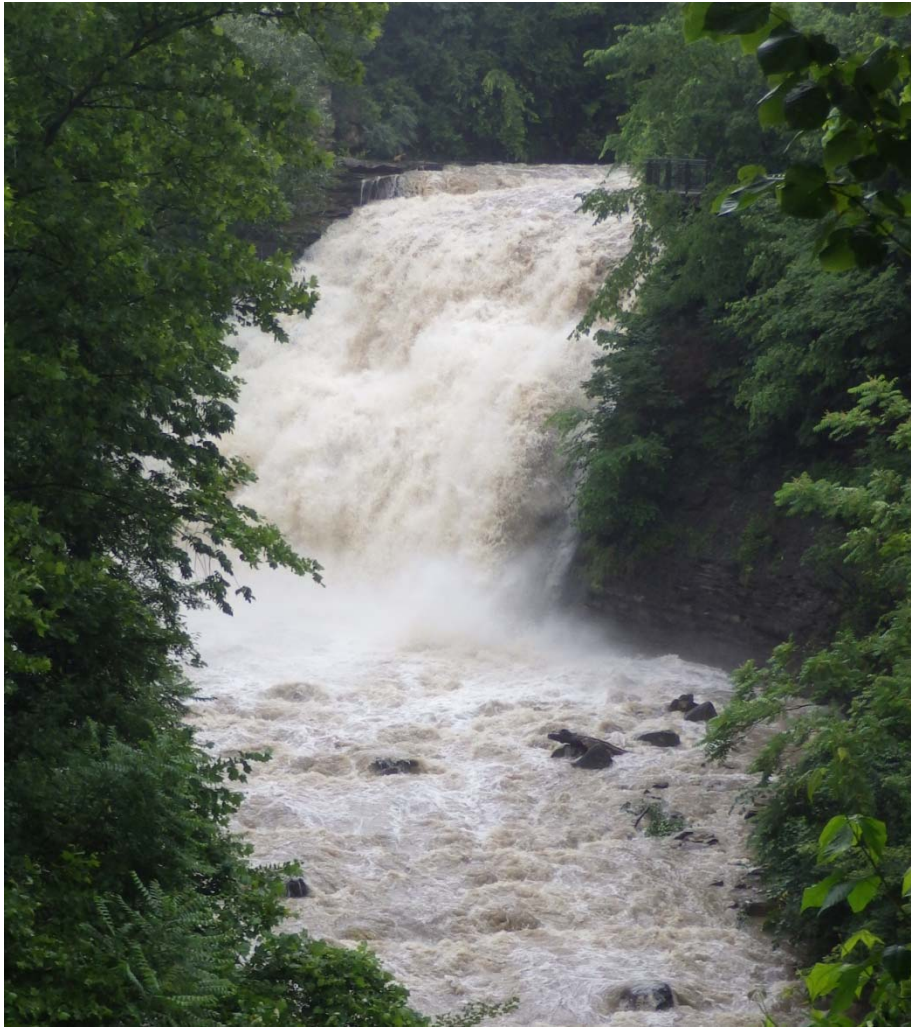


Photo: Mill Creek Falls on June 25, 2014, upstream of Mill Creek River Mile 2.75

**Prepared by
Water Quality and Industrial Surveillance Division**

Introduction

In 2015 and 2016, the Northeast Ohio Regional Sewer District (NEORS) conducted stream monitoring activities at four sites on Mill Creek, an urbanized tributary to the Cuyahoga River. NEORS assessed habitat and water chemistry conditions and evaluated the health of the fish and benthic macroinvertebrate communities at each site. The purpose of the monitoring was to continually track the health of the creek and evaluate potential impacts. The four sites, which are along Mill Creek's Main Branch, were located at river miles (RM) 8.30, 2.75, 0.70, and 0.12. Mill Creek has a natural waterfall preventing the upstream migration of fish at RM 2.80. The waterfall drops approximately 48-feet from the top to the bottom. These sites were first surveyed in 1995 as part of the Mill Creek Watershed Management Project, and were all surveyed yearly from 2011 to 2016.

The survey sites were in support of several NEORS capital improvement projects designed to provide wet-weather flow relief, stormwater storage capacity, and reduction/elimination of CSOs for several communities in the Mill Creek watershed. The Miles Avenue Relief Sewer (MARS) and the Lee Road Relief Sewer (LRRS) were completed in May 2012. The LRRS connects to the Mill Creek Tunnel, the third and final leg of which was completed in February 2013. In addition, NEORS completed a bank stabilization project on Mill Creek near Warner Road (RM 0.30) in April 2013. NEORS monitors RMs 0.12 and 8.30 as required by their Combined Sewer Overflow (CSO) permit. The watershed monitoring surveys will assist in evaluating improvements in the health of Mill Creek as a result of these projects.

Stream monitoring activities were conducted at each site by NEORS Level 3 Qualified Data Collectors certified by Ohio EPA in Fish Community Biology, Benthic Macroinvertebrate Biology, Chemical Water Quality, and Stream Habitat Assessment as explained in the NEORS Study Plans *2015 Mill Creek Environmental Monitoring* and *2016 Mill Creek Environmental Monitoring* approved by Ohio EPA on June 17, 2015, and May 17, 2016, respectively. The results obtained from these assessments were evaluated using the Ohio EPA's Qualitative Habitat Evaluation Index (QHEI), Index of Biotic Integrity (IBI), and Invertebrate Community Index (ICI). Water chemistry data was validated per the methods outlined by the Ohio EPA *Surface Water Field Sampling Manual for water quality parameters and flows* (2015) and compared to the Ohio Water Quality Standards (Ohio EPA, 2017) to determine attainment of applicable uses. An examination of the biological information was used in conjunction with the water quality data and QHEI results in order to assess the health of the stream, and the results were compared to historical data to show temporal as well as spatial trends.

Figure 1 is a map of the sampling locations on Mill Creek, and Table 1 lists the sampling locations and their respective river mile, latitude/longitude, site description, and

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surveys conducted. A digital photo catalog of the sampling locations is available upon request by contacting the NEORSD Water Quality and Industrial Surveillance (WQIS) Division.

Table 1. Mill Creek Sampling Locations

Location	Latitude	Longitude	River Mile	Location Information	Purpose¹
Upstream of Mill Creek Falls	41.4422	-81.6216	8.30	Upstream of South Miles Road, first site upstream of NEORSD CSOs	Evaluate overall watershed health, monitor in support of Capital Improvement projects. Site required by Ohio EPA NPDES Permit No. 3PA00002*HD ²
Downstream of Mill Creek Falls	41.4451	-81.6271	2.75	Downstream of the Mill Creek Falls	Evaluate overall watershed health, monitor in support of Capital Improvement projects
Upstream of Warner Road Tributary	41.4240	-81.6376	0.70	Upstream of the Warner Road Tributary, adjacent to 5000 Warner Road	Evaluate overall watershed health, monitor in support of Capital Improvement projects
Upstream of Canal Road	41.4178	-81.6387	0.12	Upstream of Canal Road	Evaluate overall watershed health, monitor in support of Capital Improvement projects. Site required by Ohio EPA NPDES Permit No. 3PA00002*HD ²

¹ Water Chemistry, habitat, fish, and benthic macroinvertebrates were evaluated at each site.
² Water chemistry and benthic macroinvertebrate monitoring was required at RM 0.12 and RM 8.30 by Ohio EPA NPDES Permit No. 3PA00002*HD.

Mill Creek Monitoring Sites

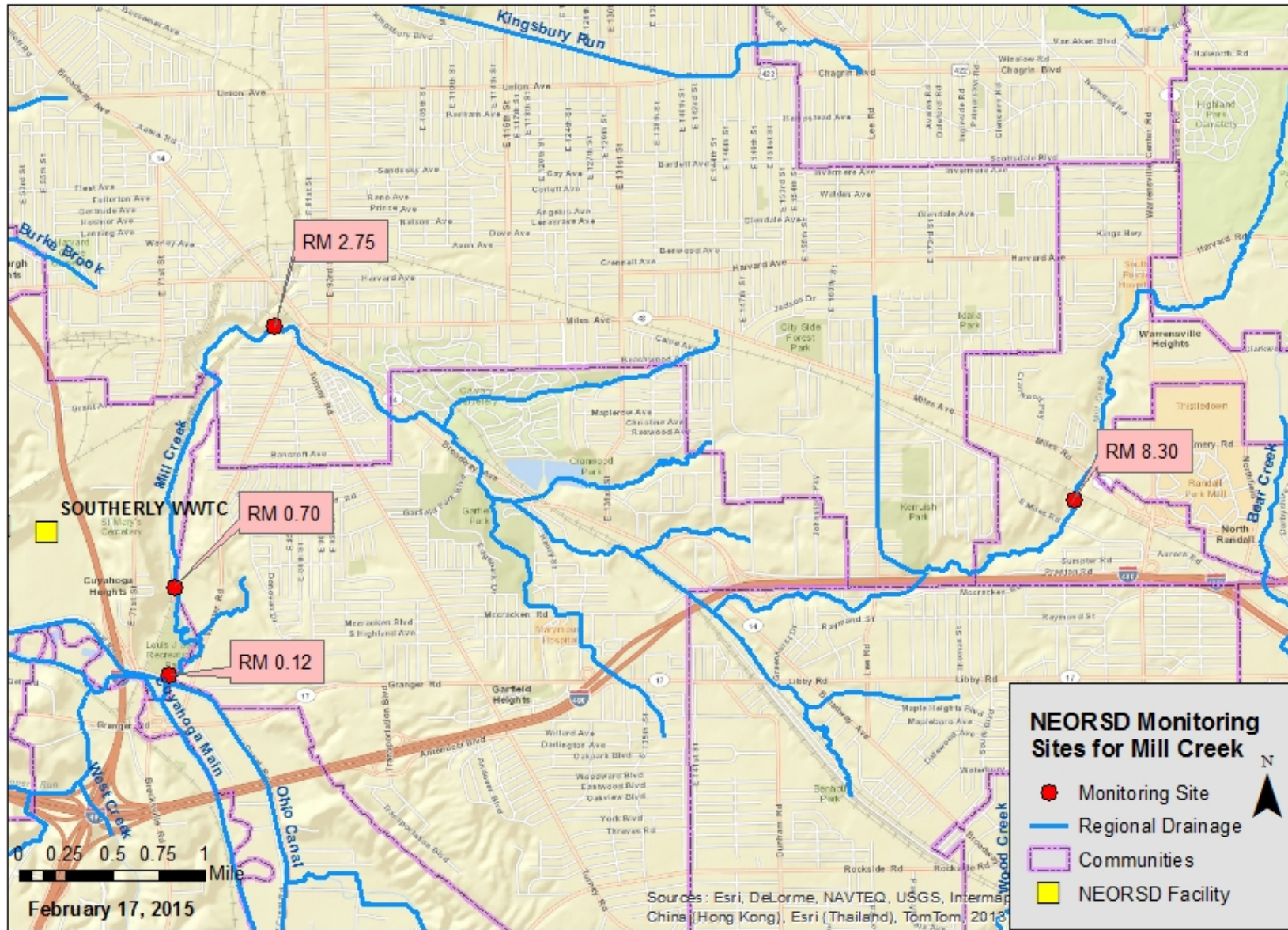


Figure 1. Sampling Locations

Water Chemistry Sampling

Methods

Water chemistry and bacteriological sampling was conducted five times each on Mill Creek at RMs 8.30, 2.75, 0.70, and 0.12 in both 2015 and 2016. The locations at RMs 8.30 and 0.12 are also sampled to fulfill permit requirements under Ohio EPA NPDES Permit Number 3PA00002*HD. 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 a 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- μ m PVDF syringe filter. All water quality samples were collected as grab samples. Bacteriological samples were collected in sterilized plastic bottles preserved with sodium thiosulfate. At the time of sampling, measurements for dissolved oxygen, pH, temperature, and conductivity were collected using an 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).

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

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, 2013a).

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

X = sample/detection limit ratio

Those RPDs that are 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.

Water chemistry analysis sheets for each site are available upon request from the NEORSD WQIS Division.

Results and Discussion

One field blank (RM 0.12 on June 23, 2015) and two duplicate samples (RM 0.12 on June 30, 2015; RM 2.75 on July 7, 2015) were collected during the 2015 study. Two field blanks (RM 0.12 and RM 2.75 on June 22, 2016 and July 13, 2016) and two duplicate samples (RM 0.70 on July 6, 2016; RM 8.30 on July 13, 2016) were collected during the 2016 study. For the 2015 field blanks, there was only one parameter that showed possible contamination, tin (Sn). For the 2016 field blanks, there were three parameters that showed possible contamination, chemical oxygen demand (COD), chromium (Cr) and zinc (Zn). It is unclear how the field blanks could have become contaminated and may have been the result of inappropriate sample collection, handling, contaminated blank water and/or bottles. Table 2 lists water quality parameters that were qualified based on Ohio EPA (2015) data validation protocol. Field blanks were only compared to samples collected by the same crew on the same day for a single study plan.

Table 2. 2015, 2016 Data Qualified Based on Applicable Field Blank Comparison					
RM	Date	Parameter	Sample Result	Field Blank Result	Qualifier Added
0.12	06/23/15	Sn	j0.618	j0.162	Trend
0.12	06/22/16	Cr	j0.903	j0.68	Estimated
0.12	07/13/16	COD	j13	j2.8	Estimated
0.70	06/23/15	Sn	j0.801	j0.162	Trend
0.70	06/22/16	Cr	j0.96	j0.68	Estimated
2.75	06/23/15	Sn	1.315	j0.162	Estimated
2.75	06/22/16	Cr	j0.714	j0.68	Estimated
2.75	07/13/16	COD	j2.3	j2.8	Rejected
8.30	06/23/15	Sn	j0.255	j0.162	Rejected
8.30	06/22/16	Cr	j0.959	j0.68	Estimated
8.30	07/13/16	COD	j17.9	j2.8	Estimated
8.30	07/13/16	COD	j17.2	j2.8	Estimated
8.30	06/22/16	Zn	j2.347	j0.69	Trend
j- >MDL but <PQL MDL – Method Detection Limit PQL – Practical Quantification Limit					

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In 2015, only one of the duplicate samples collected had parameters in which the RPD between the sample results was greater than acceptable (Table 3). In 2016, both of the duplicate samples collected had parameters in which the RPD between the sample results was greater than acceptable (Table 3). Potential sources of contamination include lack of precision and consistency in sample collection and/or analytical procedures, environmental heterogeneity and/or improper handling of samples. An analysis of paired parameters for all sites showed no issues with any of the samples.

Table 3. 2015, 2016 Duplicate samples with greater than acceptable RPDs					
Rive Mile	Date	Parameters	Acceptable RPD	Actual RPD	Qualifier Added
0.70	07/06/16	Al	45.7	59.1	Reject
2.75	07/07/15	Ti	33.6	123.2	Reject
8.30	07/13/16	Cr	99.7	155.7	Reject
		TDS	15.8	41.5	Reject

All four sites on Mill Creek are designated as warmwater habitat (WWH), agricultural water supply, industrial water supply, and primary contact recreation waters. Exceedances of the water quality standards associated with these uses occurred for multiple parameters. The bacteriological criteria for *E. coli* are comprised 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 primary contact recreation, these criteria are 126 colony counts/100mL and 410 colony counts/100mL, respectively. The geometric mean criterion and the statistical threshold criterion values were exceeded at all four sites (Table 4) for all periods in 2015 and 2016. Wet-weather¹ sampling events coincided with the extremely elevated bacterial levels found during sampling. Other potential sources of *E. coli* found during dry weather events could be illicit discharges, animal waste, and flow from upstream tributaries.

¹NEORS D considers a sampling event to be affected by wet weather, when: 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.

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Table 4. 2015, 2016 Mill Creek <i>E. coli</i> Densities (most probable number/100mL)				
Date	RM 8.30	RM 2.75	RM 0.70	RM 0.12
06/16/15*	38,350	10,150	11,164	10,864
06/23/15*	51,200	86,000	93,400	88,200
06/30/15*	1,012	1,590	760	971**
07/07/15*	567	663.5**	383	250
07/14/15*	2,388	698	538	882
06/15/16	1026	303	266	296
06/22/16	462	424	293	354
06/29/16	441	731	799	328
07/06/16	1016	1190	758**	736
07/13/16	568**	432	188	386
*Wet-weather event				
** Duplicate sample taken- results are averaged				

Coinciding with the two of the wet-weather events, were four Cu (copper) exceedances and one exceedance for Zn (zinc) at sampling locations downstream of the falls (Table 5). The copper result was greater than twice the criterion on June 23, 2015 at all three locations.

Table 5. 2015, 2016 Mill Creek Parameter Exceedances					
RM	Date (Range)	Parameter	Type	Result	Criterion
0.12	06/23/15	Cu	OMZM	32.58	14.66
0.70	06/16/15	Cu	OMZM	17.76	17.27
	06/23/15	Cu	OMZM	35.15	15.45
2.75	06/23/15	Cu	OMZM	44.48	17.53
		Zn	OMZM	152.2	146.71

Mercury analysis for all of the sampling events was performed using EPA Method 245.1. The detection limit for this mercury method is above the Human Health Nondrinking Water and Protection of Wildlife Outside Mixing Zone Averages (OMZA), so it generally cannot be determined if the water body was in attainment of those criteria.

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Instead, this type of mercury sampling was used as a screening tool to determine whether contamination was present above the detection limit. In both 2015 and 2016, each site had at least one mercury result above the method detection limit (MDL). However, no site had more than two samples above the MDL and all sample results were below the practical quantitation limit.

One other aspect of water quality that was examined in the Mill Creek in 2015 and 2016 was that of nutrients. In 2013, Ohio EPA convened a technical advisory group to develop recommendations to determine if stream segments have been adversely affected by nutrients. The recommendations from the group were submitted to Ohio EPA in 2015 in the form of a “Stream Nutrient Assessment Procedure” (SNAP)(Ohio EPA, 2015) Within these recommendations were a table of total phosphorus (TP) and dissolved inorganic nitrogen (DIN) concentrations associated with various ecological conditions. The geometric means of these concentrations were then used to determine the potential for nutrient enrichment in Mill Creek (Table 6).

For the sites located upstream of Mill Creek Falls in 2015, the concentrations that were measured were considered to be “Levels typical of modestly enriched condition in nitrogen limited systems; low risk to beneficial use if allied responses are within normal ranges.” For the sites downstream of the falls in 2015, the concentrations were “Levels typical of enriched condition; low risk to beneficial use if allied responses are within normal ranges.” In 2016, the geometric mean nutrient concentrations were lower at all four sites compared to 2015. Above the falls, the concentrations that were measured were considered to be “Levels typical of enriched condition; low risk to beneficial use if allied responses are within normal ranges”. For the sites downstream of the falls in 2016, the concentrations were “Levels typical of working landscapes; low risk to beneficial use if allied responses are within normal ranges” and “Levels typical of developed lands; little or no risk to beneficial uses.” Although some of the concentrations that were measured indicate the potential for nutrients to be impairing the designated uses, the SNAP recommends the use of numerous other measures to determine if that is occurring. Because not all of those other measures were completed in 2015 and 2016, a full determination of impacts from nutrients could not be made.

Table 6. 2015, 2016 Mill Creek Geometric Mean Nutrient Concentrations (mg/L)					
Date	Parameter	RM 8.30	RM 2.75	RM 0.70	RM 0.12
2015	TP	0.098	0.185	0.167	0.163
2015	DIN	0.363	0.526	1.03	0.943
2015	DRP	0.033	0.047	0.034	0.259
2016	TP	0.143	0.126	0.072	0.054
2016	DIN	0.099	0.083	0.857	0.432
2016	DRP	0.111	0.091	0.022	0.006
	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 working landscapes; low risk to beneficial use if allied responses are within normal ranges				
	Levels typical of developed lands; little or no risk to beneficial uses				

Habitat Assessment

Methods

Instream habitat assessments were conducted once at all four sites (RM 0.12, RM 0.70, RM 2.75, RM 8.30) on Mill Creek in 2015 using the QHEI, and once at two sites (RM 0.12, RM 0.70) in 2016. 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. The QHEI has a maximum score of 100, and a score of 55 or more suggests that sufficient habitat exists to support a fish community that attains the warmwater habitat criterion (Ohio EPA, 2006). A more detailed description of the QHEI can be found in Ohio EPA's *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)* (2006). QHEI field sheets for each site are available upon request from the NEORSD WQIS Division.

Results and Discussion

The QHEI scores for each of the sites are shown in Table 7. A natural waterfall is located at RM 2.80. The waterfall prevents the natural passage of fish migration upstream. The evaluation of the QHEI scores upstream does, however, suggest that the

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current habitat could support a warmwater fish community for all sites both historically and presently, as they all met the target of 55 (Jeff DeShon and Dennis Mischne, personal communication, April 16, 2014).

Table 7. 2015, 2016 Mill Creek QHEI Scores					
Year	RM 8.30	Mill Creek Falls	RM 2.75	RM 0.70	RM 0.12
1995	74.00		69.50	70.50	72.00
2011	71.50		74.25	69.75	68.00
2012	72.00		73.25	72.50	64.75
2013	72.00		78.00	66.00	64.50
2014	74.00		82.50*	66.50	66.00
2015	73.50		71.50	75.75	70.25
2016	--		--	71.50	67.25
* Score obtained after the field season (10/23/14) -- Did not sample/evaluate					

Table 8 lists attributes defined by the Ohio EPA, as interpreted by NEORSD, which have both positive and negative influences on the fish community. The negative influences have been identified as attributes that can have the greatest influence on whether the system can support a WWH fish community. Please note that the habitat rating is to help determine if the habitat can support a fish community and does not necessarily reflect what type of community is actually found at the site.

It should be noted that all of the 2015 sites received a narrative rating of *Excellent* (or a score above 70 [Ohio EPA, 2006]). RMs 0.12 and RM 8.30 in 2015 showed little change compared to the almost 10-point decrease and increase of RMs 2.75 and 0.70, respectively. RM 2.75 showed a decrease in the 2015 QHEI score compared to 2014 due to the amount of instream cover reducing from a moderate amount (25-75%) to a sparse amount (5-25%), and the loss of a deep pool (>70 cm). The improvement in score for RM 0.70 in 2015 was due to more instream cover, such as rootwads and oxbows, that increased the amount from sparse to moderate.

The two sites scored in 2016 both showed a decreased QHEI score compared to 2015, but still remained consistent with past scores. The 2016 decrease can be attributed to an increase in silt, which caused embedding of the substrate.

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Table 8. Qualitative Habitat Evaluation Index Physical Attributes Summary

		Warmwater Attributes										Modified Warmwater Attributes																				
												High Influence							Moderate Influence													
River Mile	QHEI Score	Dominate Substrates: Boulder, Cobble and/or Gravel	Overall Substrate, Silt: Free	Overall Embeddedness: None or Normal	In-stream Cover Amount: Extensive or Moderate	Channel Sinuosity: Moderate or High	Channel Development: Excellent or Good	Channelization: None or Recovered	Maximum Site Depth greater than 40 cm	Current Velocity: Fast Current and Eddies	Riffle and Run Embeddedness: None or Low	Total Positive Attributes	Dominate Substrates: Silt and/or Muck	In-stream Cover Amount: Sparse or Nearly Absent	Channel Sinuosity: None	Channelization: Recent or No Recovery	Maximum Site Depth less than 40 cm	Negative High Influence Attributes	Dominate Substrate, Boat Sites Only: Sand	Substrate Origin: Hardpan	Overall Substrate, Silt: Heavy or Moderate	Overall Embeddedness: Moderate or Extensive	In-stream Cover Types: Only 1 or 2 Indicated	Channel Sinuosity: Low	Channel Development: Fair or Poor	Channelization: Recovering	Pool Width and Current Velocity: Less than or equal to Riffle Width and Intermittent, Respectively	Current Velocity: No Fast Current	Riffle Embeddedness: Moderate or Extensive	No Functional Riffle Indicated at the Site	Negative Moderate Influence Attributes	Total Negative Influence Attributes
2015 Results																																
8.30	73.50	x		x	x	x	x	x			6						0			x								x		2	2	
2.75	71.50					x	x	x			3		x				1			x		x					x	x		4	5	
0.70	75.75	x		x	x	x		x			5						0						x		x			x		3	3	
0.12	70.25			x		x	x	x		x	5		x				1			x			x							2	3	
2016 Results																																
0.70	71.5	x		x		x		x	x		5						0			x	x		x		x			x		5	5	
0.12	67.25					x	x	x			3		x				1			x	x		x					x		4	5	

Electrofishing

Methods

At least one quantitative electrofishing pass was conducted at RM 0.12, 0.70, 2.75, and 8.30 in 2015. In 2016, two quantitative electrofishing passes were conducted at both RM 0.12 and 0.70. A list of the dates when the surveys were completed, along with flow as measured at the United States Geological Survey gage station in Garfield Heights, is given in Table 9. Sampling was conducted using longline electrofishing techniques and consisted of shocking all habitat types within a sampling zone while moving from downstream to upstream. The sampling zone was 0.15 kilometers for each site. The methods that were used followed Ohio EPA protocol methods as detailed in *Biological Criteria for the Protection of Aquatic Life, Volumes II* (1987a) and *III* (1987b). Fish collected during the surveys were identified and examined for the presence of anomalies, including DELTs (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. 2015, 2016 Mill Creek Sampling Dates and River Flows

Date	Sites sampled (RMs)	Daily Mean Flow (CFS)
07/22/15	0.70	7.1
07/23/15	0.12	6.8
07/24/15	2.75	6.5
09/02/15	0.12, 8.30	7.3
09/03/15	0.70	8.1
06/20/16	0.12, 0.70	5.1
08/22/16	0.12, 0.70	9.2
From June 15 to October 15, 2015, Median Flow was 8.1 CFS From June 15 to October 15, 2016, Median Flow was 7.3 CFS *Measured at USGS 04208460 Mill Creek flow gauge in Garfield Heights, Ohio. (USGS, 2016)		

The electrofishing results for each pass were compiled and utilized to evaluate fish community health through the application of the Ohio EPA Index of Biotic Integrity (IBI). The IBI incorporates 12 community metrics representing structural and functional attributes. The structural attributes are based upon fish community aspects such as fish numbers 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 headwater are listed in Table 10.

Table 10. IBI Metrics (Headwater)
Total Number of Native Species
Number of Darters & Sculpins
Number of Headwater Species
Number of Minnow Species
Number of Sensitive Species
Percent Tolerant Species
Percent Pioneering Species
Percent Omnivores
Percent Insectivores
Number of Simple Lithophils
Percent DELT Anomalies
Number of Fish

Lists of the species, numbers, pollution tolerances and incidence of DELT anomalies for fish collected during the electrofishing passes at each site are available upon request from the NEORSWQIS Division.

Results and Discussion

Sampling on Mill Creek was completed at all four sites in 2015, and two sites in 2016. Permission from the property owners at sites 2.75 and 8.30 to conduct biological sampling was not obtained in 2016, so no assessments were done at those sites.

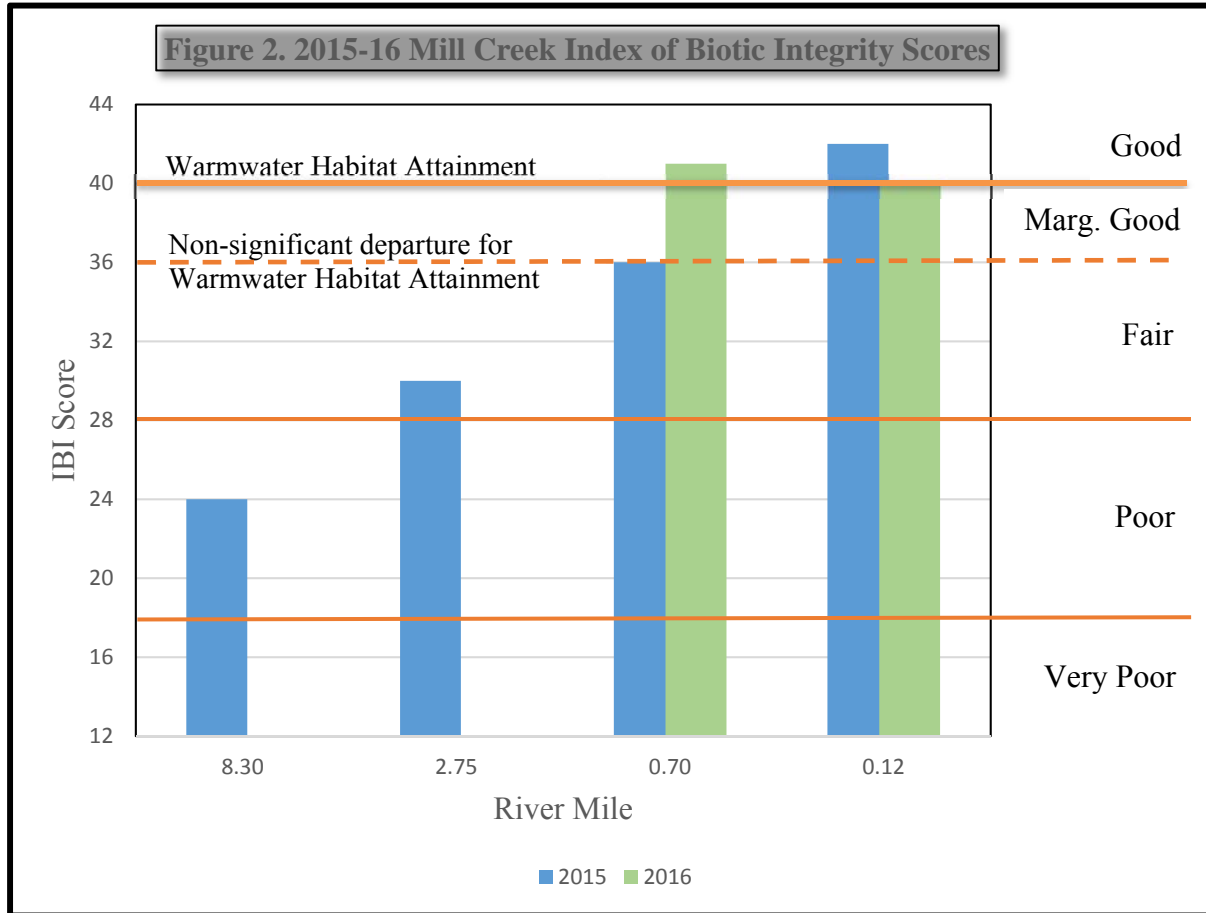
The WWH IBI criterion in the Erie-Ontario Lake Plain (EOLP) ecoregion is 40 for headwater sites. A site is considered in non-significant departure if it is within 4 IBI

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units of the criterion. Therefore, an IBI score of 36 is considered to be in attainment. The two most downstream sites, RM 0.12 and 0.70, met attainment of this criterion for the years 2015 and 2016 (Table 11). RM 2.75 was not in attainment in 2015 and the IBI score stayed consistent with previous years. RM 2.75 was not sampled in 2016. RM 8.30 has not been in attainment in any of NEORSD's assessments, and is consistently rated as poor. These four sites have scored consistently the same since 2011 (Figure 2). Please note that the scoring at RM 2.75 has been consistent since 2011 except for the year 2013. The year 2013 appears uncharacteristically high because two additional species were found (*Pimephales notatus* [bluntnose minnow] and *Clinostomus elongates* [redside dace]) during the single survey. The additional species had a total of 5 individuals in the 2013 survey and none were found in the 2012, 2014 or 2015 surveys (Table 12).

Table 11. 2015, 2016 Mill Creek IBI Results								
River Mile	Pass	Date	IBI Score	Narrative Rating	Total No. of Species	No. of Native Species	% Tolerant Species	No. of fish collected
8.30	1	09/02/15	24	Poor	4	4	99.9	677
Mill Creek Falls								
2.75	1	07/24/15	30	Fair	8	7	37.0	581
0.70	1	07/22/15	38	Marg. Good	15	15	34.3	763
	2	09/03/15	34	Fair	16	13	36.0	1276
0.70	1	06/20/16	38	Marg. Good	16	13	40.2	1060
	2	08/30/16	44	Good	24	22	44.6	1607
0.12	1	07/23/15	38	Marg. Good	22	20	31.6	700
	2	09/02/15	46	Very Good	21	20	22.9	916
0.12	1	06/20/16	36	Marg. Good	18	16	43.4	422
	2	08/30/16	44	Good	22	21	31.8	898
WWH Criterion IBI units \geq 40								
Non-significant departure from WWH criterion \geq 36 IBI units								

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Year	RM 8.30	Mill Creek Falls	RM 2.75	RM 0.70	RM 0.12
1995	13		19	19	18
2011	22		31	36	36
2012	22		30	38	38
2013	22		38	36	38
2014	22		30	37	39
2015	24		30	36	42
2016	-		-	41	40

WWH Criterion IBI units ≥ 40
 Non-significant departure from WWH criterion ≥ 36 IBI units

As reflected above, the Mill Creek Falls plays a significant role in fish passage, where the number of fish species collected above it was reduced by half. The site just downstream of the falls showed in 2013 that it has the potential for attainment, but this was based mostly on the presence of a single redbreasted dace. The removal, or replacement, of this fish from the scoring would have moved the site out of attainment. The sites below the falls had a far lesser percentage of tolerant species and greater number of fish species. The sites upstream of the falls, since 2014, have had at least 96% of the fish consisting of the highly tolerant species *Rhinichthys atratulus* (western blacknose dace) and *Semotilus atromaculatus* (creek chub).

At the sites downstream of the falls, the fish community appears healthier. For the two most downstream sites (RM 0.12, 0.70), they have consistently met the IBI criterion since 2011 and have gotten IBI scores over 40 in three of the four sampling passes conducted in 2015 and 2016. Reductions in combined and sanitary sewage and habitat stabilization projects may have allowed a greater number of migrating fish from the Cuyahoga River to move into and up the creek.

The number of darter species has also risen significantly at RMs 0.12 and 0.70. In 2015 and 2016, 92 darters (rainbow, greenside, and johnny) were collected at these two sites. Only 21 darters (rainbow and greenside) were collected during the years 2010-2014. A new species was collected at RM 0.12 in 2016, *Moxostoma erythrurum* (golden redhorse), a moderately intolerant fish that has not been previously found at any of the sites along Mill Creek. The rise in the moderately intolerant fish population, and IBI scores, at the two lower sites indicates that the water quality may be improving because these species are typically found in areas with low environmental stress (Ohio EPA, 1987b).

Overall number of species found has risen as well in 2015 and 2016. Since 2011, of the 31 times the lower sites have been sampled, only four times has there been over 20 species found during one sampling. This happened twice in 2015 and twice in 2016.

Macroinvertebrate Sampling

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 of the locations listed in Table 1 in 2015 and only two sites in 2016 (RM 0.12, 0.70). Permission to conduct biological monitoring was not obtained from the property owners of the other two sites, so no macroinvertebrate assessments were conducted there.

Methods for sampling followed the Ohio EPA’s Biological Criteria for the Protection of Aquatic Life, Volume III (1987b). The recommended period for HDs to be installed is six weeks.

The macroinvertebrate samples were sent to Third Rock Consulting (TRC) of Lexington, Kentucky 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 the NEORSD WQIS Division.

The overall aquatic macroinvertebrate community in the stream was evaluated using Ohio EPA’s Invertebrate Community Index (ICI) (Ohio EPA, 1987a, 2014a, 2014b). 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. The total of the individual metric scores result in the overall score. This scoring evaluates the community against Ohio EPA’s reference sites for each specific eco-region.

Table 13. ICI Metrics	
1.	The total number of taxa on HD.
2.	Total number of Ephemeroptera taxa on HD.
3.	Total number of Trichoptera taxa on HD.
4.	Total number of Dipteran taxa on HD.
5.	Percent of Ephemeroptera in HD sample.
6.	Percent Trichoptera in HD sample.
7.	Percent Tribe Tanytarsini midges in HD sample.
8.	Percent Dipterans (excluding Tribe Tanytarsini) and all non-insects in HD sample.
9.	Percent Tolerant organisms (as defined by metric) in HD sample.
10.	Total number of Ephemeroptera, Plecoptera and Trichoptera collected in the qualitative sample.

Results and Discussion

The WWH ICI criterion in the EOLP ecoregion is 34. A site is considered in non-significant departure if it is within 4 ICI units of the criterion and therefore would also be in attainment. Three of the four sites that were sampled in 2015 had ICI scores that met or were within non-significant departure from the criterion while an additional site was given a narrative rating of *Marginally Good*. Of the two sites sampled in 2016, one was within non-significant departure from the criterion while the other was not in non-significant departure from the criterion and received a narrative rating of *Fair* (Figure 3). Table 14

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lists the narrative ratings for the sample sites. Table 15 shows the historic ICI scores and narrative rating.

Table 14. 2015, 2016 Macroinvertebrate Results								
River Mile	Year	ICI Score	Narrative Rating	Total Number of Taxa	Number of Qualitative Taxa	Number of Qualitative EPT Taxa	Number of Qualitative Sensitive Taxa	Density (Organisms per square foot)
8.30	2015	38	<i>Good</i>	45	32	6	1	608
2.75	2015	36	<i>Good</i>	33	22	7	1	593
0.70	2015	30	<i>Marg. Good</i>	44	32	7	2	694
	2016	30	<i>Marg. Good</i>	44	35	7	2	669
0.12	2015	---	<i>Marg. Good</i>	---	27	8	2	---
	2016	28	<i>Fair</i>	38	27	6	2	286
WWH criterion is ≥ 34 ICI units Non-significant departure from WWH criterion is ≥ 30 ICI units --- not applicable								

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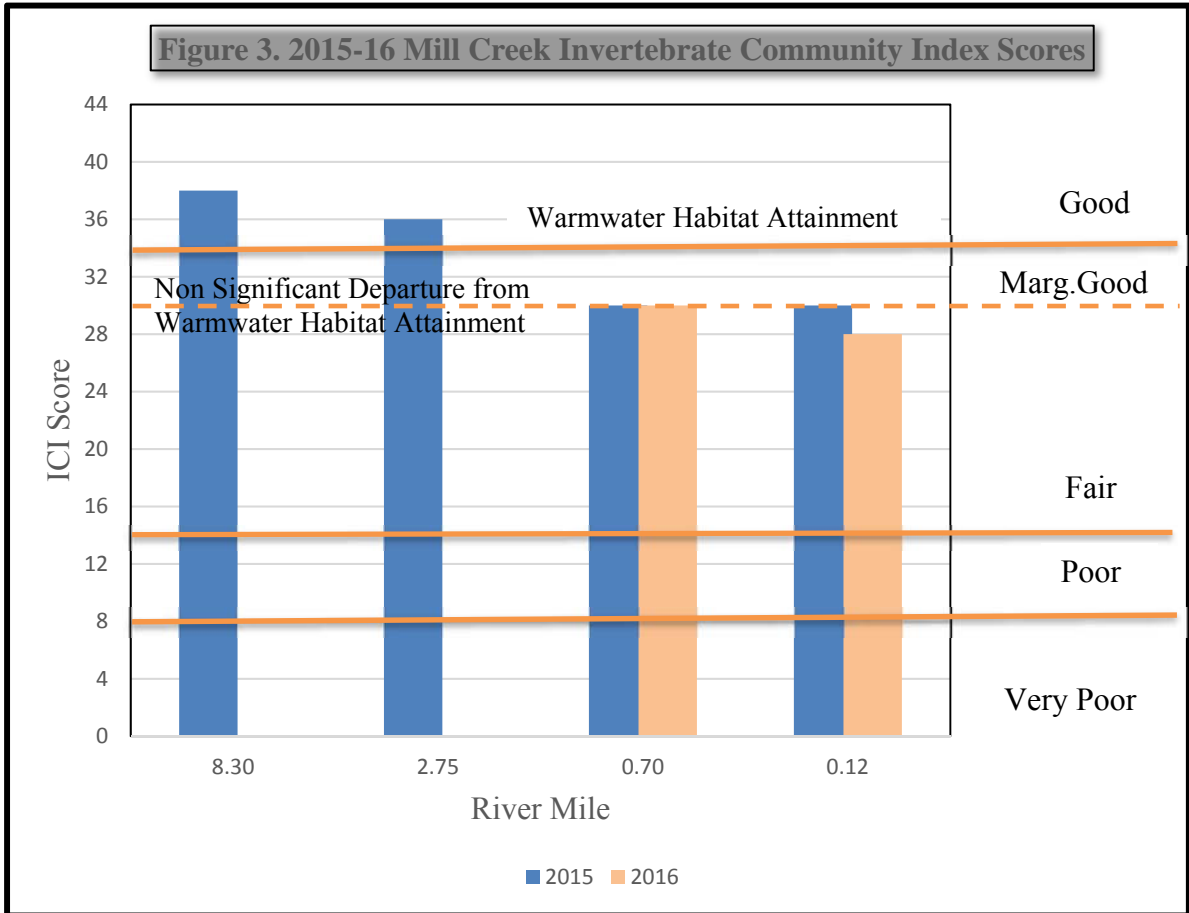


Table 15. Mill Creek ICI scores or Narrative Ratings Comparisons				
Year	RM 8.30	RM 2.75	RM 0.70	RM 0.12
1995	---	38	20	18
2011	<i>Fair</i>	40	34	<i>Fair</i>
2012	38	40	36	38
2013	24	<i>Fair</i>	<i>Fair</i>	<i>Fair</i>
2014	38	<i>Fair</i>	30	<i>Marg. Good</i>
2015	38	36	30	<i>Marg. Good</i>
2016	---	---	30	28

WWH criterion is ≥ 34 ICI units
 Non-significant departure from WWH criterion is ≥ 30 ICI units
 --- No ICI score or narrative rating available

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Mill Creek RM 0.12 was assigned a narrative rating of *Marginally Good* in 2015. While HD samplers were not recovered at this site in 2015, data from HDs recovered in 2016 were used to verify the accuracy of the 2015 narrative rating assignment. In 2015, the qualitative sample collected at Mill Creek RM 0.12 was composed of 27 taxa, including eight EPT Taxa, four taxa designated as pollution tolerant by the Ohio EPA, and two pollution-sensitive taxa. Most of the taxa collected (77.7%) were listed as facultative to pollution tolerant according to the Ohio EPA Macroinvertebrate Taxa List. The two sensitive taxa included the Trichoptera species, *Ceratopsyche morosa group*, and Chironomidae species, *Cardiocladius obscurus*, both of which are listed as moderately intolerant. EPT taxa included three Ephemeroptera species, *Baetis flavistriga*, *Baetis intercalaris*, and *Caenis sp.*, as well as five Trichoptera taxa, *Cheumatopsyche sp.*, *Ceratopsyche morosa group*, *Ceratopsyche sparna*, *Hydropsyche depravata group*, and *Hydroptila sp.* The most abundant groups noted during field collection were Baetidae, Hydropsychidae and Chironomidae. Baetidae and Hydropsychidae were listed as predominant organisms in the riffle and run during field collection while *Caenis sp.* and *Hydroptila sp.* were found to be predominant in the margin habitat. While the overall taxa diversity and number of pollution intolerant organisms is just below what would be expected of a site with a narrative rating of *Good*; the number and prevalence of EPT taxa collected at this site was the primary consideration for the narrative rating assignment of *Marginally Good* in 2015. In comparison, this site obtained an ICI score of 28 in 2016, which is the highest score in the range of the narrative category *Fair*, just below *Marginally Good*. In 2016, the qualitative sample had the same number of taxa, but two fewer EPT taxa. It should also be noted that Ephemeropteran and Trichopteran taxa were not the predominant organisms in most of the habitats in 2016. Based on this information, the macroinvertebrate population at this site appears to have performed better in 2015 than 2016, justifying the narrative rating assignment of *Marginally Good* in 2015.

RM 0.70 obtained the same ICI score of 30 in both 2015 and 2016, which is a narrative rating of *Marginally Good*; this was due to the number of taxa found (44 species both years), including seven EPT taxa and two sensitive taxa both years. The sensitive taxa found at RM 0.70 were all listed as moderately intolerant. EPT taxa in 2015 included three Ephemeroptera species and five Trichoptera taxa; 2016 included three Ephemeroptera species, and four Trichoptera taxa.

RM 2.75 and 8.30, with ICI scores of 36 and 38, respectively. Both sites received a narrative rating of *Good* in 2015. These sites were not sampled in 2016. RM 2.75 had the least number of taxa found at 33 species, but still contained seven EPT taxa and one sensitive taxa. RM 8.30 had the highest number of taxa found at 45 species, but had only one sensitive taxa Chironomidae species, *Cardiocladius obscurus*, which is listed as moderately intolerant and six EPT taxa. The macroinvertebrate ICI ratings for the four sites on Mill Creek have stayed consistent since 2014, except at RM. 2.75, which jumped from *Fair* in 2014 to *Good* in 2015.

Conclusions

The Mill Creek watershed was evaluated in 2015-2016 to continue the documentation on the health of the watershed, see Table 16. During the sampling in 2015, of the four sites sampled, two were in full attainment of the biocriteria for Aquatic Life Use Status (RMs 0.12 and 0.70), and one site was in partial attainment (RM 2.75), and one in non-attainment (RM 8.30). The partial attainment at RM 2.75 was due to an IBI score of 30 which did not meet the biocriterion. The non-attainment at RM 8.30 was due to IBI score of 24, which is considered *Poor*.

In 2016, of the two sites sampled, RM 0.70 was in full attainment and RM 0.12 was in partial attainment due to an ICI score of 28 that did not meet the biocriterion.

Table 16. 2015, 2016 Mill Creek Survey Results.						
	River Mile	Aquatic Life Use Attainment Status	IBI Score	ICI Score	Habitat	Water Quality Exceedances
2015	8.30	NON	24	38	73.50	<i>E. coli</i>
2015	2.75	PARTIAL	30	36	71.50	<i>E. coli</i> , copper, zinc
2015	0.70	FULL	36	30	75.75	<i>E. coli</i> , copper
2015	0.12	FULL	42	<i>Marg. Good</i>	70.25	<i>E. coli</i> , copper
2016	0.70	FULL	41	30	71.50	<i>E. coli</i>
2016	0.12	PARTIAL	40	28	67.25	<i>E. coli</i>
WWH Criterion IBI units ≥ 40 / ICI ≥ 34 Non-significant departure from WWH criterion ≥ 36 IBI units / >4 ICI units Note that the site above the falls received non-attainment based on the <i>Poor</i> fish score.						

Water chemistry sampling conducted at the sites showed exceedances of applicable water quality standards for *E. coli* and mercury in both 2015 and 2016. While 2015 also had exceedances of copper and zinc. The *E. coli* exceedances, an indication of sanitary sewage within the river, were, for the most part, directly related to wet weather prior to a few of the sampling events; densities were generally low during dry weather. Potential sources of pollution include illicit discharges, CSOs, stormwater runoff, and flow from upstream tributaries. For mercury, the levels that were measured were considered typical for watersheds within this region.

Biological surveys of fish and macroinvertebrate showed there may still be some impact to those communities. However, results for the fish community have risen slightly in recent years. The number of fish species found in Mill Creek's lower two sites (RM 0.12, 0.70) increased to 24 species collected during one sampling event (RM 0.70 August 30, 2016). The number of darters increased from 2 darters found in 2013-14 to 92 darters found in 2015-16. 2016 also saw the addition of the golden redhorse to the list of species found in Mill Creek. The macroinvertebrate communities continue to have ICI scores that are consistently in the *Fair to Marginally Good* range. There still may be some water quality issues remaining due to erosion, water level fluctuations, and urban runoff, but the continued documentation of Mill Creek will hopefully show the positive effects the capital improvement projects completed in the watershed will have over time.

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References

- DeShon, J.E. (1995). Development and application of the Invertebrate Community Index (ICI). In Davis and Simon (Eds.), *Biological assessment and criteria, tools for water resource planning and decision making* (pp. 217-243). Boca Raton, FL: Lewis Publishers.
- Ohio Environmental Protection Agency. (1987). *Biological Criteria for the Protection of Aquatic Life: Volume II: Users Manual for Biological Field Assessment of Ohio Surface Waters*. Columbus, OH: Division of Water Quality Planning and Assessment,

Ecological Assessment Section.

Ohio Environmental Protection Agency. (1989). Biological Criteria for the Protection of Aquatic Life: Volume III. Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities. Columbus, OH: Division of Water Quality Monitoring and Assessment.

Ohio Environmental Protection Agency. (2006). 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, Division of Surface Water. (2009, Revision Adopted July 9, 2009, Effective October 9, 2009). State of Ohio Water Quality Standards, Chapter 3745-1.

Ohio Environmental Protection Agency. (2015). *Surface Water Field Sampling Manual for water quality parameters and flows*. Columbus, Ohio: Division of Surface Water.

Ohio Environmental Protection Agency. (2013b). Trophic Index Criterion – Rationale and Scoring. Retrieved from http://epa.ohio.gov/Portals/35/rules/TIC_rationaleandscoreing.pdf

Ohio Environmental Protection Agency. (2014a). 2014 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, Ecological Assessment Section.

Ohio Environmental Protection Agency. (2014b). 2014 Updates to Biological Criteria for the Protection of Aquatic Life: Volume III. Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities. Columbus, OH: Division of Surface Water, Ecological Assessment Section.

USGS. (2015). USGS Surface-Water Daily Data for Ohio. Retrieved from http://waterdata.usgs.gov/oh/nwis/dv/?site_no=04208460&agency_cd=USGS&preferred_module=sw

Ohio Environmental Protection Agency. (2017). *State of Ohio Water Quality Standards Ohio Administrative Code Chapter 3745-1* (Revision: February 6, 2017). Columbus, OH: Division of Surface Water; Standards and Technical Support Section. <http://www.epa.ohio.gov/portals/35/rules/01-26.pdf>.