NORTHEAST OHIO REGIONAL SEWER DISTRICT

2017 Euclid Creek Environmental Monitoring
Biological, Water Quality and Habitat Survey Results

Prepared by
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Introduction

In 2017, the Northeast Ohio Regional Sewer District (NEORSD) conducted water chemistry sampling, habitat assessments, and fish and benthic macroinvertebrate community surveys on Euclid Creek. Euclid Creek drains the communities of South Euclid, Lyndhurst, Willoughby Hills, Richmond Heights, Highland Heights, Euclid and Cleveland before emptying into Lake Erie. Sampling was conducted by NEORSD Level 3 Qualified Data Collectors certified by the Ohio Environmental Protection Agency (Ohio EPA) in Fish Community and Benthic Macroinvertebrate Biology, Chemical Water Quality and Stream Habitat Assessments as explained in the NEORSD study plan *2017 Euclid Creek Environmental Monitoring* approved by Ohio EPA on May 12, 2017.

One of the study objectives at river miles (RM) 0.55 and RM 1.65, on the main branch of Euclid Creek, was to assess the attainment status of the stream segments. The sites at RM 0.55 and 1.65 are also required under the Ohio EPA National Pollutant Discharge Elimination System (NPDES) Permit No. 3PA00002*HD.

An additional objective at RMs 0.55 and 1.65 was to collect pre- and post-construction data of three NEORSD Project Clean Lake capital improvement projects that will reduce the current amount of over 60 combined sewer overflow (CSO) discharges per year to less than 2 per year entering Euclid Creek. The Euclid Creek Pump Station Project, the Euclid Creek Tunnel, and the Easterly Tunnel Dewatering Pump Station are complete and were expected to start CSO collection in the fall of 2017. However, the Easterly Tunnel Dewatering Pump Station is not operational for flow from these CSO points. This deep pump station is currently being examined to determine what the issue may be and it is expected that it will be functional this spring. Once complete, these construction projects are anticipated to control the number of CSO discharges to Euclid Creek and reduce pollution to Lake Erie.

Table 1 lists the sampling sites with respect to RM, latitude/longitude, description, and types of surveys conducted, and Figure 1 is a map of the sampling locations on the creek.

Table 1. 2017 Euclid Creek Sampling Sites

Water Body	Latitude	Longitude	River Mile	Location Information	USGS HUC 8 Number Name	Purpose
Euclid Creek, Main Branch	41.5741	-81.5467	1.65	Upstream of Saint Clair Avenue	04110003 Ashtabula-Chagrin	Evaluate water chemistry, habitat, fish & macroinvertebrates in support of Ohio EPA Permit No. 3PA00002*HD
Euclid Creek, Main Branch	41.5833	-81.5594	0.55	Downstream of Lake Shore Boulevard	04110003 Ashtabula-Chagrin	Evaluate water chemistry, habitat, fish & macroinvertebrates in support of Ohio EPA Permit No. 3PA00002*HD

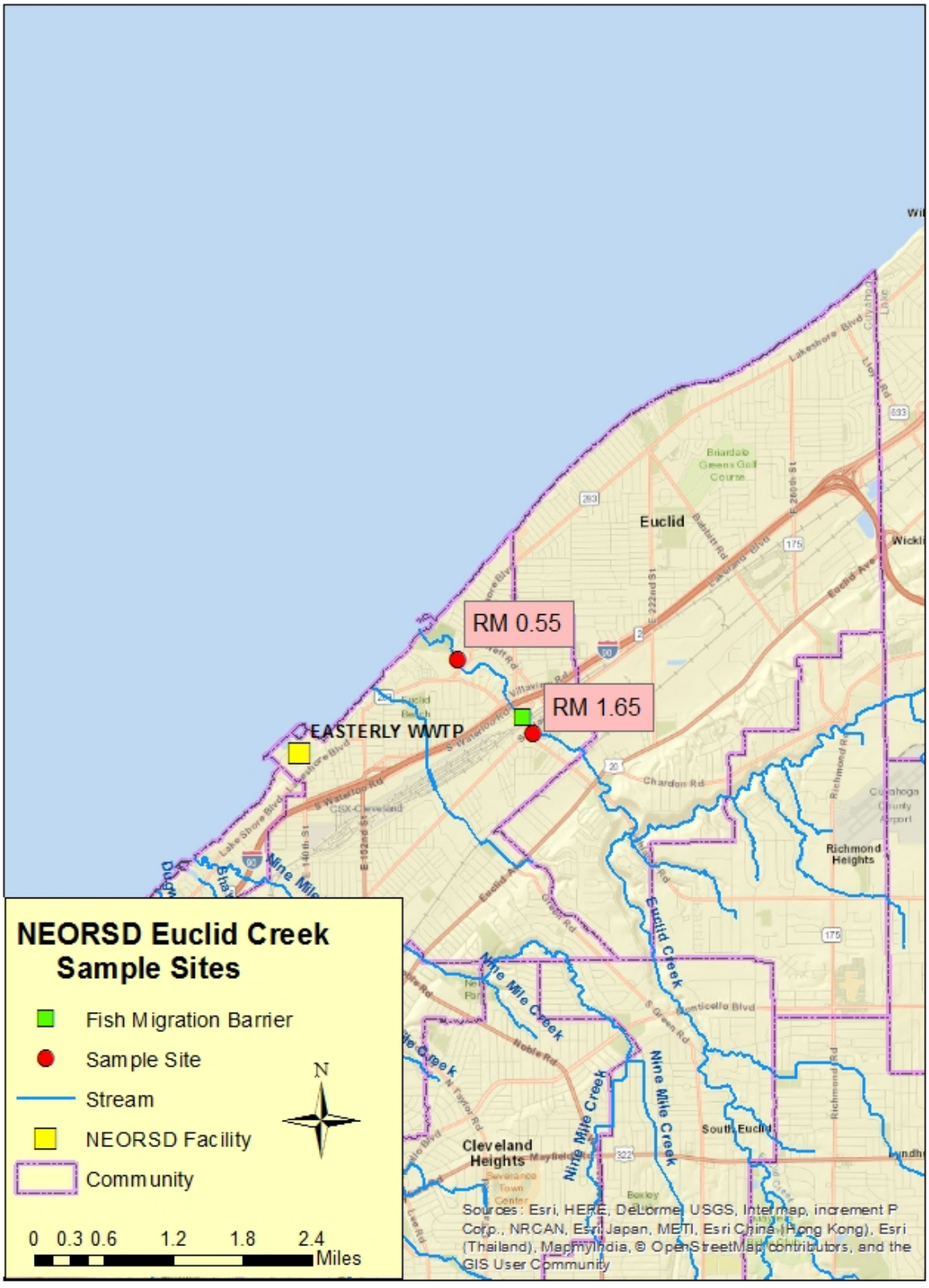


Figure 1. 2017 Sampling Locations on Euclid Creek

Water Chemistry & Bacteriological Sampling

Methods

Water chemistry and bacteriological sampling was conducted five times between June 15 and July 12, 2017. Techniques used for sampling and analyses followed the Ohio EPA *Surface Water Field Sampling Manual for water quality parameters and flows* (2015). Chemical water quality samples from each site were collected with a 4-liter disposable polyethylene cubitainer with a disposable polypropylene lid, three 473-mL plastic bottles and one 125-mL plastic bottle. The first 473-mL plastic bottle was field preserved with trace nitric acid, the second was field preserved with trace sulfuric acid, and the third bottle received no preservative. The sample collected in the 125-mL plastic bottle (dissolved reactive phosphorus) was filtered using a 0.45-µm PVDF syringe filter. All water quality samples were collected as grab samples. Bacteriological samples were collected in sterilized plastic bottles preserved with sodium thiosulfate. At the time of sampling, measurements for dissolved oxygen, pH, temperature, and conductivity were collected using either a YSI 600XL sonde or YSI EXO1 sonde. Duplicate samples and field blanks were each collected at randomly selected sites, at a frequency not less than 5% of the total samples collected. Relative percent difference (RPD) was used to determine the degree of discrepancy between the primary and duplicate sample (Formula 1).

Formula 1:

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

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

The acceptable percent RPD is based on the ratio of the sample concentration and detection limit (Formula 2) (Ohio EPA, 2013a).

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

Over the course of the sampling, one field blank was collected for QA/QC purposes on July 5, 2017, at RM 0.55. A total of two water quality parameters were estimated due to potential field blank contamination. It is unclear how the field blanks became contaminated and may be due to inappropriate sample collection, handling, contaminated

blank water and/or interference during analysis. Table 2 lists water quality parameters that were listed as estimated based on Ohio EPA data validation protocol.

Table 2. Potential Field Blank Contamination
Chromium
Dissolved Reactive Phosphorus

One duplicate sample was collected on June 21, 2017, at RM 1.65 for QA/QC purposes. The duplicate sample collected at RM 1.65 revealed one parameter that was rejected due to RPDs that were greater than the acceptable RPD (Table 3). There are numerous potential reasons for why this parameter was rejected, such as a lack of precision and consistency in sample collection and/or analytical procedures, environmental heterogeneity and/or improper handling of samples.

Table 3. Unacceptable Duplicate RPDs					
River Mile	Date	Parameter	Acceptable RPD (%)	Actual RPD (%)	Qualifier
1.65	6/21/2017	COD	73.3	87.1	Rejected

Paired parameters for all samples collected were also evaluated and compared for QA/QC purposes using the same RPD formula as with the duplicate samples. In 2017, six instances occurred in which the data for the paired parameters needed to be qualified because the sub-parameter was greater than the parent one (Table 4). The reason for the TDS and NO_3 being greater than the parent parameters is unknown, but may be due to the fact that there are two separate methods for analyzing the individual parameters.

Table 4. Unacceptable Paired Parameter RPDs					
River Mile	Date	Paired Parameter	Acceptable RPD (%)	Actual RPD (%)	Qualifier
0.55	6/28/2017	NO_3+NO_2/NO_3	33.2	0.3	J
	7/5/2017	NO_3+NO_2/NO_3	34.7	0.3	J
1.65	6/21/2017	NO_3+NO_2/NO_3	26.7	0.1	J
	6/28/2017	NO_3+NO_2/NO_3	32.0	1.6	J
	7/5/2017	TS/TDS	15.8	8.1	J
	7/12/2017	NO_3+NO_2/NO_3	38.4	0.5	J
J = Result is estimated.					

All sites on Euclid Creek are designated as Warmwater Habitat (WWH), Agricultural Water Supply, Industrial Water Supply, and Primary Contact Recreation (Ohio EPA, 2016). The results of the water chemistry and bacteriological samples were compared to the applicable water quality standards to determine attainment status for those designated uses. Of that comparison, exceedances were noted for *Escherichia coli*.

The Primary Contact Recreation criteria for Euclid Creek includes an *E. coli* criterion not to exceed a statistical threshold value (STV) of 410 colony counts per 100 milliliters in more than ten percent of the samples taken during any ninety-day period, and a ninety-day geometric mean criterion of 126 colony counts/100mL (Ohio EPA, 2016). The STV of 410 colony counts/100mL in more than ten percent of the samples taken was exceeded at both RM 0.55 and RM 1.65 for all 90-day periods. Additionally, all sites exceeded the ninety-day geometric mean criterion of 126 colony counts/100mL for all 90-day periods (Table 5).

There are several possible reasons why these sites exceeded the STV and ninety-day geometric mean criteria. The NEORSD has three CSOs on Euclid Creek and there are additional CSOs upstream in the city of Euclid, all of which may cause elevated *E. coli* densities in the creek during wet-weather overflows. Four of the five sampling dates were considered wet-weather events. Elevated *E. coli* levels were observed for each wet-weather sampling, but also the dry-weather sample collected July 5, 2017. *E. coli* densities were highest at all sites on June 15, 2017, which was considered a wet-weather sampling event. The rainfall before sampling may have contributed to elevated bacteria levels. Wet-weather may contribute to elevated bacteria levels by causing discharges from CSOs, storm sewer runoff, and urban runoff into Euclid Creek.

Table 5. 2017 Euclid Creek *E. coli* Densities (most probable number/100mL)

Sample Date	RM 0.55		RM 1.65	
	E. coli (MPN/100 mL)	90-Day Geomean	*E. coli* (MPN/100 mL)	90-Day Geomean
*6/15/2017	7,980	2,089	3,470	1,134
*6/21/2017	1,485	1,494	874	857
*6/28/2017	992	1,497	496	852
7/5/2017	1,386	1,839	1,232	1,117
*7/12/2017	2,439	2,439	1,012	1,012

*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.

Exceeds statistical threshold value criterion for 90-day period starting on that date

Exceeds 90-day geometric mean criterion

Additionally, there are numerous documented improper connections and bacteriologically contaminated storm sewer discharges in the cities of Cleveland and Euclid, which could have an impact on the water quality in Euclid Creek during dry-weather conditions. The issue of storm sewer bacteriological contamination within the Euclid Creek watershed has been thoroughly investigated since 2005 and communicated to the appropriate community for eventual remediation. Between 2013 and 2017, NEORSD revisited many of the documented issues and have found that, while some have been remediated in the last few years, there were still some active problems. Finally, bacteriological contamination from failing septic systems in the Euclid Creek watershed may also be impacting the water quality at the sample sites.

Mercury analysis for 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 (USEPA, 2004).

In 2015, the Ohio EPA Nutrients Technical Advisory Group released a proposed Stream Nutrient Assessment Procedure (SNAP) designed to determine the degree of impairment in a stream due to nutrient enrichment. SNAP assigns designations for quality of surface waters based on factors including dissolved oxygen (DO) swings, benthic chlorophyll *a*, total phosphorous, and dissolved inorganic nitrogen (Ohio EPA, 2015a).

While all the parameters necessary for SNAP were not assessed in 2017 at Euclid Creek, nutrients were assessed for general watershed monitoring at the sites. Table 6 shows the results of the geometric mean concentration and standard deviations of all five sampling events in 2017 for dissolved inorganic nitrogen, total phosphorus, and dissolved reactive phosphorus. Table 2 of SNAP assesses a general ecological risk of nutrient enrichment based upon the dissolved inorganic nitrogen and total phosphorus concentrations. According to this section of SNAP, RM 1.65 exhibits "levels typical of developed lands; little or no risk to beneficial uses." RM 0.55 exhibits "background levels typical of least disturbed conditions," (Ohio EPA, 2015a). This indicated that neither phosphorus nor nitrogen are of a significant concern as a primary source of impairment at these two sites. Some of the nutrients measurements were made during wet weather and SNAP requires dry weather.

Table 6. Nutrient Results for Euclid Creek used for SNAP Analysis

River Mile	Sample Date	Total Phosphorus (mg/L)	DRP (mg/L)	Dissolved Inorganic Nitrogen (mg/L)
0.55	6/15/2017	0.032	0.015	0.775
	6/21/2017	0.050	0.032	0.785
	6/28/2017	0.037	0.023	0.344
	7/5/2017	0.029	0.017	0.297
	7/12/2017	0.047	0.020	0.177
	GeoMean	0.038	0.021	0.406
	StdDev	0.009	0.008	0.266
1.65	6/15/2017	0.032	0.016	0.826
	6/21/2017	0.054	0.041	0.730
	6/28/2017	0.038	0.032	0.389
	7/5/2017	0.035	0.022	0.381
	7/12/2017	0.038	0.029	0.212

	Table 6. Nutrient Results for Euclid Creek used for SNAP Analysis			
River Mile	Sample Date	Total Phosphorus (mg/L)	DRP (mg/L)	Dissolved Inorganic Nitrogen (mg/L)
	GeoMean	0.039	0.027	0.452
	StdDev	0.010	0.011	0.230

Land Cover Analysis

A land cover analysis was performed of the watershed areas that drain to each 2017 sample location. The United States Geologic Survey StreamStats Program was first used to obtain a polygon representing the watershed. The corresponding watershed polygon was then imported to ArcMap 10.3 and the intersect tool was used to combine the watershed with the National Land Cover Database, 2011 (Homer et.al, 2015). The resulting figure represented the different types of land cover that drain to each sample location. The entire Euclid Creek watershed is presented in Figure 2. Percentages of the total area at each site were then calculated. Similar land cover types were combined and are displayed in Figure 3.

A highly urban floodplain has been linked to numerous water-quality and flow effects. Pollutants associated with urban runoff include sediments, nutrients, pathogens, oxygen-demanding matter, heavy metals, and salts (Schueler, 1987). Both sites on Euclid Creek exhibit high amounts of a developed landscape and this may have a negative effect on water quality in Euclid Creek.

Figure 2: Euclid Creek Watershed Land Cover Map

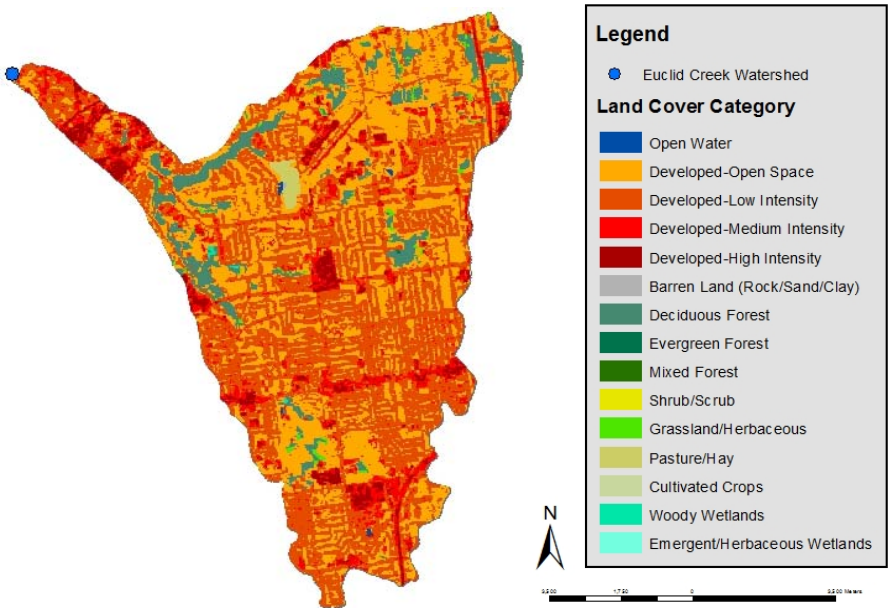
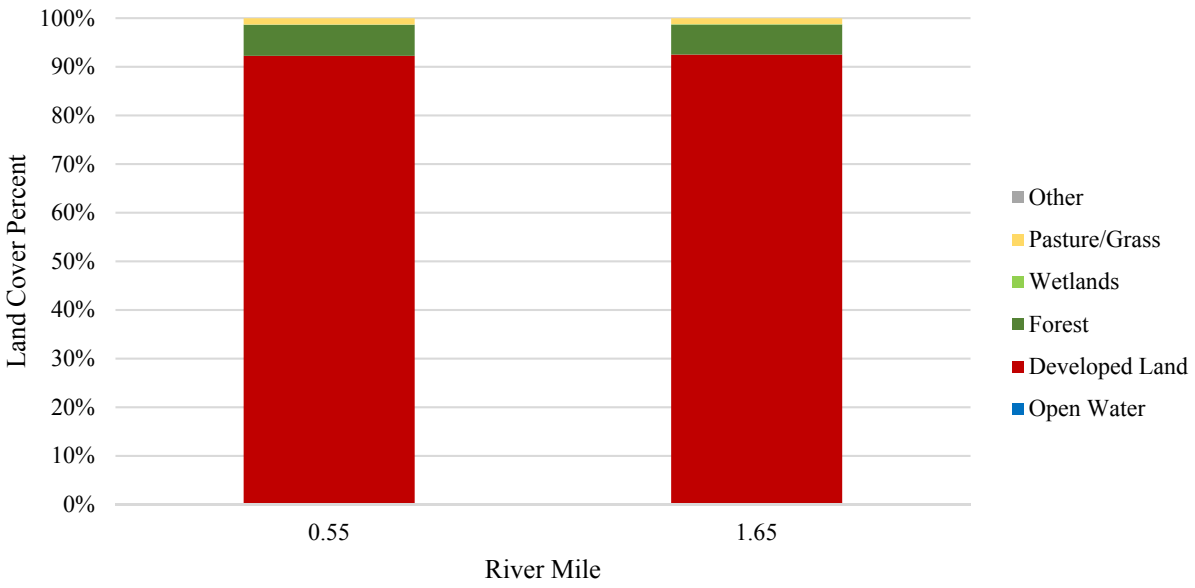


Figure 3: Land Cover Percentages in the Euclid Creek Watershed



Habitat Assessment

Methods

Instream habitat assessments were conducted once at each site on Euclid Creek in 2017 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 in streams >20 square miles suggests that sufficient habitat exists to support a fish community that meets the warmwater habitat criterion (Ohio EPA, 2005). 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

QHEI scores on Euclid Creek ranged from *Good* to *Excellent* in 2017. Both sampling sites RM 1.65 and 0.55 met the Ohio EPA's target score of 60, meaning that these sites have habitat suitable to support a community of warmwater habitat fish species (Table 7).

Euclid Creek RM 1.65 had the highest QHEI score in 2017, receiving an *Excellent* narrative rating. There were pools greater than 1-meter deep, riffle depths greater than ten centimeters, and riffles and runs with high stability. Cobble and boulder were the predominant substrate types with five of the best types of substrate present in the riffle areas. There was a diverse, moderate to sparse, amount of instream cover including undercut banks, overhanging vegetation, shallows, rootwads, rootmats, boulders and woody debris. The QHEI score at this site has not significantly changed for the last two years. In 2016, RM 1.65 scored 77.75 and in 2015 scored 79.50.

RM 0.55 met Ohio EPA's target score of 60 for streams >20 square miles with a score of 60.25. RM 0.55 substrate was predominately comprised of cobble and gravel with moderate instream cover including overhanging vegetation, pools, rootwads, boulders, and logs or woody debris. This site exhibited moderate stability with no functional riffles. The QHEI score at this site has decreased from the 2015 score of 71.25 and from 2016 with a score of 65.25. In the past, there has been a riffle present at the upstream end of the site at RM 0.55. This riffle has not been functional for multiple years and now appears to act as more of a shallows habitat area during normal flow conditions.

Table 7. 2017 Qualitative Habitat Evaluation Index Scores and Physical Attributes

			WWH Attributes											MWH Attributes															
														High Influence						Moderate Influence											
River Mile	QHEI Score	Habitat Rating	No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Development	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max. Depth > 40 cm	Low-Normal Riffle Embeddedness	**Total WWH Attributes**	Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max. Depth < 40 cm (WD, HW sites)	**Total High Influence Attributes**	Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrate Origin (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	No Riffle	**Total Moderate Influence Attributes**
1.65	79.25	*Excellent*		X		X		X	X	X	X	X	7		X				1		X			X	X						3
0.55	60.25	*Good*	X	X				X					3		X				1		X			X	X			X		X	5

Electrofishing

Methods

Two quantitative electrofishing passes were conducted at each wading site in 2017. A list of the dates when the surveys were completed, along with flow as measured at the United States Geological Survey gage station 04208700 in Cleveland, is given in Table 8. Sampling was conducted using longline electrofishing techniques and consisted of shocking all habitat types within a sampling zone while moving from downstream to upstream. The sampling zone was 0.20 kilometers. 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 anomalies, including DELTs (deformities, eroded fins, lesions, and tumors). All fish were then released to the waters from which they were collected, except for vouchers and those that could not be easily identified in the field.

Table 8. 2017 Euclid Creek Electrofishing Surveys

Site	Date	Stream Discharge (ft^3/s)[#]
0.55 & 1.65	6/16/2017	8.2
	8/14/2017	20

[#] Approved flow data obtained from USGS 04208700 Euclid Creek flow gauge in Cleveland, Ohio

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 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 sites are listed in Table 9.

Table 9. IBI Metrics

Wading	
Total Number of Native Species	Percent Omnivores
Number of Darter Species	Percent Insectivores
Number of Sunfish Species	Percent Top Carnivores
Number of Sucker Species	Percent Simple Lithophils

Table 9. IBI Metrics	
Wading	
Number of Intolerant Species	Percent DELT Anomalies
Percent Tolerant Species	Number of Fish

The second fish index utilized by Ohio EPA is the Modified Index of Well-being (MIwb). 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: $$MIwb = 0.5\ lnN + 0.5\ lnB + \overline{H}(No.) + \overline{H}(Wt.)$$

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

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

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

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

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

n_i = Relative numbers or weight of species

N = Total number or weight of the sample

An MIwb score ≥ 7.9 (*Good*) is in attainment of the WWH biocriterion for wading sites in the EOLP ecoregion. An MIwb score of 7.4 (*Marginally Good*) is also in attainment, as it is considered non-significant departure (≤ 0.5 MIwb units) from the criterion. The IBI criterion for wading is 38 or greater. The non-significant departure for the IBI is ≤ 4 units from the criterion.

Results and Discussion

RM 1.65 was in non-attainment of the WWH biocriteria and received an average IBI score of 27 and an average MIwb score of 5.7. There was a total of 9 species collected in 2017. In both passes, 100% of the fish collected were native species. The IBI metrics that received the highest scores (5) were for the Proportion of Omnivores, Proportion of Simple Lithophils, and Proportion with DELT Anomalies for both passes. The majority of the remainder of the metrics received the lowest score (1), with a majority of the fish collected being highly tolerant to pollution such as common white sucker (*Catostomus commersonii*), blacknose dace (*Rhinicthys atratulus*), bluntnose minnow (*Pimephales notatus*), and creek chub (*Semotilus atromaculatus*). The low score at this site may be due to the East 185th Street dam located at RM 1.50, which acts as a migration barrier

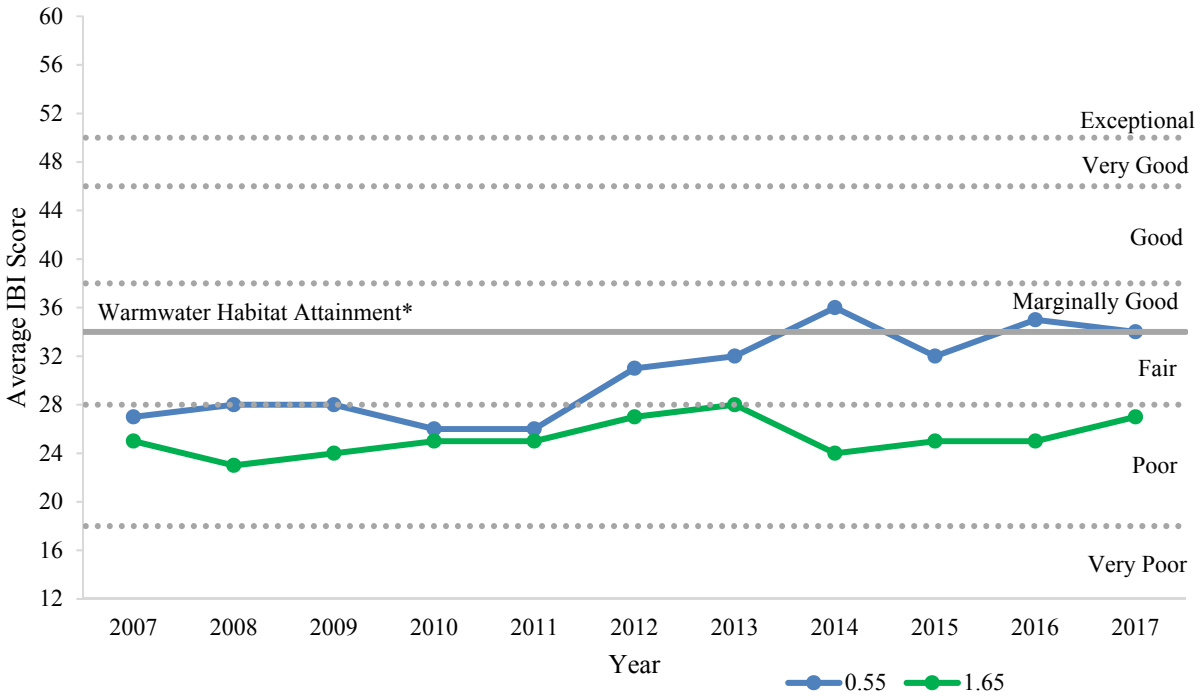
preventing upstream fish passage. Therefore, attainment of the fish biocriteria at this site may never be achievable unless the dam is removed. Other contributing factors such as CSO discharges, improper connections, and urban runoff may be negatively impacting the fish community at this site as well.

Table 10. 2017 Euclid Creek IBI & MIwb Results				
Site	Type	Date	IBI	MIwb
RM 1.65	Wading	6/16/2017	30	6.4
		8/14/2017	24	5.0
RM 0.55	Wading	6/16/2017	28	**8.5**
		8/14/2017	**40**	**8.1**
IBI criteria wading ≥38, boat ≥40 ; MIwb criteria wading ≥7.9, boat ≥8.7				
Bold = meets biocriterion				
Italics=Non-significant departure [IBI wading ≥34, boat ≥36; MIwb wading ≥7.4, boat ≥8.2]				

RM 0.55 met the MIwb biocriterion for both passes and received an average MIwb score of 8.3 (*Marginally Good*) and an average IBI score of 34 (*Marginally Good*), which is in non-significant departure of the WWH biocriterion. There were 26 species collected in 2017. During the first pass, thirteen of the sixteen species collected were native species. The second pass consisted of twenty native species of the twenty-two collected. Collections from the two passes consisted of three species of fish that are moderately intolerant to pollution: sand shiner (*Notropis stramineus*), shorthead redhorse (*Moxostoma macrolepidotum*), and smallmouth bass (*Micropterus dolomieu*). The IBI metrics that received the highest scores (5) during at least one of the passes was the Number of Sunfish Species, Number of Sucker Species, Proportion of Omnivores, Proportion of Insectivores, and Proportion of DELT Anomalies. The August 14, 2017, pass met attainment of the biocriterion because it contained a high number of native species which is consistent with both passes that took place in 2016; this contributed to the average IBI score of 34 (Table 10).

RMs 1.65 and 0.55 have been evaluated for fish since as early as 2007 in order to determine the impact that NEORSD-owned CSOs may have on downstream biological communities. In 2017, RM 0.55 scored higher than the upstream site; however, again, this is most likely due to the East 185th Street dam that is impeding fish movement upstream. Historical IBI and MIwb data from Euclid Creek at RM 0.55 and 1.65 are graphically displayed in Figure 4 and listed in Table 11.

Figure 4: Historic IBI Scores at Euclid Creek RMs 1.65 and 0.55



*Non-significant departure (≤4 IBI units) from applicable criterion.

Table 11. 2007 - 2017 Euclid Creek Average IBI & MIwb Scores

Year	RM 1.65		RM 0.55	
	IBI	MIwb	IBI	MIwb
2007	25	5.2	27	7.4
2008	23	6.2	28	7.4
2009*	24	6.2	28	6.9
2010	25	5.6	26	6.6
2011	25	4.9	26	6.8
2012	27	6.2	31	**7.6**
2013*	28	5.6	32	7.3
2014	24	4.9	**36**	7.0
2015	25	5.4	32	6.9
2016	25	4.9	**35**	**8.0**
2017	27	5.7	**34**	**8.3**

Bold indicates nonsignificant departure of WWH biocriterion
*Only one electrofishing survey conducted

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 RMs 1.65 and 0.55. 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 the WQIS Division.

The overall aquatic macroinvertebrate community in the stream was evaluated using Ohio EPA's Invertebrate Community Index (ICI) (Ohio EPA 1987a). 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	Percent caddisflies
Number of mayfly taxa	Percent Tanytarsini midges
Number of caddisfly taxa	Percent other diptera and non-insects
Number of dipteran taxa	Percent tolerant organisms (as defined)
Percent mayflies	Number of qualitative EPT taxa

Results and Discussion

In 2017, HDs were installed at Euclid Creek RM 1.65 and 0.55 and were retrieved along with a qualitative sampling at all sites. RM 1.65 was in attainment of the WWH ICI biocriterion with a score of 40; however, RM 0.55 was not (Table 13).

Table 13. 2017 Euclid Creek Macroinvertebrate Results					
River Mile	ICI Score	Narrative Rating	Total Quantitative Taxa	Total Qualitative Taxa	Total Qualitative EPT Taxa
1.65	**40**	*Good*	38	26	8
0.55	16	*Fair*	25	19	0
Bold indicates attainment of WWH biocriterion					

The ICI score at RM 1.65 was calculated at 40 in 2017 with a narrative rating of *Good.* The highest scoring metrics were Number of Caddisfly Taxa, Percent Caddisflies, Percent Tanytarsini Midges and Percent Tolerant Organisms. Additionally, five taxa collected were considered moderately intolerant of pollution. RM 1.65 has been sampled for macroinvertebrates since 2007 (Table 14). Of eleven years of sampling, eight of the years were in attainment of the WWH ICI biocriterion. The score increased in both 2016 and 2017 due to the increase in the Percent Tanytarsini Midges (Figure 5).

Table 14. 2002– 2017 Euclid Creek ICI Scores

Year	RM 1.65	RM 0.55
2002	--	25
2003	--	26
2004	--	14
2005	--	16
2006	--	24
2007	26	22
2008	26	12
2009	**38**	24
2010	**42**	18
2011	**36**	24
2012	**36**	24
2013	Fair	**34**
2014	*30*	**34**
2015	**36**	18
2016	**38**	16
2017	**40**	16

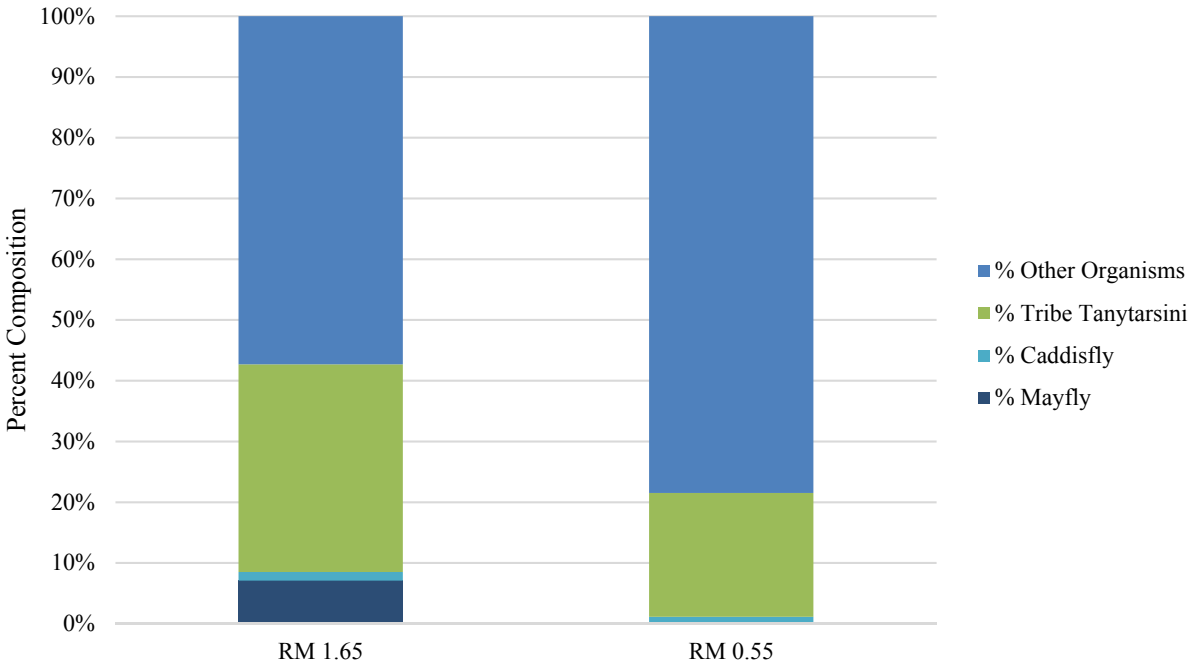
Bold indicates attainment of WWH biocriterion

Italics indicates non-significant departure of WWH biocriterion

--Macroinvertebrates not evaluated

HD not collected; qualitative assessment only

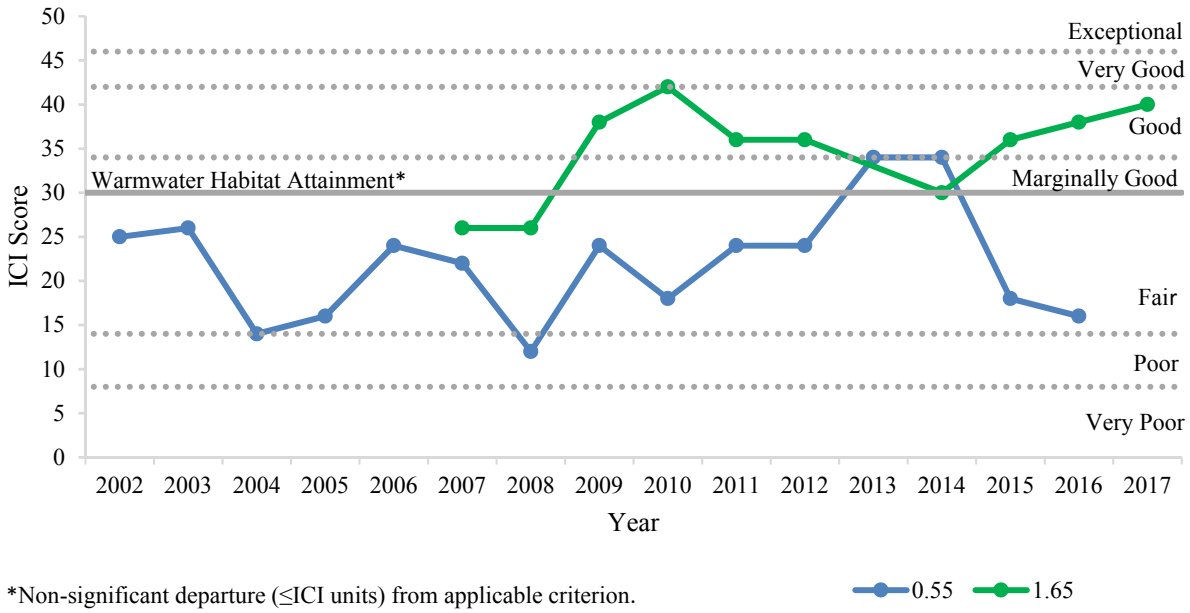
Figure 5. 2017 Macroinvertebrate Community Composition



RM 0.55 maintained an ICI score of 16 in 2017 with a narrative rating of *Fair.* The highest scoring metric was Percent Tanytarsini Midges, Percent Tolerant Organisms, and Total Number of Taxa. RM 0.55 has been sampled for macroinvertebrates since 2002 (Table 17). Of these samples, two years were in attainment of the WWH ICI biocriterion. The reason for the significant score decrease in 2015 through 2017 was due to a lack of habitat; RM 0.55 does not have a functioning riffle or run, which may have led to a decrease in Number of Caddisfly Taxa, Percent Mayflies and Percent Caddisflies.

RMs 1.65 and 0.55 have been evaluated for macroinvertebrates since as early as 2002 to help determine the impact that NEORSD-owned CSOs may have on downstream biological communities (Figure 6). However, other factors may have also had an influence on the score. At RM 0.55, beginning in 2015, the HD was placed in a different location from the previous years, which may account for some of the difference in scores from 2014. There is no longer a functional riffle within the site and this may be causing changes within the macroinvertebrate populations. Additionally, there are known illicit connections that discharge to Euclid Creek near RM 0.55. Furthermore, RM 0.55 is considered to have lacustuary influences. These influences may have an impact on the macroinvertebrate populations contributing to the non-attainment of the WWH ICI biocriterion. Further monitoring of RM 0.55 and 1.65 will be conducted again in 2018.

Figure 6: Historic ICI Scores at Euclid Creek RMs 1.65 and 0.55



*Non-significant departure (≤ICI units) from applicable criterion.

Conclusions

The results of NEORSD's water chemistry sampling, habitat assessments, and fish and benthic macroinvertebrate community surveys indicate that the Euclid Creek watershed may be impacted by a variety of aquatic habitat limitations and environmental stressors, as mentioned previously. Biological assessments that were conducted at both sites showed non or partial attainment of WWH biological criteria (Table 15). The East 185th dam, located downstream of RM 1.65, is inhibiting fish migration to the upper reaches of the watershed causing the fish community assessment to be in non-attainment. It appears to not have had a negative impact on the macroinvertebrate community assessment. Water chemistry results at all sites exhibited exceedances for *E. coli*, an indicator of sewage contamination. Potential sources of pollution include illicit discharges, CSO discharges and urban runoff. This contamination may be responsible for the Aquatic Life Use non-attainment status of RM 0.1.65 and may also be negatively impacting RM 0.55.

Macroinvertebrate assessments at RM 0.55 showed that the benthic community was not meeting the WWH ICI biocriterion, but this site has only met the criterion twice in 16 years of sampling. RM 1.65, which is located upstream of NEORSD-owned CSOs, was in attainment of the WWH ICI biocriterion. Additionally, a restoration project was recently completed at RM 0.40 and was anticipated to increase the overall health of lower Euclid Creek.

Table 15. 2017 Euclid Creek Survey Results						
River Mile	Aquatic Life Use Attainment Status	Average IBI Score (*Narrative Rating*)	Average MIwb Score (*Narrative Rating*)	ICI Score (*Narrative Rating*)	QHEI Score (*Narrative Rating*)	Water Quality Exceedances
1.65	NON	27 *Poor*	5.7 *Poor*	40 *Good*	79.25 *Excellent*	*E. coli*
0.55	PARTIAL	34 *Marginally Good*	8.3 *Marginally Good*	16 *Fair*	60.25 *Good*	*E. coli*
WWH biocriterion attainment: IBI score of 38; MIwb score of 7.9; ICI score of 34						
Non-significant departure: ≤4 IBI units; ≤0.5 MIwb units; ≤4 ICI units						

Overall, the water quality status of the Euclid Creek watershed is fair. Many of the sites may be negatively impacted by sources of pollution associated with bacteriological contamination from CSO discharges, improper connections, failing septic systems, and urban runoff. Moreover, documented storm sewer bacteriological contamination in Cleveland and Euclid remains an issue. Until these problems are remediated, bacteriological contamination continues to be an important concern by NEORSD for Euclid Creek.

Future monitoring of Euclid Creek will be vital as current and proposed NEORSD capital improvement projects are anticipated to control the number of CSO discharges to Euclid Creek. The Tunnel Dewatering Pump Station and Euclid Creek Tunnel construction projects began in December 2010 and the Euclid Creek Pump Station project began in the fall of 2014. The projects were completed in 2017, but testing showed an operational fail at the Euclid Creek Tunnel Dewatering Pump Station, which now has an anticipated completion in 2018 for these projects. Further sampling post-construction will help determine the effectiveness of the projects and any improvements on the water quality, habitat and biological communities in Euclid Creek.

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References

DeShon, J. E. (1995). Development and Application of the Invertebrate Community Index (ICI). In W. Davis and T. Simon (Ed.), *Biological assessment and criteria, tools for water resource planning and decision making* (pp. 217-243). Boca Raton, FL: Lewis Publishers.

Homer, C.G., Dewitz, J.A., Yang, L., Jin, S., Danielson, P., Xian, G., Coulston, J., Herold, N.D., Wickham, J.D., and Megown, K., 2015, *Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information.* Photogrammetric Engineering and Remote Sensing, v. 81, no. 5, p. 345-354.

McCabe, D.J. (2010). Rivers and Streams: Life in Flowing Water. *Nature Education Knowledge* 1(12):4.

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

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

Ohio Environmental Protection Agency. (1997). Draft. *Biological Criteria for the Protection of Aquatic Life: Volume IV: Fish and Macroinvertebrate Indices for Ohio's Lake Erie Nearshore Waters, Harbors, and Lacustuaries*. Columbus, OH: Division of Surface Water, Ecological Assessment Unit.

Ohio Environmental Protection Agency. (2005). *Total Maximum Daily Loads for the Euclid Creek Watershed*. Columbus, OH: Ohio EPA, Division of Surface Water.

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

Ohio Environmental Protection Agency. (2008). *Delisting Targets for Ohio Areas of Concern*. Columbus, OH: Division of Surface Water, Lake Erie Program Staff.

Ohio Environmental Protection Agency. (2016). *State of Ohio Water Quality Standards Ohio Administrative Code Chapter 3745-1* (Revision: Adopted October 2, 2015; Effective January 4, 2016). Columbus, OH: Division of Surface Water, Standards and Technical Support Section.

Ohio Environmental Protection Agency. (2010). Draft. *Methods of Assessing Habitat in Lake Erie Shoreline Waters Using the Qualitative Habitat Evaluation Index (QHEI) Approach (Version 2.1)*. Columbus, OH: Division of Surface Water.

Ohio Environmental Protection Agency. (2012). *Manual of Ohio EPA Surveillance Methods and Quality Assurance Practice.* Columbus, OH: Division of Surface Water; Division of Environmental Services.

Ohio Environmental Protection Agency. (2013a). *Surface Water Field Sampling Manual for water chemistry, bacteria, and flows.* Columbus, OH: Division of Surface Water.

Ohio Environmental Protection Agency. (2013b). *Trophic Index Criterion—Rational and Scoring.* Columbus, OH: Division of Surface Water, Division of Environmental Services.

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

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

Posius, C. (2013). Wildwood Stream and Wetland Restoration Project / Lacustrine Refuge in the Cuyahoga AOC Project. Retrieved from http://www.cuyahogaswcd.org/EuclidCreekFiles/EC_LacustrineRefuge.htm (accessed on January 29, 2014).

RiverWorks. (2013). Cuyahoga Soil and Water Conservation District, Euclid Creek Restoration Project, Lacustrine Refuge in the Cuyahoga AOC, Maintenance and Montioring Plan.

Schueler, T., 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban Best Management Practices.* Metropolitan Washington Council of Governments, Washington, DC.

Trautman, M. B. (1981). *The Fishes of Ohio*. Columbus, Ohio: The Ohio State University Press.

United States Environmental Protection Agency (2004). Mercury Pollutant Minimization Program Guidance. Region 5, NPDES Programs Branch. Retrieved from http://www.epa.gov/r5water/npdestek/ pdfs/2004mercury_pmp_guidance.pdf.

United States Geological Survey (2012). The StreamStats program for Ohio, online at https://water.usgs.gov/osw/streamstats/ohio.html.