

NORTHEAST OHIO REGIONAL SEWER DISTRICT

2012 Chagrin River Environmental Monitoring Biological, Water Quality and Habitat Survey Results



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

Introduction

In 2012, 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 2012 was compared with baseline data collected in 2009 downstream of each of these treatment plants and on the Chagrin River upstream and downstream of all tributaries. 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 *2012 Chagrin River Environmental Monitoring* approved by Ohio EPA on May 15, 2012.

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.

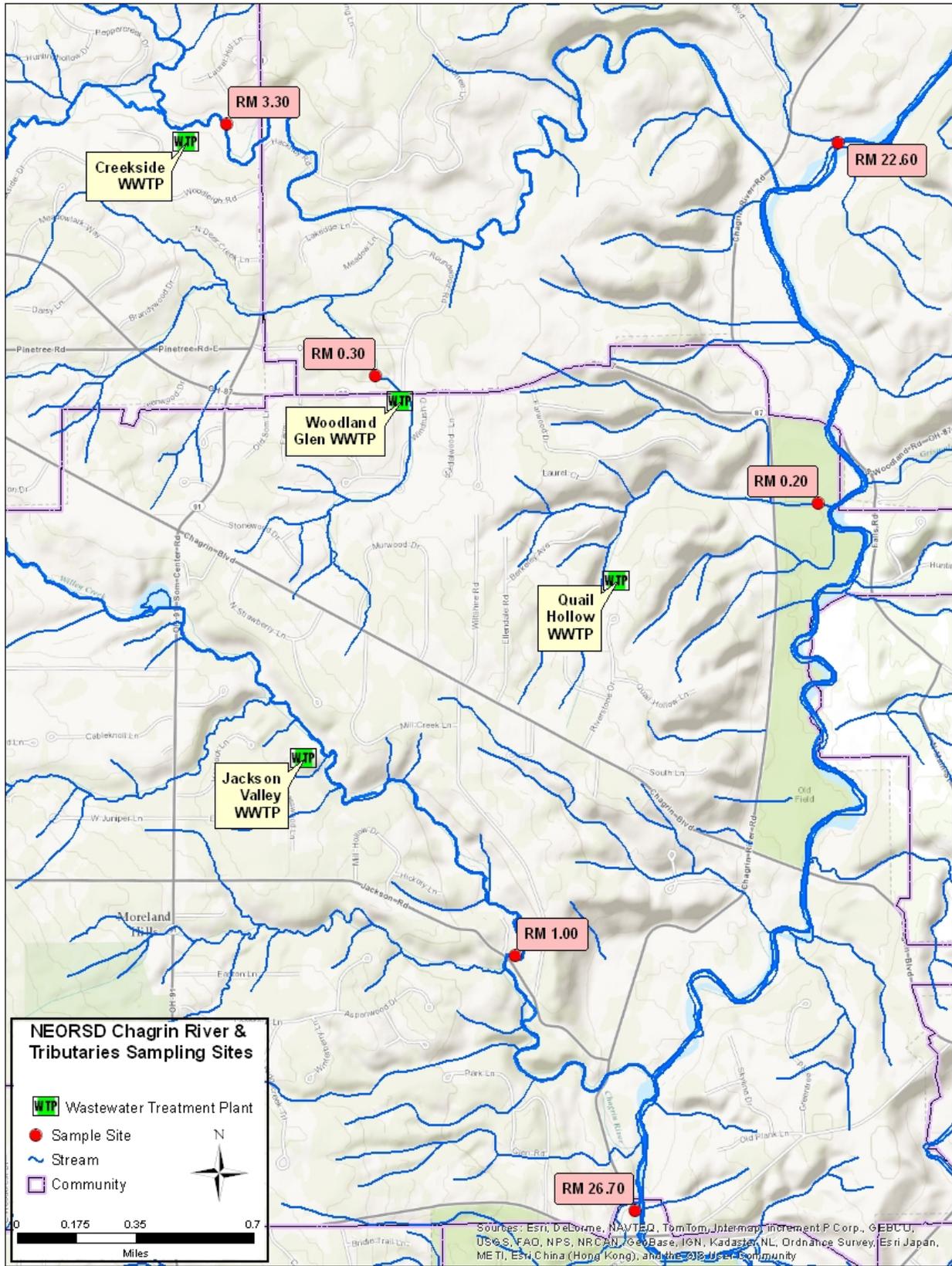


Figure 1. Chagrin River and Tributaries Biological, Habitat and Water Chemistry Sites

Table 1. 2012 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

Water Chemistry Sampling

Methods

Water chemistry and bacteriological sampling was conducted six times between July 25th, 2012 and August 22nd, 2012, on the Chagrin River and select tributaries. Techniques used for sampling and analyses followed the Ohio EPA *Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices* (2012) and *Surface Water Field*

Sampling Manual (2013). Chemical water quality samples from each site were collected with two 4-liter disposable polyethylene cubitainers with disposable polypropylene lids and two 473-mL plastic bottles. One of the plastic bottles was field preserved with trace nitric acid and the other was field preserved with trace sulfuric acid. All water quality samples were collected as grab samples. Bacteriological samples were collected in sterilized plastic bottles. 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 collected at randomly selected sites, at a frequency not less than 10% 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 Outside Mixing Zone Averages (OMZA), it generally cannot be determined if the Chagrin River and tributaries 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 those levels typically found in the river.

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

Results and Discussion

All of the sites monitored during the 2012 study, with the exception of Wiley Creek, are designated warmwater habitat, agricultural water supply, industrial water supply, and Class A primary contact recreation (Ohio EPA, 2009). Wiley Creek also has the latter three designations, but is designated coldwater habitat rather than warmwater habitat. The sites on the Chagrin River mainstem have an additional designation of seasonal salmonid habitat, in effect from October through May. Upon application of the Ohio water quality standards associated with each of these designations, exceedances for mercury and *Escherichia coli* (*E. coli*) were noted at several sampling sites.

Over the course of the sampling, three field blanks were collected for QA/QC purposes. The turbidity result for the field blank collected on August 8 at Wiley Creek RM 1.00 was rejected. The turbidity result for the field blank collected at the un-named tributary RM 0.10 on the same day was qualified as a “J”, or estimated value. It is unclear how the field blank became contaminated and may be due to inappropriate sample collection, handling, contaminated blank water and/or interference during turbidity analysis. Ohio EPA’s Credible Data program includes a data validation protocol for QA/QC samples. Using this protocol, none of the sample results needed to be downgraded from Level 3 to Level 2 credible data when compared to the field blanks.

Duplicate samples were collected on July 25 at Wiley Creek RM 1.00, August 1 at Chagrin River RM 22.60, and August 22 at Un-named tributary RM 0.10 for QA/QC purposes. The duplicate samples revealed 12 parameters that were rejected due to RPDs that were greater than the acceptable RPD (Table 2). There may be numerous reasons for why a large number of parameters were rejected, such as a lack of precision and consistency in sample collection and/or analytical procedures, environmental heterogeneity and/or improper handling of samples.

Paired parameters for all samples collected were also evaluated and compared for QA/QC purposes. These comparisons revealed that all of the data for chromium and hexavalent chromium were either estimated or rejected. Because there were no exceedances associated with these parameters, qualification of these results did not significantly change the overall water chemistry assessment of the streams in this study.

Table 2. Unacceptable RPDs

Date	Site	Parameter	Acceptable RPD (%)	Actual RPD (%)	Qualifier
7/25/2012	Wiley Creek RM 1.00	Aluminum	40.9	41.4	Rejected
		Chloride	16.6	20.5	Rejected
		Sulfate	15.8	27.2	Rejected
		TSS	43.4	73.3	Rejected

Table 2. Unacceptable RPDs					
Date	Site	Parameter	Acceptable RPD (%)	Actual RPD (%)	Qualifier
		Turbidity	35.8	107.4	Rejected
8/1/2012	Chagrin River RM 22.60	Ammonia	39.7	82.8	Rejected
		Vanadium	68.7	104.0	Rejected
		Aluminum	37.3	64.3	Rejected
8/22/2012	Un-named Tributary RM 0.10	E. coli	9.5	13.0	Rejected
		Iron	19.3	40.8	Rejected
		Manganese	9.9	14.8	Rejected
		TSS	39.8	74.8	Rejected

Table 3 lists exceedances of the Recreation Season geometric mean criterion for *E. coli* in the Chagrin River and its tributaries. The Class A Primary Contact Recreation criterion for the Chagrin River is an *E. coli* criterion not to exceed a single sample maximum (SSM) of 298 colony-forming units per 100 milliliters (CFU/100mL) in more than ten percent of the samples taken during any thirty-day period, and a seasonal geometric mean (SGM) criterion of 126 CFU/100mL (Table 3). The *E. coli* densities at two sites (Pepper-Luce Creek RM 3.30 and Chagrin River RM 26.70) exceeded the SSM of 298 CFU/100mL in more than ten percent of the samples taken for all thirty-day periods, while two sites (Un-named Tributary RM 0.30 and Un-named Tributary RM 0.10) exceeded the SSM for three thirty-day periods. Exceedances caused by bacterial contamination may be attributed to failing septic systems, improper sanitary connections, and other illicit discharges.

Table 3. 2012 Chagrin River and Tributaries <i>E. coli</i> Recreation Season Geometric Mean Exceedances (colony-forming units/100mL)				
Date	Un-named tributary RM 0.10	Un-named tributary RM 0.30	Pepper- Luce Creek RM 3.30	Chagrin River RM 26.70
7/25/2012	1267	180	370	170
8/1/2012	767	210	245	190
8/8/2012	76	4600	125	190
8/15/2012 ¹	933	252	504	395
8/22/2012	7700	205	400	210
Seasonal Geomean	512	389	296	219

Table 4. 2012 Chagrin River and Tributaries <i>E. coli</i> Recreation Season Single Sample Maximum (SSM) Exceedances (% Days > 298 cfu/100mL)				
30-Day Period	Un-named tributary RM 0.10	Un-named tributary RM 0.30	Pepper- Luce Creek RM 3.30	Chagrin River RM 26.70
7/25/2012 - 8/24/2012	75.0	20.0	60.0	20.0
8/1/2012 - 8/31/2012	66.7	25.0	50.0	25.0
8/8/2012 - 9/7/2012	50.0	33.3	66.7	33.3
8/15/2012 - 9/14/2012	--	--	100	50.0

Tables 5 and 6 list mercury exceedances of the nondrinking water criteria and protection of wildlife OMZA criterion. All sample sites in the 2012 study exceeded the criterion for the protection of wildlife for all 30-day periods. Similarly, all sites exceeded the OMZA criterion for nondrinking water for all 30-day periods except the 30-day period from August 15th-September 14th.

¹ Wet weather sampling events: 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 5. Chagrin River Mercury Exceedances

Site	Sample Date	Form (units)	Concentration	30-day period	30-day Average Concentration	OMZA Criterion Nondrinking	OMZA Criterion Wildlife
Chagrin River Upstream of Wiley Creek							
RM 26.70	7/25/2012	TR (µg/L)	<0.005	7/25/2012-8/24/2012	0.004	0.0031	0.0013
RM 26.70	8/1/2012	TR (µg/L)	<0.005	8/1/2012-8/31/2012	0.004	0.0031	0.0013
RM 26.70	8/8/2012	TR (µg/L)	j 0.009	8/8/2012-9/7/2012	0.005	0.0031	0.0013
RM 26.70	8/15/2012	TR (µg/L)	<0.005	8/15/2012-9/14/2012	0.003	0.0031	0.0013
Chagrin River Downstream of Pepper-Luce Creek							
RM 22.60	7/25/2012	TR (µg/L)	<0.005	7/25/2012-8/24/2012	0.004	0.0031	0.0013
RM 22.60	8/1/2012	TR (µg/L)	<0.005	8/1/2012-8/31/2012	0.004	0.0031	0.0013
RM 22.60	8/8/2012	TR (µg/L)	j 0.009	8/8/2012-9/7/2012	0.005	0.0031	0.0013
RM 22.60	8/15/2012	TR (µg/L)	<0.005	8/15/2012-9/14/2012	0.003	0.0031	0.0013

TR= Total Recoverable

j= Estimated value between PQL and MDL

Shading= 30-day period exceedance of the criterion

Table 6. Chagrin River Tributaries Mercury Exceedances

Site	Sample Date	Form (units)	Concentration	30-day period	30-day Average Concentration	OMZA Criterion Nondrinking	OMZA Criterion Wildlife
Wiley Creek Downstream of Jackson Valley WWTP							
RM 1.00	7/25/2012	TR (µg/L)	<0.005	7/25/2012-8/24/2012	0.004	0.0031	0.0013
RM 1.00	8/1/2012	TR (µg/L)	<0.005	8/1/2012-8/31/2012	0.004	0.0031	0.0013
RM 1.00	8/8/2012	TR (µg/L)	j 0.009	8/8/2012-9/7/2012	0.005	0.0031	0.0013
RM 1.00	8/15/2012	TR (µg/L)	<0.005	8/15/2012-9/14/2012	0.003	0.0031	0.0013
Un-named Tributary Downstream of Quail Hollow WWTP							
RM 0.10	7/25/2012	TR (µg/L)	<0.005	7/25/2012-8/24/2012	0.003	0.0031	0.0013
RM 0.10	8/1/2012	TR (µg/L)	<0.005	8/1/2012-8/31/2012	0.004	0.0031	0.0013
RM 0.10	8/8/2012	TR (µg/L)	j 0.009	8/8/2012-9/7/2012	0.004	0.0031	0.0013
RM 0.10	8/15/2012	TR (µg/L)	<0.005	8/15/2012-9/14/2012	0.003	0.0031	0.0013
Un-named Tributary to Pepper-Luce Creek Downstream of Woodland Glen WWTP							
RM 0.30	7/25/2012	TR (µg/L)	<0.005	7/25/2012-8/24/2012	0.005	0.0031	0.0013
RM 0.30	8/1/2012	TR (µg/L)	<0.005	8/1/2012-8/31/2012	0.005	0.0031	0.0013
RM 0.30	8/8/2012	TR (µg/L)	j 0.013	8/8/2012-9/7/2012	0.006	0.0031	0.0013

Table 6. Chagrin River Tributaries Mercury Exceedances

Site	Sample Date	Form (units)	Concentration	30-day period	30-day Average Concentration	OMZA Criterion Nondrinking	OMZA Criterion Wildlife
RM 0.30	8/15/2012	TR (µg/L)	<0.005	8/15/2012-9/14/2012	0.003	0.0031	0.0013
Pepper-Luce Creek Downstream of Creekside WWTP							
RM 3.30	7/25/2012	TR (µg/L)	<0.005	7/25/2012-8/24/2012	0.004	0.0031	0.0013
RM 3.30	8/1/2012	TR (µg/L)	<0.005	8/1/2012-8/31/2012	0.005	0.0031	0.0013
RM 3.30	8/8/2012	TR (µg/L)	j 0.012	8/8/2012-9/7/2012	0.006	0.0031	0.0013
RM 3.30	8/15/2012	TR (µg/L)	<0.005	8/15/2012-9/14/2012	0.003	0.0031	0.0013

TR= Total Recoverable

j= Estimated value between PQL and MDL

Shading= 30-day period exceedance of the criterion

Habitat Assessment

Methods

Instream habitat assessments were conducted once at each site in 2012 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 60 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 NEORSWQIS Division.

Results and Discussion

Of the six sites surveyed in 2012, five were classified as “*Good*” or “*Excellent*” and exceeded the target score of 60 set by the Ohio EPA (Table 7). Sites meeting this goal are expected to meet the warmwater habitat or coldwater habitat designated uses. Three sample locations exceeded a score of 75, which indicates that they should have the ability to support exceptional warmwater habitat communities.

Table 7. 2012 Chagrin River and Tributaries QHEI Results and Stream Flows

River Mile	Date	2012 QHEI Score	2009 QHEI Score	2012 Narrative Rating	Stream Flow (ft ³ /s)*
Chagrin River RM 26.70	10/04/2012	78.00	76.00	<i>Excellent</i>	116
Wiley Creek RM 1.00	10/04/2012	77.25	80.00	<i>Excellent</i>	116
Un-named Trib. RM 0.10	10/04/2012	42.50	38.00	<i>Poor/Fair</i>	116
Un-named Trib. RM 0.30	10/12/2012	62.25	62.00	<i>Good</i>	117
Pepper-Luce Creek RM 3.30	10/09/2012	82.50	71.25	<i>Excellent</i>	179
Chagrin River RM 22.60	10/09/2012	81.00 ¹	71.50	<i>Excellent</i>	179

*Provisional flow data obtained from USGS 04209000 Chagrin River flow gauge in Willoughby, Ohio
¹ 2012 sampling site moved approximately 0.60 RMs upstream from 2009 sampling site

The two Chagrin River mainstem sites both obtained narrative ratings of “*Excellent*”. Each site contained high quality substrates including boulders, boulder slabs, and cobble. Instream cover included boulders, rootmats, woody debris, and deep pools. Fair to good development and high quality riffles were present at both sites.

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, obtained a score of 42.50 and a narrative rating of “*Poor/Fair*”. 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.

Wiley Creek at RM 1.00, downstream of Jackson Valley WWTP, obtained a QHEI score of 77.25. This site was dominated by a cobble substrate and a moderate

amount of suitable instream cover including undercut banks, deep pools, and rootmats. Moderate sinuosity and good development combined with a wide riparian zone and semi-forested floodplain contributed to a narrative rating of “*Excellent*” at this site.

The site on the un-named tributary to Pepper-Luce Creek downstream of Woodland Glen WWTP obtained a QHEI score of 62.25 and a narrative rating of “*Good*”. Instream cover at this site consisted of undercut banks, shallows, rootmats, woody debris, and boulders. Riparian width was wide, with a forested floodplain present. Factors detracting from the score at this site included the presence of moderate silt, moderate erosion, and lack of deep pools.

Pepper-Luce Creek at RM 3.30, downstream of Creekside WWTP, obtained a QHEI score of 82.50 and a narrative rating of “*Excellent*”. This site was characterized by a moderate amount of instream cover consisting of undercut banks, deep pools, woody debris and rootwads. The substrate was made up of cobble and gravel with heavy to moderate siltation present. The riparian zone was wide, with the floodplain dominated by forest. Deep pools and a stable riffle were present, leading to an overall high score.

Electrofishing

Methods

Electrofishing passes were conducted one time at each site in 2012. 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 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, and examined for the presence of DELT anomalies (deformities, eroded fins, lesions, and tumors). All fish were then released to the waters from which they were collected, except for vouchers and those that could not be easily identified in the field.

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). The IBI is used for both wading and headwater sites, while the MIwb does not apply to headwater 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 12 metrics utilized for wading and headwater sites are listed in Table 8.

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 8. 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

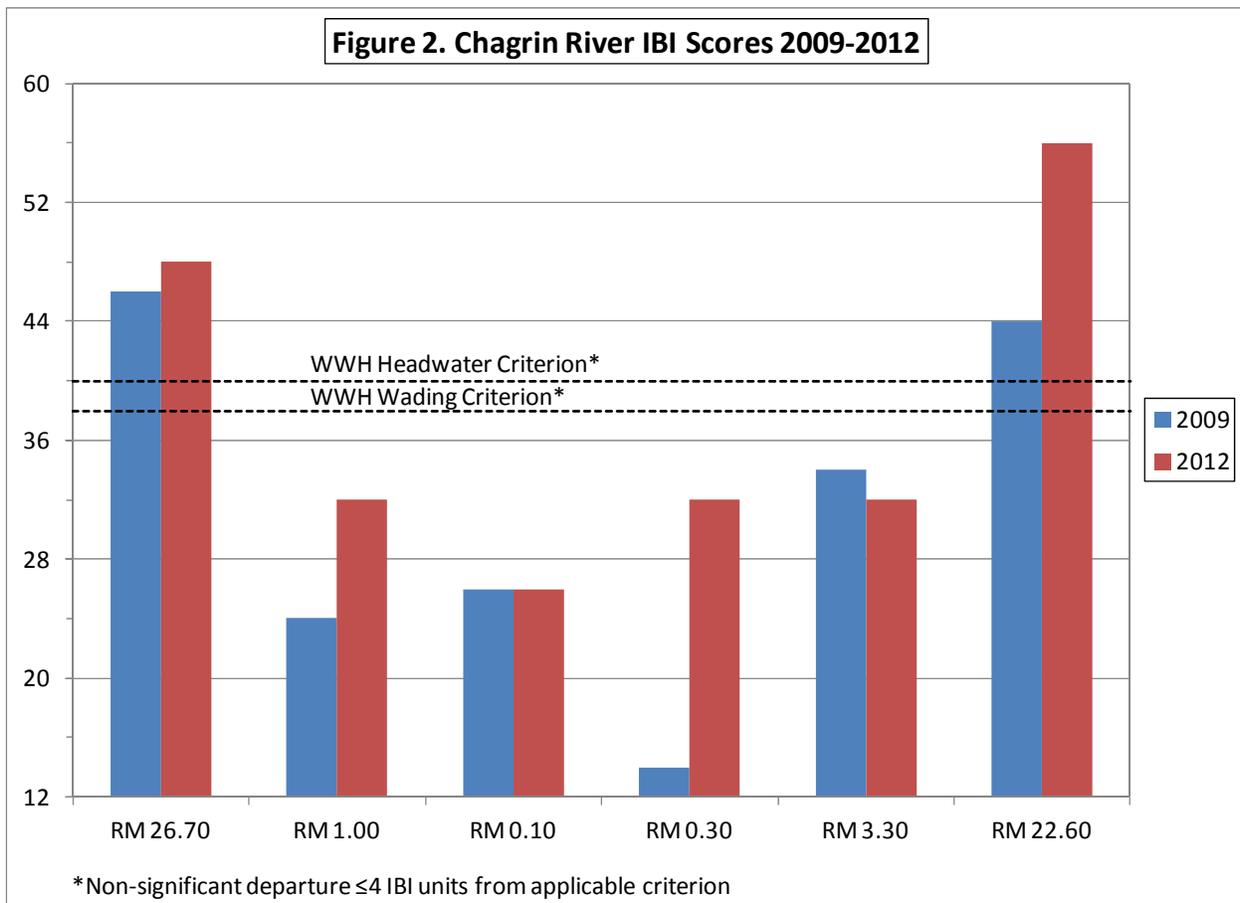
As shown in Table 9 and Figure 2, electrofishing results indicate that the two sites on the Chagrin River were in full attainment of warmwater habitat criteria for fish communities. An IBI score of 48 (*Very Good*) was obtained at RM 26.70 while a score of 56 (*Exceptional*) was obtained at RM 22.60. These scores indicate that the Chagrin River mainstem is fully capable of supporting a diverse population of pollution-sensitive species as indicated by the presence of river chub (*Nocomis micropogon*), rosyface shiner (*Notropis rubellus*), stonecat madtom (*Noturus flavus*) and black redhorse (*Maxostoma duquesnei*). Golden redhorse (*Maxostoma erythrurum*) and black redhorse were not collected during the 2009 survey, but were collected in 2012. The removal of the Gates Mills dam at RM 18.00 in February 2011 most likely allowed these species to migrate upstream and colonize previously-uninhabited portions of the stream. Overall index scores indicate that the mainstem of the Chagrin River is of good quality and is currently unimpacted by the tributary streams surveyed in this study plan.

None of the headwater sites sampled in 2012 met their respective habitat designations. Pepper-Luce Creek at RM 3.30 obtained an IBI score of 32 (*Fair*). 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, potentially diminishing the IBI score.

Table 9. Index of Biotic Integrity and Modified Index of Well-Being Scores					
Site	River Mile	2012 IBI Score	2009 IBI Score	2012 MIwb Score	2009 MIwb Score
Chagrin River Upstream of Wiley Creek	26.70	48 (Very good)	46 (Very good)	9.7 (Exceptional)	8.6 (Good)
Wiley Creek Downstream of Jackson Valley WWTP	1.00	32 (Fair)	24 (Poor)	N/A	N/A
Un-named tributary to Chagrin River Downstream of Quail Hollow WWTP	0.10	26 (Poor)	26 (Poor)	N/A	N/A
Un-named tributary to Pepper-Luce Creek Downstream of Woodland Glen WWTP	0.30	32 (Fair)	14 (Very Poor)	N/A	N/A

Table 9. Index of Biotic Integrity and Modified Index of Well-Being Scores					
Site	River Mile	2012 IBI Score	2009 IBI Score	2012 MIwb Score	2009 MIwb Score
Pepper-Luce Creek	3.30	32 (Fair)	34 (Fair)	N/A	N/A
Chagrin River Downstream of Pepper-Luce Creek	22.60	56 (Exceptional)	44 (Good)	10.1 (Exceptional)	8.8 (Good)

Bold indicates attainment of applicable criterion



Wiley Creek at RM 1.00 obtained an IBI score of 32 (*Fair*) in 2012, an improvement from the score of 24 (*Poor*) in 2009. Although this site is designated coldwater habitat, no species associated with such a designation were collected. Pollution-tolerant species including white sucker, 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.

The un-named tributary to the Chagrin River downstream of the Quail Hollow WWTP obtained an IBI score of 26 (*Poor*). Only two species were collected at this site, western blacknose dace and creek chub, both 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 43.5 (*Poor*).

The un-named tributary to Pepper-Luce Creek downstream of the Woodland Glen WWTP obtained an IBI score of 32 (*Fair*), an improvement from the 2009 IBI score of 14 (*Very Poor*). A total of 146 individuals were collected in 2012 compared to 12 individuals in 2009, which most likely contributed to a higher IBI score. Creek chub, western blacknose dace, and largemouth bass made up the 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 Midwest Biodiversity Institute (MBI) of Columbus, Ohio, 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 10) 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 10. 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

Four out of the six sites sampled in 2012 were sampled both quantitatively using HDs in conjunction with qualitative sampling. Two 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 very low. All of the sites sampled quantitatively were in attainment or non-significant departure (≤ 4 ICI units) from the warmwater habitat ICI criterion of 34 (Table 11). The upstream site on the Chagrin River (RM 26.70) obtained the highest ICI score (42) and highest number of taxa collected from the HD (“quantitative taxa”) (38) of any site sampled. The downstream site (RM 22.60) had slightly fewer quantitative taxa than upstream (33) and a slightly lower ICI score (40). 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.

Table 11. Macroinvertebrate Results

Stream & Location	River Mile	2012 ICI Score	2009 ICI Score	Number of Quantitative Taxa 2012	Number of Quantitative Taxa 2009	Number of EPT Taxa 2012	Number of EPT Taxa 2009
Chagrin River Upstream of Wiley Creek	26.70	42	44	38	31	15	15
Wiley Creek ¹ Downstream of Jackson Valley WWTP	1.00	42	36	29	24	8	5
Unnamed tributary creek to Chagrin River Downstream of Quail Hollow WWTP	0.10	--*	30	--*	19	4	1
Unnamed tributary creek to Pepper-Luce Creek Downstream of Woodland Glen WWTP	0.30	--*	18	--*	16	0	0
Pepper-Luce Creek	3.30	34	40	29	32	5	4
Chagrin River Downstream of Pepper-Luce Creek	22.60	40	38	33	22	12	13

* Indicates no HD installed in 2012, qualitative sample only

Bold indicates attainment of designated criterion

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

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 and concerns over lack of flow over the HD. The number of total taxa collected increased from 18 taxa in 2009 to 35 taxa in 2012. EPT taxa increased from one taxon in 2009 to four taxa in 2012, 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 *Marginally Good/Fair* based on 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. The ICI score for this site improved from 36 in 2009 to 42 in 2012. 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. The number of coldwater taxa decreased from four in 2009 to two in 2012 and included *Diamesa* and

Parametriocnemus. 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). One factor at this sampling site that may have affected its ability to meet criteria could be changes along the streambank made by the landowner.

Pepper-Luce Creek RM 3.30, downstream of Creekside WWTP, obtained an ICI score of 34 and a qualitative narrative rating of *Fair*. This represents an overall decrease in scoring from 2009, in which the site obtained an ICI score of 40. A total of 48 taxa were collected, including 5 EPT taxa, a decrease of one taxon from 2009. Tanytarsini midges made up 54% of the sample. Pollution-tolerant taxa including *Dicrotendipes*, *Physella*, and *Cricotopus* were also present, indicating possible water quality impairments. Low-flow periods during the 6-week sampling period may have also contributed to the decrease in taxa in 2012.

The un-named tributary to Pepper-Luce Creek downstream of the Woodland Glen WWTP (RM 0.30) received a narrative rating of *Poor/Very Poor* based on qualitative sampling results. A total of 17 taxa were collected during the qualitative sample; no EPT taxa were collected. The presence of pollution-tolerant taxa including *Oligochaeta*, *Dicrotendipes*, and *Polypedilum* may indicate water quality impairments from elevated bacteria levels or metals contamination. Moderate siltation was noted in the QHEI at this site, which may have also contributed to the lack of more sensitive species.

Conclusions

The purpose of this study was to collect post-construction monitoring data to determine if the decommissioning of the four WWTPs 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, as the site downstream of all the tributaries was similar to the upstream site, and both were in full attainment of the biocriteria.

The sites that were sampled downstream of the Jackson Valley, Creekside, and Quail Hollow WWTPs were in partial attainment of the biocriteria, meeting the ICI criterion, but not the IBI criterion. The first two of these streams had downstream migration barriers that were likely impacting the fish community. For the site downstream of the Quail Hollow WWTP, habitat is most likely the limiting factor, as the QHEI score continues to be below that which is expected to meet attainment of the warmwater habitat criteria. There is no strong indication that water quality impacts are significantly affecting the biological community at these sites since the macroinvertebrate results are indicative of a healthy population.

The final tributary stream that was sampled, downstream of the Woodland Glen WWTP, was in non-attainment of the biological criteria. The IBI score at this site improved significantly; an IBI score of 32 (Fair) was obtained in 2012, an increase from a score of 14 in 2009. Low drainage area and pollution from metals may be adversely affecting the macroinvertebrate community at this site. Since bacterial contamination is still present in the stream after the decommissioning of the Woodland Glen WWTP, failing septic tanks in the area may be the source of contamination.

Each of the sites in the study was assessed again in 2013 to collect additional post-decommissioning 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.

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