

NORTHEAST OHIO REGIONAL SEWER DISTRICT

2013 Chagrin River Environmental Monitoring Biological, Water Quality and Habitat Survey Results



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

Introduction

In 2013, 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 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. The purpose of this study, therefore, was to collect post-construction monitoring data and 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 2013 was compared with baseline data collected in 2009 and sampling done in 2012 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, and Chemical Water Quality and Stream Habitat Assessments as explained in the NEORSD study plan *2013 Chagrin River Environmental Monitoring* approved by Ohio EPA on July 10, 2013.

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.

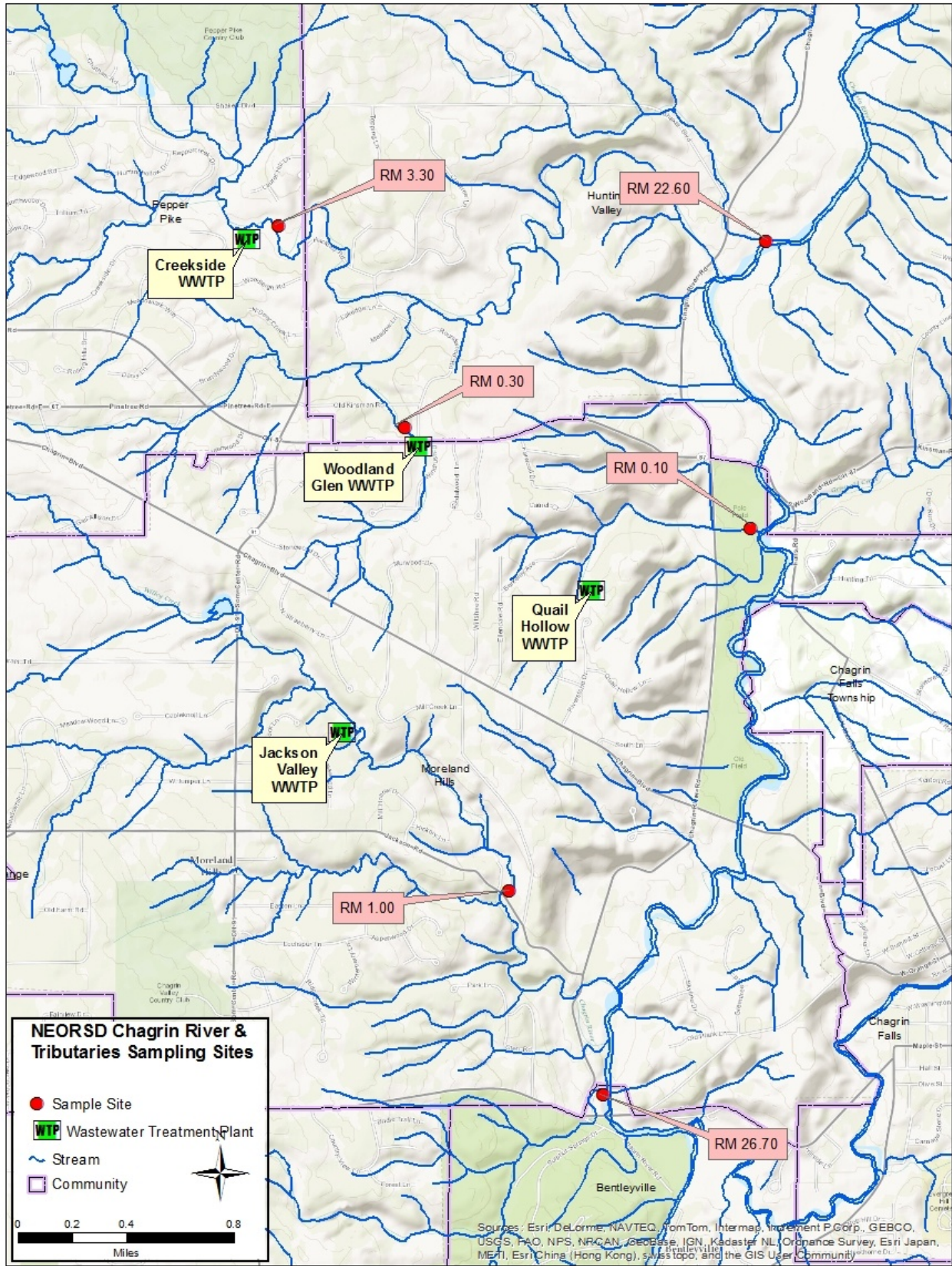


Figure 1. Chagrin River and Tributaries Biological, Habitat and Water Chemistry Sites

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Table 1. 2013 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	Un-named tributary Creek to Chagrin River Downstream of Quail Hollow WWTP	04110003- Ashtabula- Chagrin	Evaluate Un-named 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	Un-named tributary Creek to Pepper-Luce Creek Downstream of Woodland Glen WWTP	04110003- Ashtabula- Chagrin	Evaluate Un-named 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 and 2013 data from RM 22.60

Water Chemistry Sampling

Methods

Water chemistry and bacteriological sampling was conducted five times between August 26th, 2013 and September 23rd, 2013, 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 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.

Mercury analysis for all of the 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 OMZA, it generally cannot be determined if Chagrin River was in attainment of those criteria. Instead, 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.

Results and Discussion

All of the sites monitored during the 2013 study, with the exception of Wiley Creek and Chagrin River RM 22.60, are designated warmwater habitat, agricultural water supply, industrial 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 September 3rd, 2013 and September 9th, 2013. Some parameters 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 when compared to the field blanks (Table 2).

Duplicate samples were collected on September 3rd at Chagrin River RM 22.60 and September 9th at Chagrin River RM 26.70 for QA/QC purposes. The duplicate samples revealed three parameters that were rejected due to RPDs that were greater than the acceptable RPD (Table 3). There may be numerous reasons for why these parameters needed to be rejected, such as a lack of precision and consistency in sample collection and/or analytical procedures, environmental heterogeneity and/or improper handling of samples.

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Table 2. Unacceptable Field Blank Parameters

Date	Water Body	Parameter					
		Cr	NH3	Sb	Cu	TKN	Pb
09/03/2013	Wiley Creek, RM 1.00	J	J	Level 2	--	--	--
	Un-named Tributary, RM 0.10	Level 2	--	X	--	--	--
	Chagrin River, RM 22.60	Level 2	--	X	--	--	--
	Pepper-Luce, RM 0.30	X	J	X	--	--	--
	Pepper-Luce, RM 3.30	J	--	J	--	--	--
	Chagrin River, RM 26.70	J	--	X	--	--	--
09/09/2013	Wiley Creek, RM 1.00	Level 2	--	--	J	Level 2	X
	Un-named Tributary, RM 0.10	Level 2	--	--	Level 2	X	Level 2
	Chagrin River, RM 22.60	Level 2	--	--	Level 2	Level 2	Level 2
	Pepper-Luce, RM 0.30	Level 2	J	--	J	Level 2	J
	Pepper-Luce, RM 3.30	Level 2	--	--	J	J	J
	Chagrin River, RM 26.70	Level 2	--	--	Level 2	Level 2	J

X, Rejected; J, Estimated Value

Table 3. Unacceptable RPDs from Duplicate Samples

Date	Site	Parameter	Acceptable RPD (%)	Actual RPD (%)	Qualifier
09/03/13*	Chagrin River RM 22.60	Aluminum	25.3	27.2	Rejected
		Iron	18.1	18.4	Rejected
09/09/13	Chagrin River RM 26.70	Zinc	48.2	99.1	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 one estimated value for a sample

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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collected on September 16th at Pepper-Luce RM 3.30 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-forming units per 100 milliliters (CFU/100mL) and a criterion not to exceed a single sample maximum (SSM) of 298 CFU/100mL in more than ten percent of the samples taken during any thirty-day period. The *E. coli* densities at RM 22.60 exceeded the SSM of 298 CFU/100mL in more than ten percent of the samples taken for all thirty-day periods (Table 4 for densities and Table 5 for percent of samples exceeding the SMS). This site exceeded the SGM with 183.6 CFU/100mL, which is above the 126 CFU/100mL limit (Table 4).

For the Class B Primary Recreation Sites, which is the other five sites, the single sample maximum (SSM) is 523 CFU/100mL in more than ten percent of the samples during any thirty-day period and the seasonal geometric mean (SGM) is 161 CFU/100mL. 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 for *E. coli* in the Chagrin River and its tributaries.

On average, the *E. coli* densities were higher in 2013 than the samples collected in 2012. In 2012, four of the sites exceeded the seasonal geomean and two fewer single sample maximum exceedances were observed compared to 2012. The two sites which exceeded the seasonal geomean this year and not last year, Wiley Creek RM 1.00 and Chagrin RM 22.60, have the lowest exceedances of all the sites. There could be multiple explanations as to why levels are slightly higher this year compared to last year. There was one more wet-weather sampling event this year than there was in 2012, which could have contributed to the density of *E. coli* in the stream. The sample taken on September 3, 2013, is considered a wet-weather sampling event because there was more than 0.25 inches of rain accumulation on September 1. In addition, there was over an inch of rain on September 21, 2013, before the sample was collected on September 23, making it a wet weather sampling event as well. This level of precipitation could have caused polluted runoff and led to higher *E. coli* densities in the streams. Unnamed Tributary RM 0.10 runs through a polo field so high densities could be linked to events being held at that site.

Table 4. 2013 Chagrin River and Tributaries <i>E. coli</i> Densities (colony-forming units/100mL)						
Date	Un-named tributary RM 0.10	Un-named 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
8/26/2013	1600	385	100	210	49	212
9/3/2013*	1267	404	1600	404	319	650
9/9/2013	200	EC 2150	215	67	39	250
9/16/2013	7350	175	400	315	290	408
9/23/2013*	980	EC 37400	840	920	1180	1220
Seasonal Geomean	1239.05	1169.60	409.81	277.56	183.6	443.4

EC – Estimated Count
 * Wet-weather sampling event

Table 5. 2013 Chagrin River and Tributaries <i>E. coli</i> Recreation Season Single Sample Maximum (SSM) Exceedances (% Days > 523 cfu/100mL)						
30-Day Period	Un-named tributary RM 0.10	Un-named 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
8/26/2013-9/24/2013	80.0	40.0	40.0	20.0	40.0	40.0
9/3/2013-10/2/2013	75.0	50.0	50.0	25.0	50.0	50.0
9/9/2013-10/8/2013	66.7	66.7	33.3	33.3	33.3	33.3
9/16/2013-10/15/2013	100.0	50.0	50.0	50.0	50.0	50.0
9/23/2013-10/22/2013	100.0	100.0	100.0	100.0	100.0	100.0

*% Days > 298 cfu/100mL

As shown in Tables 6 and 7, all sample sites in the 2013 study exceeded the mercury criterion for the protection of wildlife OMZA and the OMZA criterion for nondrinking water for all 30-day periods. This result is similar to the results in 2012, except that the OMZA criterion for nondrinking water was not exceeded in the last 30-day period of 2012. One potential cause of these exceedances may be from atmospheric deposition. Human-related activities such as industrial uses, coal combustion, and waste incineration can put organic mercury into the atmosphere which could then bioaccumulate and biomagnify once in the stream system. There are also inorganic forms of mercury which are naturally found in the environment.

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Table 6. Chagrin River Mercury Exceedances

Site	Sample Date	Form (units)	Adjusted Result	30-day period	30-day Average Concentration	OMZA Criterion Nondrinking	OMZA Criterion Wildlife
Chagrin River Upstream of Wiley Creek							
RM 26.70	8/26/2013	TR (µg/L)	0.004	8/26/2013-9/25/2013	0.01	0.0031	0.0013
RM 26.70	9/3/2013	TR (µg/L)	0.004	9/3/2013-10/3/2013	0.01	0.0031	0.0013
RM 26.70	9/9/2013	TR (µg/L)	0.004	9/9/2013-10/9/2013	0.01	0.0031	0.0013
RM 26.70	9/16/2013	TR (µg/L)	0.017	9/16/2013-10/16/2013	0.02	0.0031	0.0013
Chagrin River Downstream of Pepper-Luce Creek							
RM 22.60	8/26/2013	TR (µg/L)	0.004	8/26/2013-9/25/2013	0.010	0.0031	0.0013
RM 22.60	9/3/2013	TR (µg/L)	0.004	9/3/2013-10/3/2013	0.012	0.0031	0.0013
RM 22.60	9/9/2013	TR (µg/L)	0.004	9/9/2013-10/9/2013	0.015	0.0031	0.0013
RM 22.60	9/16/2013	TR (µg/L)	0.025	9/16/2013-10/16/2013	0.020	0.0031	0.0013
TR= Total Recoverable							

Table 7. Chagrin River Tributaries Mercury Exceedances

Site	Sample Date	Form (units)	Adjusted Result	30-day period	30-day Average Concentration	OMZA Criterion Nondrinking	OMZA Criterion Wildlife
Wiley Creek Downstream of Jackson Valley WWTP							
RM 1.00	8/26/2013	TR (µg/L)	0.004	8/26/2013-9/25/2013	0.011	0.0031	0.0013
RM 1.00	9/3/2013	TR (µg/L)	0.004	9/3/2013-10/3/2013	0.013	0.0031	0.0013
RM 1.00	9/9/2013	TR (µg/L)	0.004	9/9/2013-10/9/2013	0.015	0.0031	0.0013
RM 1.00	9/16/2013	TR (µg/L)	0.022	9/16/2013-10/16/2013	0.021	0.0031	0.0013
Un-named Tributary Downstream of Quail Hollow WWTP							
RM 0.10	8/26/2013	TR (µg/L)	0.004	8/26/2013-9/25/2013	0.011	0.0031	0.0013
RM 0.10	9/3/2013	TR (µg/L)	0.004	9/3/2013-10/3/2013	0.013	0.0031	0.0013
RM 0.10	9/9/2013	TR (µg/L)	0.004	9/9/2013-10/9/2013	0.015	0.0031	0.0013
RM 0.10	9/16/2013	TR (µg/L)	0.023	9/16/2013-10/16/2013	0.021	0.0031	0.0013
Un-named Tributary to Pepper-Luce Creek Downstream of Woodland Glen WWTP							
RM 0.30	8/26/2013	TR (µg/L)	0.004	8/26/2013-9/25/2013	0.011	0.0031	0.0013
RM 0.30	9/3/2013	TR (µg/L)	0.004	9/3/2013-10/3/2013	0.013	0.0031	0.0013
RM 0.30	9/9/2013	TR (µg/L)	0.004	9/9/2013-10/9/2013	0.016	0.0031	0.0013
RM 0.30	9/16/2013	TR (µg/L)	0.022	9/16/2013-10/16/2013	0.022	0.0031	0.0013

Table 7. Chagrin River Tributaries Mercury Exceedances

Site	Sample Date	Form (units)	Adjusted Result	30-day period	30-day Average Concentration	OMZA Criterion Nondrinking	OMZA Criterion Wildlife
Pepper-Luce Creek Downstream of Creekside WWTP							
RM 3.30	8/26/2013	TR (µg/L)	0.004	8/26/2013-9/25/2013	0.012	0.0031	0.0013
RM 3.30	9/3/2013	TR (µg/L)	0.004	9/3/2013-10/3/2013	0.014	0.0031	0.0013
RM 3.30	9/9/2013	TR (µg/L)	0.004	9/9/2013-10/9/2013	0.017	0.0031	0.0013
RM 3.30	9/16/2013	TR (µg/L)	0.023	9/16/2013-10/16/2013	0.024	0.0031	0.0013
TR= Total Recoverable							

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).

For Wiley Creek RM 1.00, high DIN levels of 3.75 mg/l and total phosphorus of an average of 0.0796 mg/l were measured. These levels are considered “Threatened” and are a narrative rating of, “Concentrations observed with high-intensity landuse and WWTP loadings” (Ohio EPA). For Unnamed Tributary RM 0.30, an Aquatic Life OMZA exceedance of NH₃ occurred on 9/16/2013. The average DIN was 1.509 mg/l and the average of 0.29 mg/l total phosphorus. This is also a rating of “Threatened” on the nutrient component and above the target loading of nitrogen. This may have been caused by stormwater runoff from fertilized land.

For Pepper-Luce RM 3.30, the average DIN was 0.741 mg/l and the average total phosphorus was 0.118 mg/l. This is a narrative rating of “Acceptable” and is described as, “Concentrations typical of healthy streams in working landscapes.” Chagrin RMs 22.60 and 26.70 and Unnamed Tributary RM 0.10 also received a narrative rating of “Acceptable.”

Habitat Assessment

Methods

Instream habitat assessments were conducted once at each site in 2013 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 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 2013, four sites received a narrative rating of “*Excellent*” or “*Good*” and exceeded the target score of 55 set by the Ohio EPA (Table 8). These sites should have the ability to support healthy warmwater habitat communities.

At the Chagrin River RM 26.70, the site contained high quality substrates including boulders, boulder slabs, and cobble. Instream cover included boulders, backwaters, 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 went from a narrative rating of “*Excellent*” to “*Good*” due to small decreases in most categories.

At the Chagrin River RM 22.60, the site had a narrative rating of “*Excellent*” with a score of 84.25. The main substrate at this site was cobble with moderate instream cover. This site had wide riparian width and excellent to good development. It had eddies and deep pools with well developed riffles, which contributed to its high QHEI narrative rating.

In contrast, the site on the un-named tributary to the Chagrin River downstream of the Quail Hollow WWTP, located in the Cleveland MetroParks Polo Fields, received a score of 39.00 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 nearly absent, with a sparse amount of rootwads 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 78.00 was calculated at Wiley Creek RM 1.00, downstream of Jackson Valley WWTP. This site was dominated by a cobble substrate and a moderate amount of suitable instream cover including undercut banks, woody debris, and boulders. Deep pools, wide riffles and good 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 53.00 was calculated with a narrative rating of “*Fair*” 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 wide on river right and narrow on river left, with a forested floodplain present. Factors detracting from the score at this site included the presence of moderate silt, moderate to heavy erosion, lack of deep pools, and no functioning riffle.

A QHEI score of 73.25 was calculated with a narrative rating of “*Excellent*” at Pepper-Luce Creek RM 3.30, downstream of Creekside WWTP. This site was characterized by a moderate amount of instream cover consisting of undercut banks, shallows, woody debris and rootwads. The substrate was made up of cobble and gravel with moderate siltation present. The riparian zone was wide, with the floodplain dominated by forest. Deep pools and a moderate to stable riffle at a high gradient were present, leading to an overall high score.

Table 8. 2013 Chagrin River and Tributaries QHEI Results and Stream Flows

River Mile	Date of Most Recent QHEI	2009 QHEI Score	2012 QHEI Score	2013 QHEI Score	2013 Narrative Rating	Stream Flow (ft ³ /s)*
Chagrin River RM 26.70	09/24/2013	76.00	78.00	74.50	<i>Good</i>	116
Wiley Creek RM 1.00 Downstream of Jackson Valley WWTP	09/11/2013	80.00	77.25	78.00	<i>Excellent</i>	116
Un-named Trib. RM 0.10 Downstream of Quail Hollow WWTP	09/11/2013	38.00	42.50	39.00	<i>Poor</i>	116
Un-named Trib. RM 0.30 Downstream of Woodland Glen WWTP	09/24/2013	62.00	62.25	53.00	<i>Fair</i>	117
Pepper-Luce Creek RM 3.30 Downstream of Creekside WWTP	09/11/2013	71.25	82.50	73.25	<i>Excellent</i>	179
Chagrin River RM 22.60	10/11/2013	71.50	81.00	84.25	<i>Excellent</i>	179

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

Electrofishing

Methods

Electrofishing passes were conducted one time at each site in 2013. Sampling was conducted using longline electrofishing techniques, as well as backpack electrofishing, and consisted of shocking all habitat types within a sampling zone while moving from downstream to upstream. The sampling zone was 150 meters for the headwater sites and 200 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 waters from which they were collected, except for vouchers and those that could not be easily identified in the field.

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 boat and wading sites. 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 MIwb, Formula 3 below, incorporates four fish community measures: numbers of individuals, biomass, and the Shannon Diversity Index (H) (Formula 4 below) based on numbers and weight of fish. The MIwb is a result of a mathematical calculation based upon the formula.

Formula 3:
$$MIwb = 0.5 \ln N + 0.5 \ln B + \bar{H}(No.) + \bar{H}(Wt.)$$

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

Formula 4:
$$\bar{H} = -\sum \left[\left(\frac{n_i}{N} \right) \log_e \left(\frac{n_i}{N} \right) \right]$$

n_i = Relative numbers or weight of species

N = Total number or weight of the sample

Table 9. IBI Metrics	
Headwater	Wading
Total Number of Native Species	Total Number of Native Species
Number of Darters & Sculpins	Number of Darter species
Number of Headwater Species	Number of Sunfish Species
Number of Minnow Species	Number of Sucker Species
Number of Sensitive Species	Number of Intolerant Species
Percent Tolerant Species	Percent Tolerant Species
Percent Pioneering Species	Percent Omnivores
Percent Omnivores	Percent Insectivores
Percent Insectivores	Percent Top Carnivores
Number of Simple Lithophils	Percent Simple Lithophils
Percent DELT Anomalies	Percent DELT Anomalies
Number of Fish	Number of Fish

Results and Discussion

Chagrin River, RM 26.70 was not assessed 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 2012, an IBI score of 46 (*Very Good*) and a MIwb score of 9.7 (*Exceptional*) were calculated at RM 26.70.

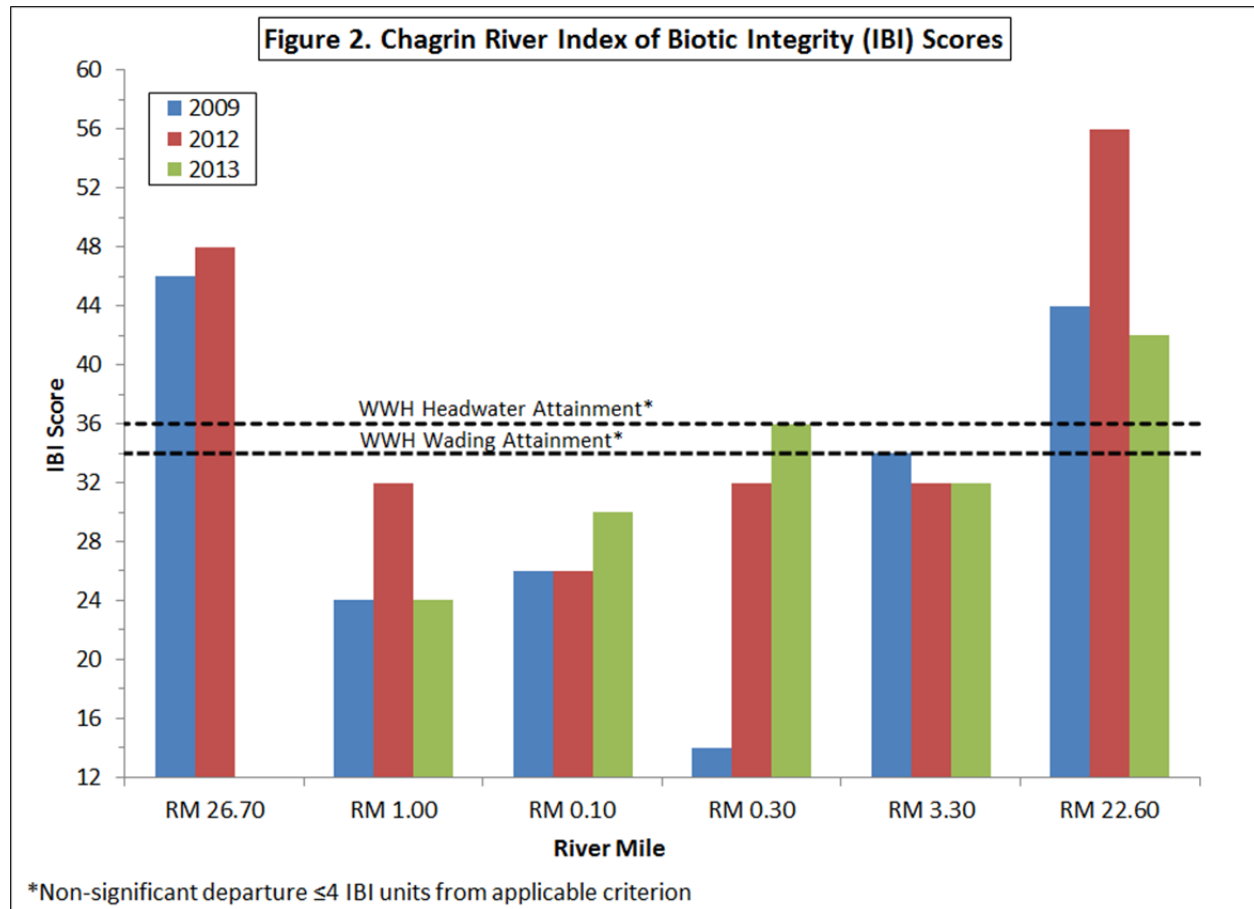
As shown in Table 10 and Figures 2 and 3, electrofishing results indicate that Chagrin River RM 22.60 was in full attainment of the criteria. A MIwb score of 9.0 (*Very Good*) was calculated at this site. This was slightly lower than the 2012 score of 10.1 (*Exceptional*), but still within attainment. An IBI score of 42 (*Good*) was calculated. Two pollution-intolerant species were collected, the rosyface shiner and the river chub. Many other species sampled at this site were moderately intolerant. In 2012, an IBI score of 56 (*Exceptional*) was calculated and three pollution-intolerant species were collected. The sample size of the fish in 2012 was more than three times larger than that in 2013, being 1676 and 426, respectively. This may have been due to the time of year that the electrofishing was completed. The 2012 electrofishing pass occurred on August 16th, whereas the 2013 pass occurred on October 11th. As the water temperature

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within the stream decreases, some smaller fish species will move to warmer, deeper water in the fall. This may explain why some fish are less likely to be located near riffles and are more likely to be in a slower part of the stream with more pools that are outside of the electrofishing sample zone. Many of the same species will be moving toward areas with more cover due to a loss of leaves from the trees in the fall. The stream habitat around RM 22.60 is relatively open with a setback tree line on river right, so any cover that is there would be less in the fall. Predatory fish species begin consuming more during this time of year in order to create fat reserves for the winter, this often means migrating to pools and warmer areas of the river to find smaller fish species (ODNR, 2013).

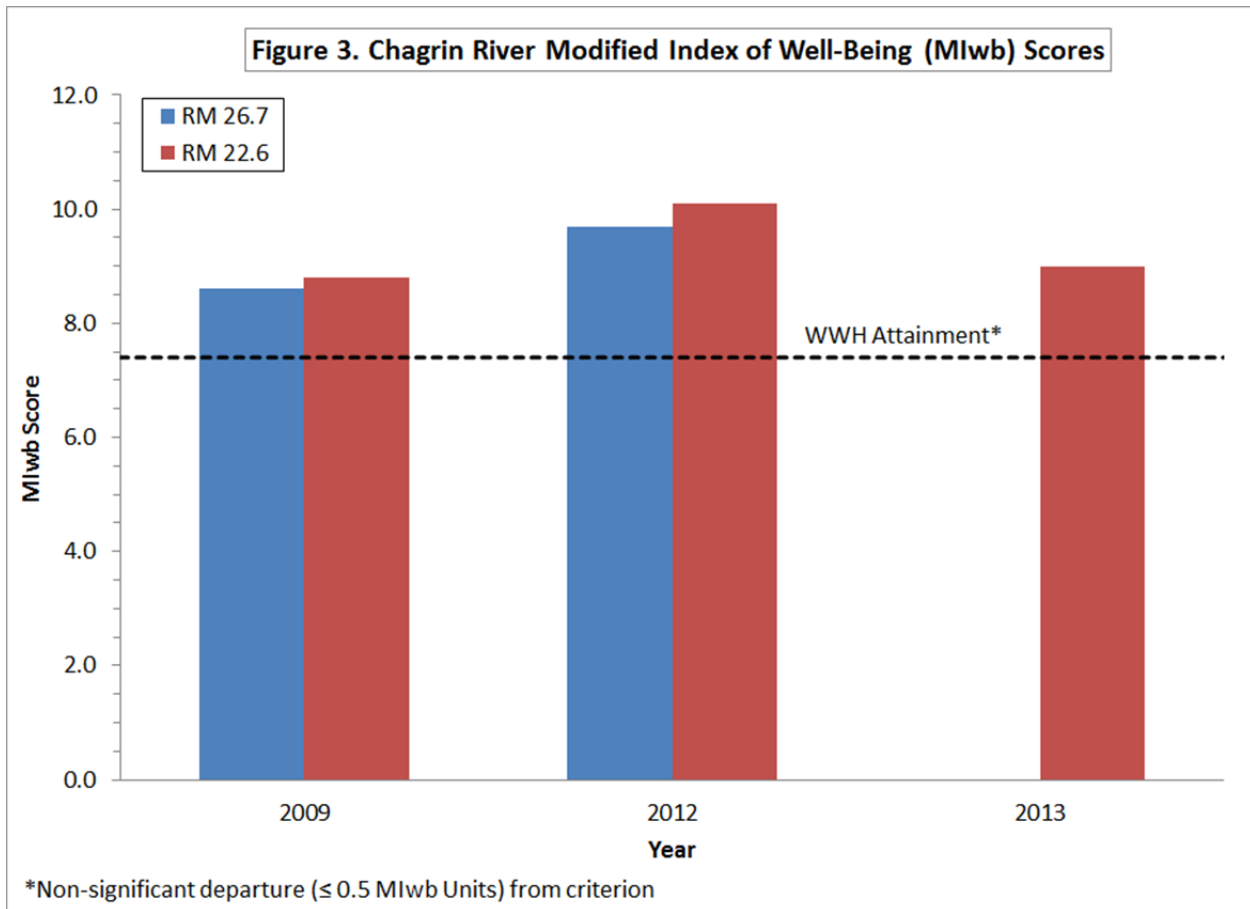
Table 10. Index of Biotic Integrity Scores

Site	River Mile	2009 MIwb (Narrative Rating)	2009 IBI Score (Narrative Rating)	2012 MIwb (Narrative Rating)	2012 IBI Score (Narrative Rating)	2013 MIwb (Narrative Rating)	2013 IBI Score (Narrative Rating)
Chagrin River Upstream of Wiley Creek	26.70	8.6 (Good)	46 (Very Good)	9.7 (Exceptional)	48 (Very Good)	<i>Not completed</i>	Not completed
Wiley Creek Downstream of Jackson Valley WWTP	1.00	NA	24 (Poor)	NA	32 (Fair)	NA	24 (Poor)
Un-named tributary to Chagrin River Downstream of Quail Hollow WWTP	0.10	NA	26 (Poor)	NA	26 (Poor)	NA	30 (Fair)
Un-named tributary to Pepper-Luce Creek Downstream of Woodland Glen WWTP	0.30	NA	14 (Very Poor)	NA	32 (Fair)	NA	36 (Fair)
Pepper-Luce Creek	3.30	NA	34 (Fair)	NA	32 (Fair)	NA	32 (Fair)
Chagrin River Downstream of Pepper-Luce Creek	22.60	8.8 (Good)	44 (Good)	10.1 (Exceptional)	56 (Exceptional)	9.0 (Very Good)	42 (Good)
Bold indicates attainment of applicable criterion							



None of the headwater sites sampled in 2013 met their respective aquatic life use designations. An IBI score of 32 (*Fair*) was calculated at Pepper-Luce Creek RM 3.30. This site had a high number of individuals characterized as 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, possibly making it more difficult. An IBI score of 32 (*Fair*) was calculated in 2012 and the IBI score was 34 (*Fair*) in 2009.

An IBI score of 24 (*Poor*) was calculated at Wiley Creek RM 1.00 in 2013; past scores included a 24 in 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, creek chub, and western blacknose dace dominated the sample. Natural barriers (waterfalls) downstream of the site may be affecting the IBI score at this site by impeding the upstream migration of fish further upstream on Wiley Creek.



An IBI score of 26 (*Fair*) was calculated at the un-named tributary to the Chagrin River downstream of the Quail Hollow WWTP (RM 0.10) compared to the score of 26 (*Poor*) from 2012. Three species were collected at this site, 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 39.0 (*Poor*).

An IBI score of 36 (*Marginally Good*) was calculated at the un-named tributary to Pepper-Luce Creek downstream of the Woodland Glen WWTP (RM 0.30), an improvement from the 2009 IBI score of 14 (*Very Poor*), and from the IBI score of 32 (*Good*) in 2012. A total of 79 individuals were collected in 2013 compared to the 146 individuals in 2012, and the 12 individuals in 2009. Although there were fewer individuals than in 2012, there was an additional species, the northern bluegill sunfish. Creek chub, western blacknose dace, largemouth bass and the northern bluegill sunfish made up the entire sample at this site.

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

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 11) 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 11. 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

Table 11. ICI Metrics
Percent tolerant organisms (as defined)
Number of qualitative EPT taxa

Results and Discussion

Four of the sites in 2013 were sampled both quantitatively and qualitatively. Two headwater sites, the un-named tributary downstream of Quail Hollow WWTP RM 0.10 and the un-named tributary to Pepper-Luce Creek at RM 3.30, were only sampled qualitatively since their drainage areas were $< 10 \text{ mi}^2$. 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 it (Table 12). An ICI score of 48 was calculated at Chagrin River RM 22.60 and also had the highest number of taxa collected from the HD (37) of any site sampled. In 2009 and 2012, the ICI score was calculated at 38 and 40, respectively. The data suggests that this site continues to support an increasingly diverse macroinvertebrate community.

The upstream site on the Chagrin River at RM 26.70 had 30 taxa and an ICI score of 42. This site is within attainment and has not changed significantly since 2009. Both Chagrin River sites had a relatively high number of caddisflies and a low percentage of pollution-tolerant organisms. The results for the downstream site indicate no significant water quality impacts from the WWTPs that were discharging to the tributaries upstream of it.

On the un-named 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 increased from 18 in 2009 to 35 in 2012 and to 40 in 2013. EPT taxa increased from 4 taxa in 2012 to 7 taxa in 2013, indicating possible water quality improvements at the site. 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 *Fair* based on qualitative sampling results and best professional judgment.

Table 12. Macroinvertebrate Results

Stream & Location	River Mile	ICI Score 2009	ICI Score 2012	ICI Score 2013	Number of Qualitative Taxa	Number of Quantitative Taxa	Number of EPT Taxa
Chagrin River Upstream of Wiley Creek ¹	26.70	44	42	42	51	30	15
Wiley Creek ¹ Downstream of Jackson Valley WWTP	1.00	36	42	40	27	25	5
Unnamed tributary creek to Chagrin River Downstream of Quail Hollow WWTP	0.10	--*	--*	--*	40	--*	7*
Unnamed tributary creek to Pepper-Luce Creek Downstream of Woodland Glen WWTP	0.30	--*	--*	--*	21	--*	2*
Pepper-Luce Creek	3.30	40	34	32	34	35	3
Chagrin River Downstream of Pepper-Luce Creek	22.60	38	40	48	53	37	14
*Indicates no HD installed, 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.							

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. The ICI score for this site improved from 36 in 2009 to 42 in 2012, but slightly decreased from 2012 to 2013 with a score of 40. While this site had a low percentage of mayflies, it also had a low percentage of pollution-tolerant organisms. A high percentage of Tanytarsini midges were collected at this site. In 2009, the number of coldwater taxa was four, which then decreased to two in 2012. The number of coldwater taxa remained the same as in 2012 with two species, which included *Boyeria grafiana* and *Parametriocnemus*; the latter of these two species was the same as in 2012. The collection of only two coldwater taxa signifies failure to meet the coldwater habitat use Ohio EPA had assigned following their last sampling on this stream in 1995 (Ohio EPA, 1997).

An ICI score of 32 was calculated with a narrative rating of *Fair* at Pepper-Luce Creek RM 3.30, downstream of Creekside WWTP. This is 2 points lower than the ICI score from 2012. It is also lower than the score from 2009, in which the ICI score was 40. A total of 35 taxa were collected, including 3 EPT taxa. Tanytarsini midges made up 32.8% of the sample and dipteran midges made up 30% of the sample. Pollution-tolerant

taxa including *Dicrotendipes*, *Ferrissa*, *Oligochaeta*, and *Cricotopus (C.) bicinctus* were also present, indicating possible water quality impairments.

The un-named tributary to Pepper-Luce Creek downstream of the Woodland Glen WWTP (RM 0.30) received a narrative rating of *Poor* based on qualitative sample results. A total of 21 taxa were collected in 2013 compared to the 17 taxa in 2012. Two EPT taxa were collected in 2013 compared to zero collected in 2012. In 2009, this site had an ICI score of 18 with 16 quantitative taxa sampled. The presence of pollution-tolerant taxa including *Oligochaeta* and *Polypedilum* may indicate water quality impairments from elevated bacteria levels. Moderate siltation was noted in the QHEI at this site, which may have also contributed to the lack of more sensitive species. Because this site received a *Poor* narrative rating on the ICI, it is in nonattainment for aquatic life use attainment status even though it had an IBI score of 36 (*Marginally Good*).

Conclusions

The purpose of this study was to collect post-construction monitoring data to determine if the decommissioning 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. Results from the Chagrin River mainstem indicate no overall impact at this time from the WWTPs, nor was impact notable when monitoring was conducted prior to the decommissioning in 2009. The site downstream of all the tributaries was similar to the upstream site, and both were in attainment of the biocriteria (Table 13).

Water quality at these sites changed very little from the year prior. *E. coli* densities and mercury levels at these sites are consistently elevated. The high mercury levels maybe due to atmospheric deposition, while the *E. coli* density could be caused by illicit discharges and run off from ponds, agricultural fields, and recreational fields located near the river. Nutrient loading varied from site to site, with only Pepper-Luce RM 0.30 and Wiley Creek RM 1.00 having levels of DIN and total phosphorus above the average amounts. Pepper-Luce RM 0.30 also had an Aquatic Life Exceedance for NH₃.

The QHEI analysis showed that most of the sites should be able to support robust fish communities. The sites not meeting the target score were Pepper-Luce RM 0.30 and Un-named Tributary RM 0.10 downstream of Quail Hollow. The low QHEI scores were reflected in the low IBI scores at these sites. In contrast, Chagrin RM 22.60, Wiley Creek RM 1.00 and Pepper-Luce RM 3.30 all received QHEI narrative ratings of *Excellent*.

The IBI and MIwb analyses conducted revealed a healthy fish community on Chagrin River RM 22.60, although lower than last year. This may have been due to a seasonal difference in river temperature during the electrofishing run. This site exceeded

the WWH Biocriterion, and it is expected that, had Chagrin River RM 26.70 been electrofished, it would have met WWH biocriterion as well. The other sites did not meet the WWH biocriterion and had the narrative rating of *Fair*, similar to 2012.

The macroinvertebrate communities surveyed at Chagrin River RM 26.70, Pepper-Luce RM 3.30 and Chagrin River RM 22.60 met the WWH biocriterion for. At Wiley Creek RM 1.00, four coldwater taxa were not collected on the Hester-Dendy; therefore, the site failed to meet the coldwater habitat designated use. Un-named tributary Downstream of Quail Hollow RM 0.10 and Un-named tributary Downstream of Woodland Glen RM 0.30 were not sampled using a quantitative method due to its small drainage area, and so, no ICI score was calculated.

Un-named tributary to Pepper- Luce at RM 0.30 and Pepper-Luce RM 3.30 were in partial attainment of the biocriteria. One characteristic setting them apart from the other sites may be the dam inhibiting upstream migration of fish from the Chagrin River.

The mainstem sites, Chagrin RM 22.60 and 26.70, seem 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. Pepper-Luce RM 3.30 is in partial attainment, while Wiley Creek RM 1.00, Unnamed tributary Downstream of Quail Hollow RM 0.10 and Pepper-Luce Downstream of Woodland Glen RM 0.30 are in non-attainment.

Each of the sites in the study will be assessed again in 2014 to collect additional post-construction data. The results of these assessments may help to further determine if the WWTPs were contributing to impacts to the biological community when they were still operational.

Table 13. 2013 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	--	--	42 (Very Good)	74.50 (Good)	FULL	<i>E. coli</i> , Mercury
Wiley Creek ¹ Downstream of Jackson Valley WWTP	1.00	--	--	40 (Good)	78.00 (Excellent)	NON	<i>E. coli</i> , Mercury
Unnamed tributary creek to Chagrin River Downstream of Quail Hollow WWTP	0.10	30 (Fair)	--	--* (Fair)	39.00 (Poor)	NON	<i>E. coli</i> , Mercury
Unnamed tributary creek to Pepper-Luce Creek Downstream of Woodland Glen WWTP	0.30	36 (Marginally Good)	--	--* (Poor)	53.00 (Fair)	NON	<i>E. coli</i> , Mercury, NH ₃
Pepper-Luce Creek	3.30	32 (Fair)	--	32 (Fair)	73.25 (Excellent)	PARTIAL	<i>E. coli</i> , Mercury
Chagrin River Downstream of Pepper-Luce Creek	22.60	42 (Good)	9 (Very Good)	48 (Exceptional)	84.25 (Excellent)	FULL	<i>E. coli</i> , Mercury

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

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