

NORTHEAST OHIO REGIONAL SEWER DISTRICT

2014 Chagrin River Environmental Monitoring Biological, Water Quality and Habitat Survey Results



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

Introduction

In 2014, the Northeast Ohio Regional Sewer District (NEORSD) conducted water chemistry sampling, aquatic habitat assessments, and fish and benthic macroinvertebrate community surveys on the Chagrin River and three of its tributaries in the vicinity of the City of Pepper Pike and the Village of Moreland Hills, Ohio. Beginning in late May 2012, four wastewater treatment plants (WWTP) in the area, including the Jackson Valley WWTP, Quail Hollow WWTP, Creekside WWTP, and Woodland Glen WWTP, were decommissioned. Their flows were redirected to NEORSD's Easterly WWTP via the SOM Center Relief Sewer. By removing these flows and conveying them to NEORSD, the water quality downstream of these WWTPs is expected to improve. Therefore, the purpose of this study was to determine whether the decommissioning of the above-mentioned WWTPs has led to an improvement in the water quality and biological communities of the receiving waters. Data collected in 2014 was compared with baseline data collected in 2009 and sampling done in 2012 and 2013 downstream of each of these treatment plants and on the Chagrin River upstream and downstream of where the three tributaries enter the river. Sampling was conducted by NEORSD Level 3 Qualified Data Collectors certified by Ohio EPA in Fish Community and Benthic Macroinvertebrate Biology, Chemical Water Quality and Stream Habitat Assessments as explained in the NEORSD study plan *2014 Chagrin River Environmental Monitoring* approved by Ohio EPA on April 14, 2014.

Figure 1 is a map of the sampling locations evaluated during the study, and Table 1 indicates the sampling locations with respect to river mile (RM), latitude/longitude, description and surveys conducted. A digital photo catalog of the sampling locations is available upon request by contacting the NEORSD Water Quality and Industrial Surveillance Division.

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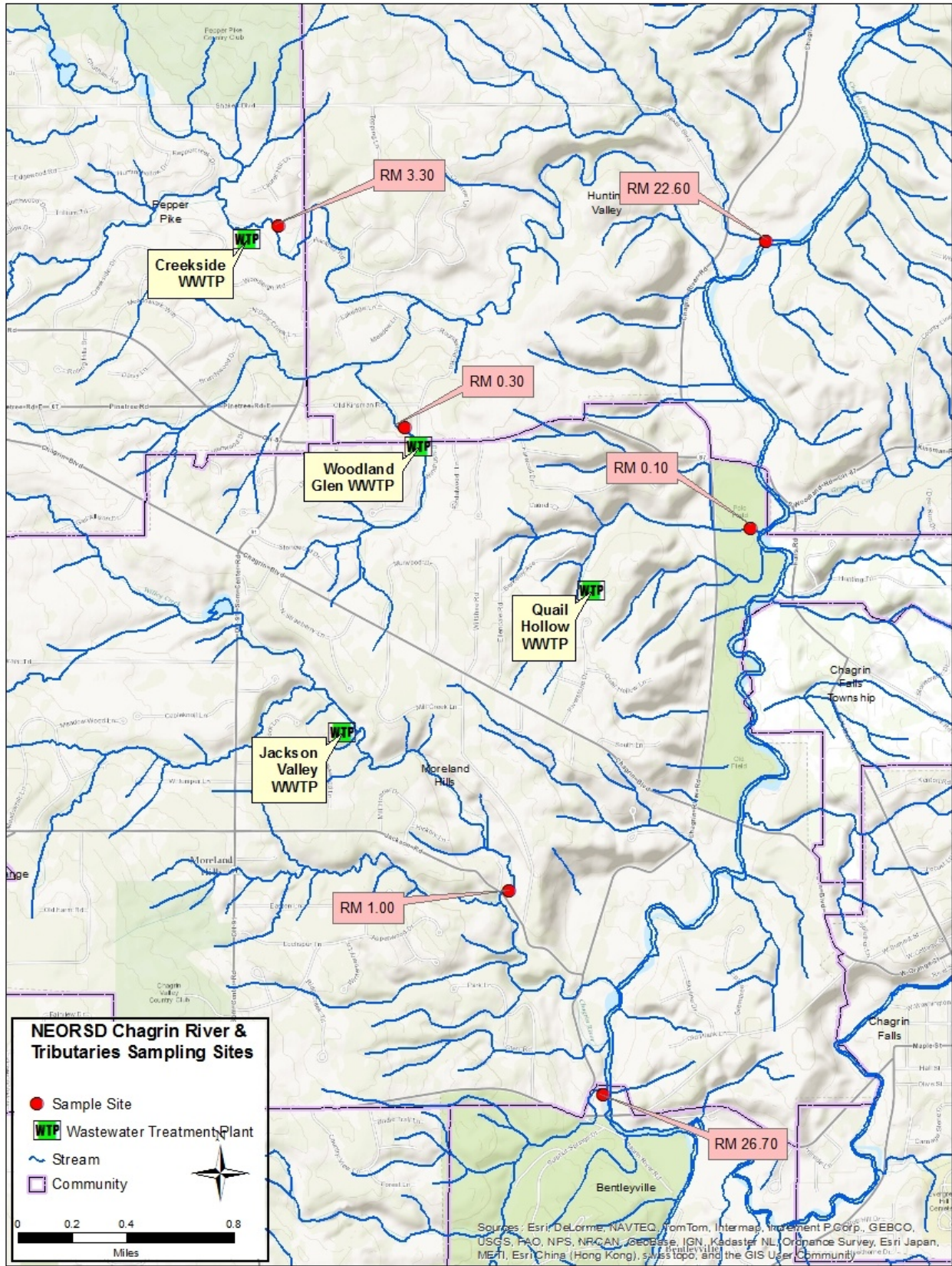


Figure 1. Chagrin River and Tributaries Biological, Habitat and Water Chemistry Sites

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Table 1. 2014 Chagrin River and Tributaries Sampling Locations

Location	Latitude	Longitude	River Mile	Description	USGS HUC 8 Number-Name	Purpose
Chagrin River	41.4250	-81.4176	26.70	Chagrin River Upstream of Wiley Creek	04110003-Ashtabula-Chagrin	Background data for fish, habitat and macroinvertebrates
37855 Jackson Road	41.4360	-81.4242	1.00	Wiley Creek Downstream of Jackson Valley WWTP	04110003-Ashtabula-Chagrin	Evaluate Wiley Creek fish, habitat, macroinvertebrates, and water chemistry post decommissioning of Jackson Valley WWTP
3780 Chagrin River Road	41.4553	-81.4066	0.10	Unnamed tributary Creek to Chagrin River Downstream of Quail Hollow WWTP	04110003-Ashtabula-Chagrin	Evaluate Unnamed Creek fish, habitat, macroinvertebrates, and water chemistry post decommissioning of Quail Hollow WWTP
South Woodland Road West of Windrush Drive	41.4600	-81.4318	0.30	Unnamed tributary Creek to Pepper-Luce Creek Downstream of Woodland Glen WWTP	04110003-Ashtabula-Chagrin	Evaluate Unnamed Creek fish, habitat, macroinvertebrates, and water chemistry post decommissioning of Woodland Glen WWTP
3226 S.O.M. Center Road	41.4719	-81.4401	3.30	Pepper-Luce Creek Downstream of Creekside WWTP	04110003-Ashtabula-Chagrin	Evaluate Pepper-Luce Creek fish, habitat, macroinvertebrates, and water chemistry post decommissioning of Creekside WWTP
3051 Chagrin River Road	41.4707	-81.4053	22.60*	Chagrin River Downstream of Pepper-Luce Creek	04110003-Ashtabula-Chagrin	Evaluate WWTP decommissioning on fish, macroinvertebrates, habitat, and water chemistry on the Chagrin River

*This site was moved in 2012 approximately 0.60 RMs upstream from the 2009 sampling site; data from the 2009 site of Chagrin RM 22.0 will be directly compared to the 2012, 2013, and 2014 data from RM 22.60.

Water Chemistry Sampling

Methods

Water chemistry and bacteriological sampling was conducted five times between August 26, 2014, and September 23, 2014, on the Chagrin River and select tributaries. Techniques used for sampling and analyses followed the Ohio EPA *Surface Water Field Sampling Manual* (2013). 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 a YSI 600XL or a YSI EXO 1 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, 2013).

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

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.

Results and Discussion

All the sites monitored during the 2014 study, except for Wiley Creek and Chagrin River RM 22.60, are designated warmwater habitat, agricultural water supply, industrial

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water supply, and Class B primary contact recreation (Ohio EPA, 2009; 2013). Wiley Creek also has the latter three designations, but is designated coldwater habitat rather than warmwater habitat. Chagrin River RM 22.60 is designated a Class A primary contact recreation. The sites on the Chagrin River mainstem have an additional designation of seasonal salmonid habitat, in effect from October through May. Duplicate samples, field blanks and paired parameters were all utilized for QA/QC purposes and the results are as stated below.

Over the course of the sampling, two field blanks were collected, on August 26, 2014, and September 2, 2014. Some parameters seen in the table below showed possible contamination. It is unclear how the field blanks became contaminated and may be due to incorrect sample collection, handling, or contaminated blank water. Ohio EPA's Credible Data program includes a data validation protocol for QA/QC samples. Using this protocol, some of the sample results needed to be designated as estimated values ('J'), downgraded from Level 3 to Level 2 credible data or rejected ('R') when compared to the field blanks (Table 2).

Date	Water Body	Parameter					
		Ag	Cr	NH ₃	Sb	Tl	Zn
08/26/2014	Wiley Creek, RM 1.00		Level 2	R	J	Level 2	Level 2
	Unnamed Tributary, RM .10						
	Chagrin River, RM 22.60						
	Pepper-Luce, RM 0.30						
	Pepper-Luce, RM 3.30						
	Chagrin River, RM 26.70		R	R	R	R	Level 2
09/02/2014	Wiley Creek, RM 1.00	R	Level 2				J
	Unnamed Tributary, RM .10	R	Level 2		J		J
	Chagrin River, RM 22.60	R/R	Level 2/J		J/J	J/J	J/J
	Pepper-Luce, RM 0.30	R	J		J	J	J
	Pepper-Luce, RM 3.30	R	J		J	J	J
	Chagrin River, RM 26.70	R	J		J		J

R, Rejected; J, Estimated Value

Duplicate samples were collected on August 26 at Pepper-Luce Creek RM 3.30 and September 2 at Chagrin River RM 22.60 for QA/QC purposes. The duplicate samples revealed three parameters that were rejected due to RPDs that were greater than acceptable (Table 3). There may be numerous reasons for the differences between the samples, such as a lack of precision and consistency in sample collection and/or analytical procedures, environmental heterogeneity and/or improper handling of samples.

Date	Site	Parameter	Acceptable RPD (%)	Actual RPD (%)	Qualifier
08/26/14	Pepper-Luce RM 3.30	COD	59.8	66.7	Rejected
		Ti	47.7	163.9	Rejected
		TI	33.3	97.3	Rejected
09/02/14*	Chagrin River RM 22.60	Ti	62.3	124.6	Rejected

*Wet-weather sampling event¹

Paired parameters are evaluated in tandem using %RPD because they are interlinked and can be used for QA/QC purposes. The paired parameters evaluated for these samples were total solids and total dissolved solids, as well as, total phosphorus and dissolved reactive phosphorus. These results revealed values that needed to be listed as estimated for the samples collected on August 26 at Pepper-Luce RM 3.30 and Wiley Creek RM 1.00 for total solids and total dissolved solids.

The Class A Primary Contact Recreation criteria is applied to the Chagrin River RM 22.60 because it is considered to have frequent recreational use. The criteria used are an *E. coli* seasonal geometric mean (SGM) of 126 colony counts per 100 milliliters and a criterion not to exceed a single sample maximum (SSM) of 298 colony counts/100mL in more than ten percent of the samples taken during any thirty-day period. The *E. coli* densities at all of the sites also exceeded the SSM of 298 colony counts/100mL in more than ten percent of the samples taken for all thirty-day periods (Table 5). For the Class B Primary Recreation Sites, which is the other five sites, the single sample maximum (SSM) is 523 colony counts/100mL in more than ten percent of the samples during any thirty-day period. Table 4 lists *E. coli* densities for all samples collected, as well as exceedances of the recreation season geometric mean criterion which occurred for all of the sites in the Chagrin River and its tributaries.

On average, the *E. coli* densities were lower than the samples collected in 2013. There could be multiple explanations as to why levels were slightly lower in 2014 compared to last year, 2013. The wet-weather sampling events from 2013 had a much higher density of *E. coli* in the stream compared to the sampling events in 2014 even though the amount of rain was similar. September 16, 2014, was a wet-weather sampling event due to rain the day before. Between September 10 and 16, in 2014, there was 2.45 inches of rain. This level of precipitation could have caused polluted runoff and led to higher *E. coli* densities in the streams.

¹ Wet-weather sampling events are considered 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. For wet weather sampling events with greater than 0.25 inches of rain, the samples collected that day and the following two days are considered wet weather samples.

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Table 4. 2014 Chagrin River and Tributaries <i>E. coli</i> Densities (Most Probable Number (MPN) /100mL)						
Date	Unnamed tributary RM 0.10	Unnamed tributary RM 0.30	Pepper-Luce Creek RM 3.30	Wiley Creek RM 1.00	Chagrin River RM 22.60	Chagrin River RM 26.70
8/26/2014	320	1,158	174	136	92	254
9/2/2014*	381	476	204	194	109.5	266
9/9/2014	358	276	388	180	426	1,210
9/16/2014*	949	330	3,292	858	856	409
9/23/2014	196	340	579	64	140	104
Seasonal Geomean	381.9	443.0	482.9	192.0	219.9	322.3

EC – Estimated Count
* Wet-weather sampling event

Table 5. 2014 Chagrin River and Tributaries <i>E. coli</i> Recreation Season Single Sample Maximum (SSM) Exceedances (% Days > 523 colony counts/100mL)						
30-Day Period	Unnamed tributary RM 0.10	Unnamed tributary RM 0.30	Pepper-Luce Creek RM 3.30	Wiley Creek RM 1.00	Chagrin River RM 22.60*	Chagrin River RM 26.70
8/26/2014-9/24/2014	20.0	20.0	40.0	20.0	40.0	40.0
9/3/2014-10/2/2014	25.0	--	50.0	25.0	50.0	50.0
9/9/2014-10/8/2014	33.3	--	66.7	33.3	66.7	66.7
9/16/2014-10/15/2014	50.0	--	100.0	50.0	50.0	50.0
9/23/2014-10/22/2014	--	--	100.0	--	--	--

*% Days > 298 colony counts/100mL
Actual measurements are in MPN/100mL, which is directly comparable to colony counts/100mL

Mercury analysis for all of the sampling events was completed using EPA Method 245.1. The detection limit for this method is above the criteria for the Human Health Nondrinking and Protection of Wildlife Outside Mixing Zone Averages (OMZA), so it generally cannot be determined if the sites were in attainment of those criteria. Instead, this type of mercury sampling was used as a screening tool to determine whether contamination was present above the detection limit. Based on the sampling that was completed, mercury was not present at levels above those normally found in the watershed.

Ohio EPA's Trophic Index Criterion assigns designations for quality of surface waters based on many factors including nutrients, periphyton, dissolved oxygen, and biological assemblages. This criterion was published in 2011 as a draft, and in March 2013, some aspects of the paper were published in a document called, "Trophic Index Criterion- Rationale and Scoring" (Ohio EPA, Division of Surface Water). The scoring places the streams into one of three categories: impaired, threatened, or acceptable. NEORSD does not assess periphyton; however, nutrients were assessed. The scoring for the nutrient component is based on levels of total phosphorus and dissolved inorganic nitrogen (DIN). Wiley Creek RM 1.00 and Unnamed Tributary RM 0.30 had levels which received a narrative rating of "Threatened," in 2013. This year, all the sites received a narrative rating of "Acceptable" and were described as having, "Concentrations typical of healthy streams in working landscapes."

The other parameters that were analyzed had no exceedances and were within acceptable levels as determined by the EPA.

Habitat Assessment

Methods

Instream habitat assessments were conducted once at each site in 2014 using the Qualitative Habitat Evaluation Index (QHEI). 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 (headwater sites) or 60 (wading sites) or more suggests that sufficient habitat exists to support a fish community that meets the warmwater habitat criterion (Ohio EPA, 2003). 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

Of the six sites surveyed in 2014, five sites received a narrative rating of *Excellent* or *Good* and exceeded the target scores set by the Ohio EPA (Table 6). These sites should have the ability to support healthy warmwater habitat communities.

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Table 6. Chagrin River and Tributaries QHEI Results and Stream Flows						
River Mile	2009 QHEI Score	2012 QHEI Score	2013 QHEI Score	2014 QHEI Score	2014 Narrative Rating	Stream Flow (ft ³ /s)*
Chagrin River RM 26.70	76.00	78.00	74.50	72.50	<i>Good</i>	110
Wiley Creek RM 1.00 Downstream of Jackson Valley WWTP	80.00	77.25	78.00	79.50	<i>Excellent</i>	155
Unnamed Trib. RM 0.10 Downstream of Quail Hollow WWTP	38.00	42.50	39.00	40.50	<i>Poor</i>	138
Unnamed Trib. RM 0.30 Downstream of Woodland Glen WWTP	62.00	62.25	53.00	69.50	<i>Excellent</i>	138
Pepper-Luce Creek RM 3.30 Downstream of Creekside WWTP	71.25	82.50	73.25	70.50	<i>Excellent</i>	155
Chagrin River RM 22.60	71.50	81.00	84.25	75.00	<i>Excellent</i>	110

*Provisional flow data obtained from USGS 04209000 Chagrin River flow gauge in Willoughby, Ohio
Note: In 2012, the sampling site was moved to RM 22.60, approximately 0.60 RMs upstream from 2009 sampling site.

At the Chagrin River RM 26.70, the site contained high quality substrates including boulders and cobble. Instream cover included boulders, shallows, rootmats, woody debris, and deep pools. This site is not channelized nor has it been, which is critical to its development. Its stability is high due to the presence of bedrock and boulders. It had a narrative rating of *Good* and a score of 72.50.

At the Chagrin River RM 22.60, the site had a narrative rating of *Excellent* with a score of 75.00. The main substrate at this site was cobble with moderate instream cover. This site had wide riparian width and good development. It had woody debris and deep pools with well-developed riffles, which contributed to its high QHEI narrative rating.

In contrast, the site on the Unnamed Tributary to the Chagrin River downstream of the Quail Hollow WWTP RM 0.10, located in the Cleveland MetroParks Polo Fields,

received a score of 40.50 and a narrative rating of *Poor*. The section of the stream that was evaluated was channelized with poor development and no sinuosity. Instream cover was sparse or nearly absent, with a sparse amount of overhanging vegetation and boulders present. A lack of both deep pools and a high quality riffle also contributed to its low QHEI score and may have directly influenced the biological communities at this location.

A QHEI score of 79.50 was calculated at Wiley Creek RM 1.00, downstream of Jackson Valley WWTP. This site was dominated by a gravel substrate and a moderate amount of suitable instream cover including rootmats, woody debris, and boulders. Deep pools, wide riffles and excellent development combined with a wide riparian zone and semi-forested floodplain contributed to a narrative rating of *Excellent* at this site.

A QHEI score of 69.50 was calculated with a narrative rating of *Excellent* at Unnamed tributary (RM 0.30) to Pepper-Luce Creek downstream of Woodland Glen WWTP. Instream cover at this site consisted of undercut banks, shallows, rootwads, woody debris, and boulders. Riparian width was moderate on river right and narrow on river left, with a forested floodplain present.

A QHEI score of 70.50 was calculated with a narrative rating of *Excellent* at Pepper-Luce Creek RM 3.30, downstream of Creekside WWTP. This site is characterized by a moderate amount of instream cover consisting of undercut banks, shallows, woody debris and rootwads. The substrate was made up of sand and gravel with moderate siltation present. The riparian zone was wide, with the floodplain dominated by shrub and old field. Deep pools and a moderate to stable riffle at a high gradient were present, leading to an overall high QHEI score.

Electrofishing

Methods

One electrofishing pass was conducted at each site in 2014. A list of the dates when the surveys were completed, along with flow as measured at the United States Geological Survey gage station called USGS 04209000 Chagrin River, is given in Table 7. Sampling was conducted using longline and backpack 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 meters for the headwater sites and 0.20 meters for the wading sites. 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, weighed (wading sites only), and examined for the presence of anomalies, including DELTs (deformities, eroded fins, lesions, and tumors). All fish were then released to the

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waters from which they were collected, except for vouchers and those that could not be easily identified in the field.

Table 7. Sampling Dates and River Flows		
Date	Sites sampled (RMs)	Daily Mean Flow (CFS*)
8/26/14	Unnamed Trib. RM 0.30, Unnamed Trib. RM 0.10	137
8/27/14	Pepper-Luce RM 3.30, Wiley RM 1.00	177
8/29/14	Chagrin RMs 26.70 & 22.60	111

*Provisional Data

The electrofishing results for each pass 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) which is utilized at wading sites. For headwater sites, only the IBI is used. 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 and wading sites are listed in Tables 8 and 9, respectively.

Table 8. 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

Table 9. IBI Metrics (Wading)
Total Number of Native Species
Number of Darter species
Number of Sunfish Species
Number of Sucker Species
Number of Intolerant Species
Percent Tolerant Species
Percent Omnivores
Percent Insectivores
Percent Top Carnivores
Percent Simple Lithophils
Percent DELT Anomalies
Number of Fish

For wading sites, the second fish index utilized by Ohio EPA is the 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.

$$\text{Formula 1:} \quad MIwb = 0.5 \ln N + 0.5 \ln B + \bar{H}(No.) + \bar{H}(Wt.)$$

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

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

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

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

n_i = Relative numbers or weight of species

N = Total number or weight of the sample

Lists of the species, numbers, weights (for wading sites only), pollution tolerances and incidence of DELT anomalies for fish collected during the electrofishing passes at each site are available upon request from the NEORSD WQIS Division.

Results and Discussion

Chagrin River RM 26.70 was in full attainment of the warmwater habitat criteria (Tables 10 & 11, Figures 2 & 3). This site received a MIwb score of 9.0 (*Very Good*) and an IBI score of 50 (*Exceptional*). There were 22 native species and 1 nonnative species (rainbow trout, *Oncorhynchus mykiss*). There were three pollution-intolerant species: a stonecat madtom, roseyface shiner, and a river chub. The fish species that were the most abundant were rainbow darters, river chub, and northern hog suckers. This site was not assessed in 2013 due to equipment malfunctions at the end of the season. There was not enough time to complete this site before the end of the recommended sampling period. Based on past sampling and best professional judgment, it is expected that this site would have been in full attainment of the warmwater habitat criteria for fish communities in 2013. In 2012, an IBI score of 46 (*Very Good*) and a MIwb score of 9.7 (*Exceptional*) were calculated at RM 26.70.

Chagrin River RM 22.60 was also in full attainment of the criteria. A MIwb score of 8.2 (*Good*) was calculated at this site. In addition, an IBI score of 46 (*Very Good*) was

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calculated, which was slightly higher than the score of 42 (*Good*) in 2013. Three pollution-intolerant species were collected, the same species as Chagrin River RM 26.70. Many other species sampled at this site were moderately intolerant. There were 18 native species sampled at this site.

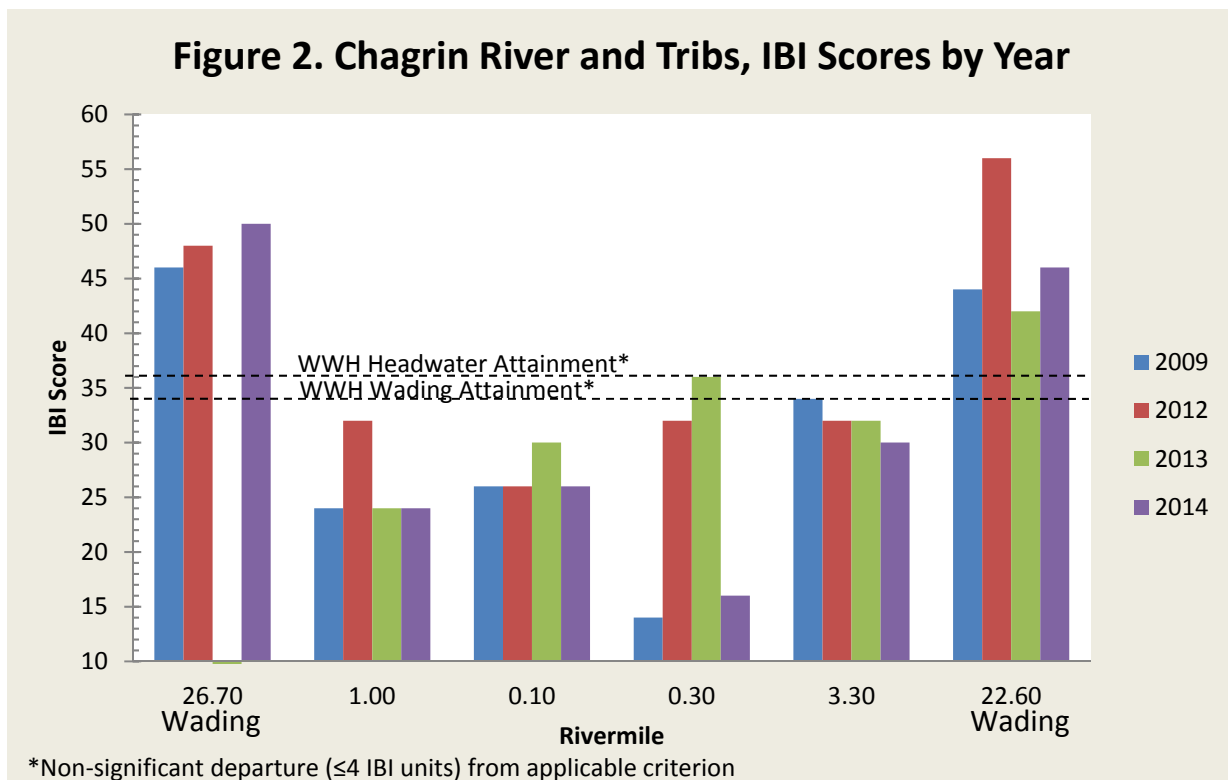
None of the headwater sites sampled in 2014 met their respective aquatic life use designations. An IBI score of 30 (*Fair*) was calculated at Pepper-Luce Creek RM 3.30. This site had a high number of individuals characterized as highly pollution-tolerant species such as white sucker, creek chub, and bluntnose minnow. Although the QHEI score for this site suggests the ability to support a healthy fish community, a dam downstream of the site prevents upstream migration of fish from the Chagrin River. IBI scores of 32 (*Fair*) were calculated in 2013 and 2012, which were similar to the score of 34 (*Fair*) in 2009.

Table 10. IBI Scores					
Site	River Mile	2009	2012	2013	2014
Chagrin River Upstream of Wiley Creek	26.70	46 (<i>Very Good</i>)	48 (<i>Very Good</i>)	Not completed	50 (<i>Exceptional</i>)
Wiley Creek Downstream of Jackson Valley WWTP	1.00	24 (<i>Poor</i>)	32 (<i>Fair</i>)	24 (<i>Poor</i>)	24 (<i>Poor</i>)
Unnamed tributary to Chagrin River Downstream of Quail Hollow WWTP	0.10	26 (<i>Poor</i>)	26 (<i>Poor</i>)	30 (<i>Fair</i>)	26 (<i>Poor</i>)
Unnamed tributary to Pepper-Luce Creek Downstream of Woodland Glen WWTP	0.30	14 (<i>Very Poor</i>)	32 (<i>Fair</i>)	36 (<i>Fair</i>)	16 (<i>Very Poor</i>)
Pepper-Luce Creek	3.30	34 (<i>Fair</i>)	32 (<i>Fair</i>)	32 (<i>Fair</i>)	30 (<i>Fair</i>)
Chagrin River Downstream of Pepper-Luce Creek	22.60	44 (<i>Good</i>)	56 (<i>Exceptional</i>)	42 (<i>Good</i>)	46 (<i>Very Good</i>)
Bold indicates attainment of applicable criterion					

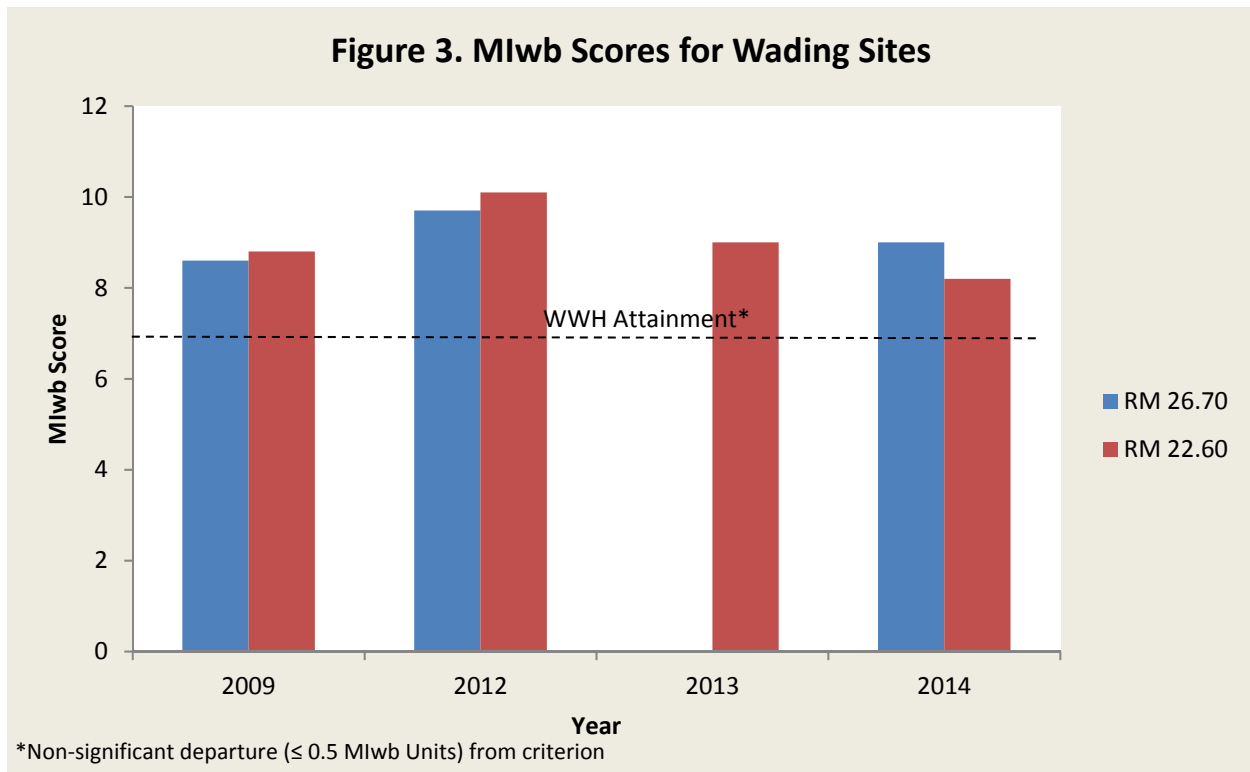
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Table 11. MIwb Scores for Wading Sites					
Site	River Mile	2009	2012	2013	2014
Chagrin River Upstream of Wiley Creek	26.70	8.6 (Good)	9.7 (Exceptional)	<i>Not completed</i>	9.0 (Very Good)
Chagrin River Downstream of Pepper-Luce Creek	22.60	8.8 (Good)	10.1 (Exceptional)	9.0 (Very Good)	8.2 (Good)

Bold indicates attainment of applicable criterion



An IBI score of 24 (*Poor*) was calculated at Wiley Creek RM 1.00 in 2014; past scores included a 24 in 2013 and 2009 and a 32 in 2012. Although this site is designated coldwater habitat, no species associated with such a designation were collected. Pollution-tolerant species including central stoneroller minnow, white sucker, creek chub, and western blacknose dace dominated the sample. Natural barriers (waterfalls) downstream may be affecting the IBI score at this site by impeding the upstream migration of fish.



An IBI score of 26 (*Poor*) was calculated at the Unnamed tributary to the Chagrin River downstream of the former Quail Hollow WWTP (RM 0.10). The site also scored 26 in 2013 and 2012. Three species were collected at this site as in 2013, which was an improvement from the two species found in 2012 and 2009. These species were western blacknose dace, central stoneroller minnow, and creek chub, all of which are considered to be pollution-tolerant species. The sampling zone at this site is channelized and lacks essential habitat features to support a diverse fish community as reflected in the QHEI of score of 40.5 (*Poor*).

2

An IBI score of 16 (*Very Poor*) was calculated at the Unnamed tributary to Pepper-Luce Creek downstream of the Woodland Glen WWTP (RM 0.30) compared to the 2013 score of 36 (*Marginally Good*), the 2012 IBI score of 32 (*Good*), and the 2009 IBI score of 14 (*Very Poor*). The number of individuals in 2009, 2012, 2013, and 2014 was 12, 146, 79, and 10, respectively. Only two species were collected at this site in 2014, which included the creek chub and the western blacknose dace. Although a higher total of fish were collected in 2012, there were only three species represented, the creek chub, blacknose dace and largemouth bass. Due to the small drainage area and low flow of this site, disturbances within the vicinity may have larger impacts than in a larger drainage area. Occasionally, largemouth bass are collected at this site, which indicates that the site receives flow or over flow from a stocked pond. The conditions of the pond and its overflow may play a role in this site's ecology.

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 5. 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 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 WQIS.

The overall aquatic macroinvertebrate community in the stream was evaluated using Ohio EPA's Invertebrate Community Index (ICI) (OEPA 1987a, Ohio EPA undated). The ICI consists of ten community metrics (Table 12) 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 12. 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

Results and Discussion

All of the sites in 2014 were sampled qualitatively. Only two sites, Wiley Creek RM 1.00 and Pepper-Luce RM 3.30 were sampled quantitatively using a Hester-Dendy. The Hester-Dendy samplers from the two mainstream sites, Chagrin River RMs 26.70 and 22.60, were unable to be recovered. Two headwater sites, the Unnamed tributary downstream of Quail Hollow WWTP RM 0.10 and the Unnamed tributary to Pepper-Luce Creek at RM 3.30, were only sampled qualitatively since their drainage areas were < 10 mi². In the Erie-Ontario Lake Plain, an ICI score of 30 is needed in order to meet the WWH criterion. Scores within 4 ICI units are also considered to be in non-significant departure of the criterion, effectively meeting the criterion (Table 13).

Table 13. Macroinvertebrate Results

Stream & Location	River Mile	ICI Score 2009	ICI Score 2012	ICI Score 2013	ICI Score 2014	Number of Qualitative Taxa	Number of Quantitative Taxa	Number of EPT Taxa
Chagrin River Upstream of Wiley Creek	26.70	44	42	42	--*	66	--*	15
Wiley Creek Downstream of Jackson Valley WWTP ¹	1.00	36	42	40	40	34	21	7
Unnamed tributary creek to Chagrin River Downstream of Quail Hollow WWTP	0.10	--*	--*	--*	--*	30	--*	7
Unnamed tributary creek to Pepper-Luce Creek Downstream of Woodland Glen WWTP	0.30	--*	--*	--*	--*	17	--*	1
Pepper-Luce Creek	3.30	40	34	32	42	39	35	6
Chagrin River Downstream of Pepper-Luce Creek	22.60	38	40	48	--*	57	--*	21

*Indicates qualitative sample only

Bold indicates attainment of applicable criterion

¹ ICI does not apply to Coldwater Habitat use designation, data used for comparative purposes only.

Chagrin River RM 22.60 had 57 taxa collected in the qualitative sampling and 21 EPT taxa. In 2013, there were 14 EPT taxa and 68 total taxa. In 2013, the ICI score was calculated at 48. In 2009 and 2012, the ICI scores were 38 and 40, respectively. Since the Hester-Dendy sampler was not recovered, best professional judgment was used to assign a narrative rating of *Good* to this site based on the ratio of tolerant to intolerant organisms, total qualitative taxa and EPT taxa.

The upstream site on the Chagrin River at RM 26.70 had 66 taxa in 2014, about the same as in 2013. There were 27 EPT species at this site in 2014; this is higher than in

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2013 when there were 15 EPT taxa. This site was given a narrative rating of *Exceptional* and has not changed significantly since 2009. This site had a relatively high number of caddisflies, a low number of pollution-tolerant organisms, and a high number of EPT taxa. The results for the downstream site indicate no significant water quality impacts to it.

On the Unnamed tributary to Chagrin River downstream of the Quail Hollow WWTP (RM 0.10), only a qualitative sample was collected. This was due to the low drainage area of the stream in conjunction with the lack of flow (<0.3 feet per second) over the HD. The number of total taxa collected qualitatively has varied over the years in which data has been collected. In 2009, 18 taxa were collected. In 2012 and 2013, 35 and 40 taxa were collected, respectively. This year, 2014, 30 taxa were collected. EPT taxa remained at 7 collected taxa in 2014. Overall, the results indicate that if water quality impairments due to exceedances of mercury and the presence of bacteriological indicators are impacting the macroinvertebrate community at this location, the impact is not significant. Thus, the site was assigned a narrative rating of *Marginally Good* based on the qualitative sampling results and best professional judgment.

The results for the site on Wiley Creek at RM 1.00 also suggest that water quality is not a major factor impacting the macroinvertebrate community at that location. Because Wiley Creek is designated coldwater, the ICI is not what indicates whether it is in attainment. The Hester-Dendy is set in the stream because it assists with collecting coldwater species, the true indicator of attainment for coldwater streams. Four coldwater species is the minimum number needed for the site to be in attainment. In 2009, the number of coldwater taxa was four, which then decreased to two in 2012 and 2013. This is the first year in NEORSD's sampling that there were 6 coldwater taxa collected and it met the coldwater habitat use Ohio EPA had assigned following their last sampling on this stream in 1995 (Ohio EPA, 1997).

An ICI score of 42 was calculated with a narrative rating of *Very Good* at Pepper-Luce Creek RM 3.30, downstream of Creekside WWTP. This is 10 points higher than the ICI score from 2013. A total of 52 taxa were collected compared to 35 taxa in 2013. There were 6 EPT taxa in 2014. *Cheumatopsyche sp* caddisfly made up 64.8% of the HD sample. Overall, this site has shown significant improvement in the macroinvertebrate community.

The Unnamed tributary to Pepper-Luce Creek downstream of the Woodland Glen WWTP (RM 0.30) was given a narrative rating of *Poor* based on qualitative sample results. A total of 17 taxa were collected in 2014 compared to the 21 taxa in 2013, but the same as in 2012. One EPT taxa was collected in 2014 compared to two collected in 2013. Moderate siltation was noted in the QHEI at this site, which may have also contributed to the lack of more sensitive species. Current velocity is slow with very little

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variation, which may not be ideal for some species. Because this site received a *Poor* narrative rating on the ICI, it is in nonattainment for aquatic life use attainment status.

Conclusions

The purpose of this study was to collect post-decommissioning monitoring data to determine if the removal of the four WWTPs in 2012 has had any effect on the water quality and biological communities of the Chagrin River and its tributaries downstream of the WWTPs. From the sampling that was conducted in 2009, prior to the decommissioning of the WWTPs, no impacts from the tributaries were found on the health of the mainstem of the Chagrin River. This continued in 2014, as once again, both sites that were assessed there were in full attainment of the biocriteria (Table 14). Site-specific factors prevented the other locations that were assessed from fully meeting their designated uses.

Table 14. 2014 Chagrin River Survey Results

River Mile Description	RM	IBI Score (Narrative Rating)	MIwb Score/ Narrative Rating	ICI Score/ Narrative Rating	QHEI Score/ Narrative Rating	Aquatic Life Use Attainment Status	Water Quality Exceedances
Chagrin River Upstream of Wiley Creek ¹	26.70	50 <i>Exceptional</i>	9.0 <i>Very Good</i>	--* <i>Exceptional</i>	72.5 <i>Good</i>	FULL	<i>E. coli</i>
Wiley Creek ¹ Downstream of Jackson Valley WWTP	1.00	24 <i>Poor</i>	--	40¹ <i>Good</i>	79.5 <i>Excellent</i>	NON	<i>E. coli</i>
Unnamed tributary creek to Chagrin River Downstream of Quail Hollow WWTP	0.10	26 <i>Poor</i>	--	--* <i>Marginally Good</i>	40.5 <i>Poor</i>	NON	<i>E. coli</i>
Unnamed tributary creek to Pepper-Luce Creek Downstream of Woodland Glen WWTP	0.30	16 <i>Very Poor</i>	--	--* <i>Poor</i>	69.5 <i>Excellent</i>	NON	<i>E. coli</i>
Pepper-Luce Creek	3.30	30 <i>Fair</i>	--	42 <i>Good</i>	70.5 <i>Excellent</i>	PARTIAL	<i>E. coli</i>
Chagrin River Downstream of Pepper-Luce Creek	22.60	46 <i>Very Good</i>	8.2 <i>Good</i>	--* <i>Good</i>	75.0 <i>Excellent</i>	FULL	<i>E. coli</i>

WWH biocriterion: IBI score of 40 for headwater sites and 38 for wading sites; ICI score of 34

Nonsignificant departure: ≤4 IBI units; ≤4 ICI units

*HD not collected; qualitative assessment only, based on ICI score and best professional judgment

¹ICI does not apply to Coldwater Habitat use designation, data used for comparative purposes only. Wiley Creek RM 1.00 met attainment.

Water quality at all the sites changed slightly from the year prior. *E. coli* densities at these sites were elevated, but no mercury levels above the detectable limit were collected compared to 2013 when all sites had exceedances during one sampling event. The *E. coli* density could be caused by illicit discharges, failing home sewage treatment systems, and run off from ponds, agricultural fields, and recreational fields located near the river. Nutrient loading of total phosphorus and dissolved inorganic nitrogen decreased in 2014 compared to 2013 and all sites were considered *Acceptable* according to guidance from Ohio EPA.

The QHEI analysis showed that most of the sites should be able to support robust fish communities. The site that did not meet the target score was Unnamed Tributary to Chagrin River RM 0.10. The low QHEI score was reflected in the low IBI score at this site. In contrast, all other sites were rated either *Excellent* or *Good*.

The IBI and MIwb analyses conducted revealed a healthy fish community on the Chagrin River at RMs 22.60 and 26.70. Both sites were slightly higher than the last year that they were sampled. The other sites did not meet the WWH biocriterion and had narrative ratings of *Poor*, *Very Poor*, and *Fair*, similar to years prior. There are still dams acting as fish barriers downstream, as there were in 2009 when the study started, on Pepper-Luce Creek and Wiley Creek. This may be contributing to the inability for fish to migrate upstream from the Chagrin River to these sites.

The macroinvertebrate communities surveyed at Chagrin River RM 26.70, Pepper-Luce Creek RM 3.30, and Chagrin River RM 22.60 met the WWH biocriterion in 2014. At Wiley Creek RM 1.00, six coldwater taxa were collected on the Hester-Dendy; therefore, the site met the coldwater habitat designated use. This is the first time this has occurred in several years. All sites met attainment for this criterion except for Unnamed Tributary to Pepper-Luce Creek RM 0.30, which was an improvement from 2013.

The mainstem sites, Chagrin River RMs 22.60 and 26.70, appear to be varying only slightly year to year and continue to be in full attainment of the biocriteria. Overall, these two sites support healthy fish and macroinvertebrate communities. Only Unnamed Tributary to Pepper-Luce Creek RM 0.30 was in non-attainment of all biocriteria. The other three sites, Pepper-Luce Creek RM 3.30, Unnamed Tributary to Chagrin River RM 0.10, and Wiley Creek RM 1.00 met the criteria for macroinvertebrates, but failed to meet the ones for fish.

In 2009, Unnamed Tributary to Pepper-Luce Creek RM 0.30, downstream of the former Woodland Glen WWTP, was the site that NEORSD investigators most suspected water quality to be a cause of nonattainment. The scores on this site have not significantly improved since the WWTP was taken offline. This site has a very small drainage area, slow current, and a drop in flow after the effluent no longer discharged to

the stream. These conditions appear to be impeding the site from meeting attainment of the biocriteria.

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