Northeast Ohio
Regional Sewer District

2020 Euclid Creek
Biological, Water Quality, and Habitat Study

Water Quality and Industrial Surveillance

Environmental Assessment Group

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Introduction

Euclid Creek is a heavily urbanized stream whose watershed encompasses several Northeast Ohio communities across Cuyahoga and Lake counties. Drainage from South Euclid, Lyndhurst, Willoughby Hills, Richmond Heights, Highland Heights, Euclid, and Cleveland ultimately discharges to Lake Erie via the stream and its tributaries. In 2020, the Ohio Environmental Protection Agency (Ohio EPA) again identified Euclid Creek as a Prioritized Impaired Water under section 303(d) of the Clean Water Act (Ohio EPA, 2018a). Of primary concern is the impact of combined sewer overflow (CSO) events that contribute significantly to bacteriological loading of the stream during wet-weather events. In 2018, three NEORSD "Project Clean Lake" capital improvement projects were implemented: the Euclid Creek Pump Station, the Euclid Creek Storage Tunnel, and the Easterly Tunnel Dewatering Pump Station. Each aims to reduce the frequency of CSO discharges from NEORSD to Euclid Creek to less than two discharge events per year.

In 2020, the Northeast Ohio Regional Sewer District (NEORSD) continued its environmental monitoring assessments of Euclid Creek, including water chemistry sampling, habitat evaluation, and fish and macroinvertebrate community surveys. Assessments of RMs 1.65 and 0.55 are required by the NEORSD's Ohio EPA National Pollution Discharge Elimination System (NPDES) Permit for CSOs. The objective of this assessment was to conduct environmental monitoring to determine attainment of the Ohio EPA water quality and aquatic life standards. This objective was outlined in the NEORSD *2020 Euclid Creek Environmental Monitoring* study plan approved by the Ohio EPA on June 15, 2020. The data collected during the 2020 environmental assessment season is also a part of ongoing monitoring of the long-term impact of Project Clean Lake infrastructure on the overall health of Euclid Creek.

Figure 1 is a study area map, noting the location of the sampling locations evaluated during the 2020 study. Table 1 indicates the sampling locations with respect to river mile, latitude and longitude, description, and the types of surveys conducted. A digital photo catalog of the sampling locations is available upon request by contacting the NEORSD WQIS Division.

Figure 1. 2020 Euclid Creek Sampling Locations

Table 1. Euclid Creek Sampling Locations

Description	Latitude	Longitude	River Mile	Station ID	Sampling Conducted
Upstream of Saint Clair Avenue	41.5741	-81.5467	1.65	504250	F, M, C, P
Downstream of Lake Shore Boulevard	41.5833	-81.5594	0.55	F01A47	F, M, C, P

F = Fish community biology (includes habitat assessment)
M = Macroinvertebrate community biology
C = Water column chemistry
P = In support of permit-required monitoring

Water Chemistry and Bacteriological Sampling

Methods

Five separate water chemistry and bacteriological sampling events were conducted between June 16 and July 14, 2020. Techniques used for sampling and analysis were conducted according to methods found in *Surface Water Field Sampling Manual for water quality parameters and flows* (Ohio EPA, 2019). 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 = concentration of the parameter in the primary sample
y = 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, 2019b).

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, this data will not be used for comparison to the water quality standards.

Water chemistry analysis sheets for each sampling location are available upon request from the NEORSD WQIS Division. Dates of water chemistry sampling compared to Euclid Creek flow data (USGS 04208700) are shown below in Figure 2.

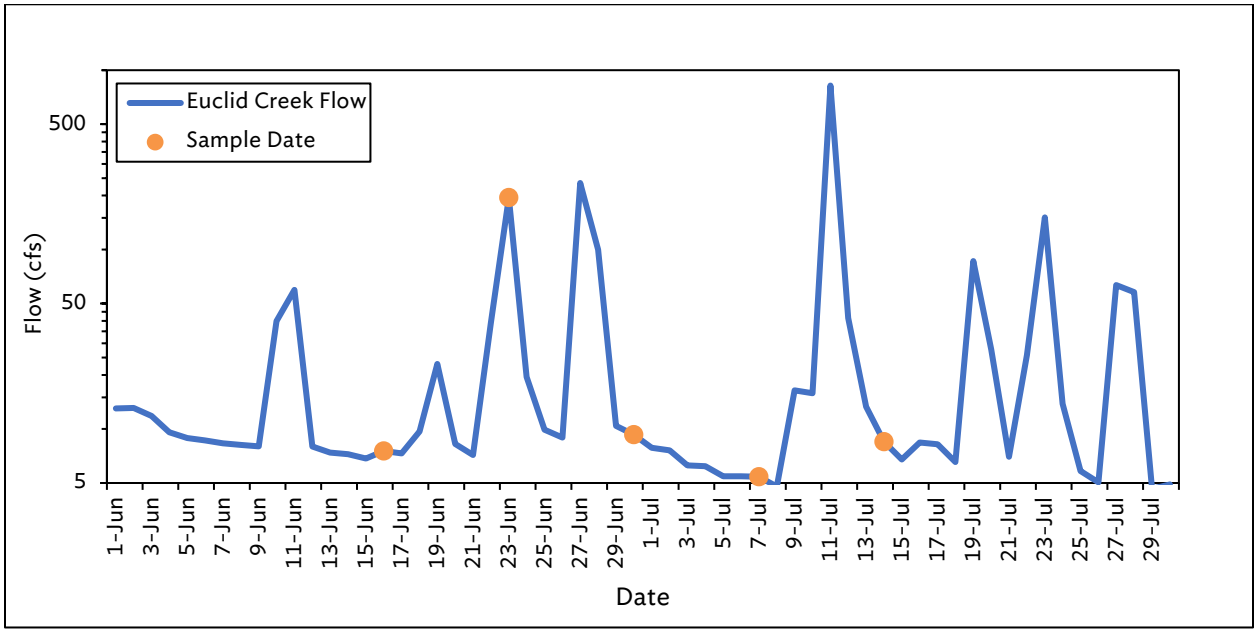

Figure 2. Euclid Creek Flow Data

Results and Discussion

Within the study area, Euclid Creek is designated as Warmwater Habitat (WWH), Agricultural Water Supply (AWS), Industrial Water Supply (IWS), and Primary Contact Recreation (PCR). The water chemistry samples collected at each site were compared to the applicable Ohio Water Quality Standards for the designated uses to determine attainment (Ohio EPA, 2019c).

One duplicate sample and two field blanks were collected in support of quality assurance and quality control (QA/QC) guidelines for field sampling. The duplicate sample was collected at Euclid Creek RM 0.55 on July 7, 2020. For this sample, no chemical parameters assessed were rejected based on RPD values outside of the acceptable RPD range. The first field blank sample was collected on June 16, 2020, at Euclid Creek RM 7.45 (Sample location for separate study). Comparative analysis of all sample and field blank results from that day showed that the chromium (Cr) results from the samples taken at RMs 0.55 were rejected due to the sample result/field blank result ratio. Additionally, on June 16, 2020, sample analysis from RM 1.65 indicated that Cr results must be estimated due to system uncertainty and qualified with a "J" because the blank result > sample result. Field blank qualification requires that the sample result/field blank result ratio to

be greater than three for a parameter to be accepted. 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 analysis.

The second field blank was collected on June 30, 2020 at RM 0.55. Sample analysis showed that the water quality parameter chemical oxygen demand (COD) was calculated to have a sample result/field blank result ratio less than three for all sampling sites and is rejected as qualified data. Results from the June 30, 2020, sampling also indicate Cr data from the sample collected at RM 1.65 was also rejected, with Cr data from RM 0.55 being estimated and qualified with a "J" due to blank concentrations being twice that of the sample result. Table 2 below shows the parameters possibly affected by field blank contamination.

Table 2. Parameters Affected by Possible Blank Contamination

Site	Date	Parameter	Qualifier	Reason
RM 1.65	6/30/20	COD	Rejected	1x Blank ≤ Result ≤ 3x Blank
RM 0.55	6/30/20	COD	Rejected	1x Blank ≤ Result ≤ 3x Blank
RM 1.65	6/16/20	Cr	J	Blank > Result
RM 0.55	6/16/20	Cr	Rejected	1x Blank ≤ Result ≤ 3x Blank
RM 1.65	6/30/20	Cr	Rejected	1x Blank ≤ Result ≤ 3x Blank
RM 0.55	6/30/20	Cr	J	Blank > Result

Paired parameters, wherein one parameter is a subset for another, were also evaluated in accordance with QA/QC protocols for all samples collected at each site within Euclid Creek. No paired parameters exceeded the relative percent difference (RPD) threshold (Table 3); therefore, all paired parameters were accepted as valid. However, nitrate, a sub-parameter of nitrate (NO_3) + nitrite (NO_2), yielded a higher numeric value in seven samples on multiple dates during the sampling season. Due to the sub parameter being greater than the parent one, the data is marked as a "J" or "estimated". Because there were no exceedances associated with these parameters, qualification of these results did not significantly change the overall water chemistry assessment of Euclid Creek.

Table 3. Paired Data Parameter Analysis

Site Location	Date	Parameter	Data Pair	Acceptable RPD (%)	Actual RPD (%)	Qualifier
RM 1.65	6/30/2020	NO_3	NO_3+NO_2	32.3	0.4	*Estimated*
	7/7/2020	NO_3	NO_3+NO_2	42.7	1.0	*Estimated*
	7/14/2020	NO_3	NO_3+NO_2	32.7	0.2	*Estimated*
RM 0.55	6/16/2020	NO_3	NO_3+NO_2	40.1	0.4	*Estimated*
	7/7/2020	NO_3	NO_3+NO_2	52.5	2.8	*Estimated*

Table 3. Paired Data Parameter Analysis						
Site Location	Date	Parameter	Data Pair	Acceptable RPD (%)	Actual RPD (%)	Qualifier
	7/7/2020*	NO_3	NO_3+NO_2	52.5	3.8	*Estimated*
	7/14/2020	NO_3	NO_3+NO_2	29.8	0.2	*Estimated*
* - Duplicate Sample						

The PCR criteria for Euclid Creek includes an *Escherichia coli* (*E. coli*) criterion not to exceed a Statistical Threshold Value (STV) of 410 colony counts (MPN) per 100mL in more than ten percent of the samples taken during any 90-day period, and a 90-day geometric mean criterion of 126 colony counts (MPN) per 100mL (Ohio EPA, 2019c). In accordance with Ohio EPA procedure and practice to qualify *E. coli* exceedances for the PCR criteria, the geometric mean and STV are only calculated and compared when a minimum of five bacteriological samples have been collected.

The STV of 410 colony counts/100mL in more than ten percent of the samples taken was exceeded at both sampling sites in 2020. Additionally, all sites exceeded the ninety-day geometric mean criterion of 126 colony counts/100mL (Table 4). One of the five sampling dates was conducted during a wet-weather event[1], which may lead to elevated *E. coli* densities due to CSOs, sanitary sewer overflows, and urban runoff. *E. coli* exceedances may also have been a result of domestic and/or wild animal waste, improper sanitary sewage connections to stormwater outfalls, failing household sewage treatment systems (HSTSs), to Euclid Creek upstream of the sampling locations.

Table 4. 2020 Euclid Creek *E. coli* Densities (MPN/100mL)		
Date	RM 1.65	RM 0.55
6/16/2020	765	923
6/23/2020*	2,040	2,585
6/30/2020	1,198	858
7/7/2020	440	1,381
7/14/2020	734	864
90-Day Geometric Mean	943	1,196

Exceeds statistical threshold value (STV) of 410 MPN/100mL
Exceeds geometric mean criterion for 90-day period of 126 MPN/100mL
* - Wet-Weather Sampling Event

Overflow discharges to Euclid Creek from NEORSD-owned CSOs have sharply declined since the 2018 activation of the Euclid Creek Tunnel Project. During large rain events, excessive storm water and untreated sanitary wastewater is now diverted to a large underground tunnel. This

[1] Wet-weather event: 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.

wastewater is later treated at NEORSD's Easterly Wastewater Treatment Plant. Due to the reduction and potential elimination of overflow discharges, it was expected that densities of *E. coli* in Euclid Creek would begin to decline over subsequent seasons. Figure 3 below shows *E. coli* geometric mean sample data collected from 2010 to 2020 for Euclid Creek RMs 1.65 and 0.55.

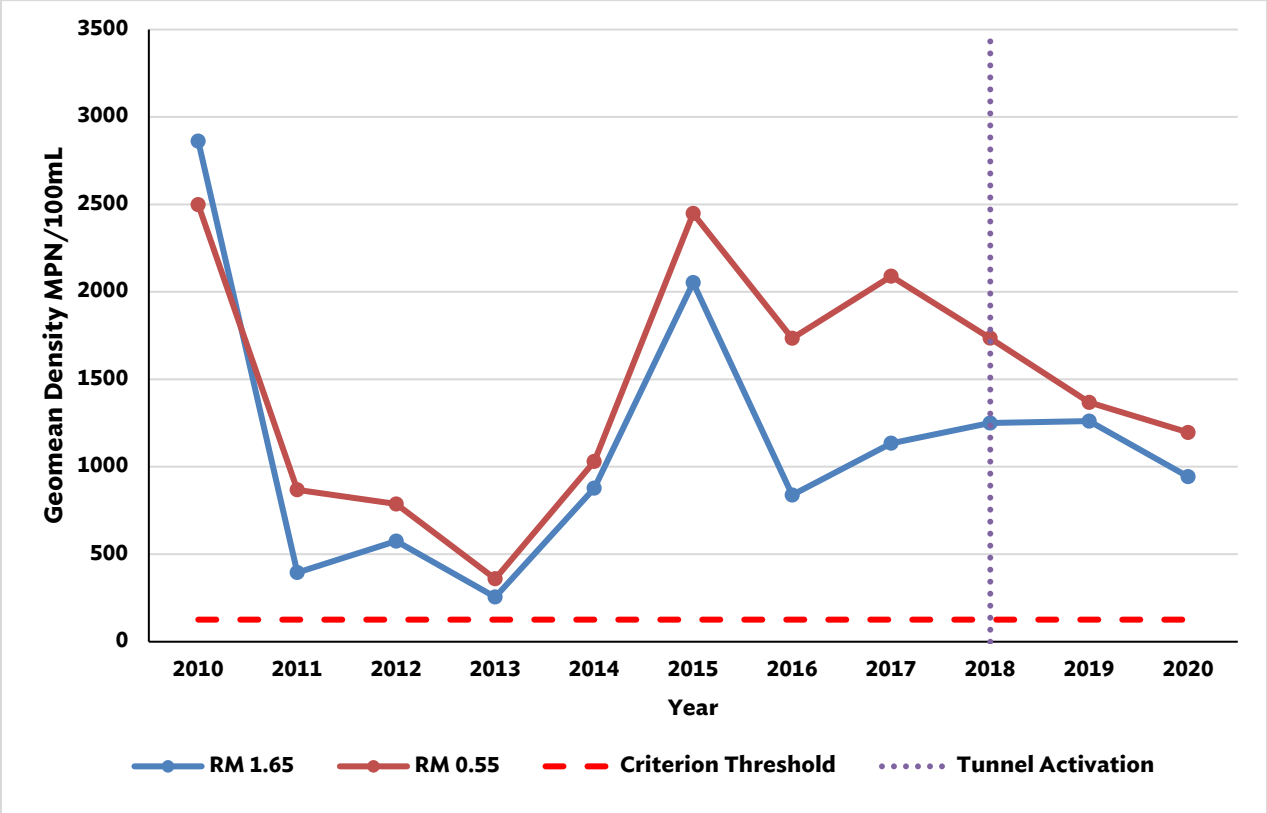

Figure 3. Euclid Creek *E. coli* Geomean Densities 2010 - 2020

The sampling reach at RM 1.65 is located upstream of any NEORSD-owned CSOs and is sampled as a reference site for the RM 0.55 location. While NEORSD CSOs are absent upstream of RM 1.65, there are other influences upstream of this sampling reach that complicate improvement efforts. Primarily, the stretch of Euclid Creek just upstream of the sampled reach is located within the service area of the City of Euclid, which maintains a CSO and a separate sanitary overflow (SSO) that discharge to the creek. Additionally, any illicit discharges or improper connections to storm outfalls in this area may significantly impact the input of *E. coli* into the Euclid Creek watershed.

Observed variation in *E. coli* densities from year to year may be due to dry and wet weather variation, as major rain events can cause elevated densities of *E. coli* due to stormwater run-off and CSO discharges upstream. Natural variability from year to year may also have influenced these elevated densities.

While both sites remain above the 126 MPN/100mL 90-day geometric mean criterion threshold, infrastructure improvements like the Euclid Creek tunnel project as well as a continued effort to detect and eliminate illicit discharges upstream of these locations may contribute to

eventual attainment of this criterion. Ongoing monitoring efforts will verify the efficacy of these improvements.

Water chemistry sampling in 2020 for Euclid Creek resulted in mercury concentrations that were below the method detection limit for EPA Method 245.1 at both RMs 1.65 and 0.55. The detection limit for this method is above the criteria for the Human Health Non-Drinking and Protection of Wildlife OMZAs, 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 those levels typically found in the stream. It is expected that the use of EPA Method 1631E, a low-level method, as opposed to EPA Method 245.1, would have resulted in exceedances of the criteria throughout the sampling period. Mercury may be introduced into Euclid Creek from urban runoff and atmospheric deposition within the watershed.

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, 2015). NEORSD did not assess DO swings or benthic chlorophyll *a* in 2020; however, nutrients were assessed.

Maintenance of low levels of nutrients such as nitrogen and phosphorus in Euclid Creek is imperative in limiting loading to Lake Erie. An excess of nitrogen and phosphorus can lead to nutrient enrichment in the lake, encouraging the growth of harmful algal blooms (HABs). HABs pose a health risk to the aquatic life of Lake Erie, as they quickly impact dissolved oxygen levels. This results in large hypoxic (low oxygen) or anoxic (oxygen depleted) zones in the water column. Some species of blue-green algae (a type of cyanobacteria) also produce toxins, including microcystins, which can cause illness in aquatic and terrestrial wildlife, as well as in humans and domestic animals. Microcystins are not easily removed via water treatment and can cause a wide range of illnesses, from mild skin irritation to severe liver damage and death.

Table 5 shows the 2020 nutrient concentrations for all sampling sites. The results of dissolved inorganic nitrogen (DIN) and total phosphorous (TP) were compared to Table 2 listed in the SNAP document (Figure 4). According to this section of SNAP, both sites on Euclid Creek received an ecological risk narrative level described as “levels typical of developed lands; little or no risk to beneficial uses” (Ohio EPA 2015). This indicates that neither phosphorus nor nitrogen are of a significant concern as a primary source of impairment at these sampling sites.

Table 5. 2020 Euclid Creek Nutrient Analysis						
River Mile	Geomean DIN (mg/L)	StdDev DIN	Geomean TP (mg/L)	StdDev TP	Geomean DRP (mg/L)	StdDev DRP
1.65	0.406	0.139	0.064	0.014	0.050	0.009
0.55	0.317	0.169	0.062	0.017	0.042	0.017
Data used in Table 2 of SNAP (Ohio EPA, 2015b)						

← *DECREASING RISK*

TP Conc. (mg/l) ↓ *DECREASING RISK*	DIN Concentration (mg/l) <0.44	0.44 < 1.10	1.10 < 3.60	3.60 < 6.70	≥6.70
<0.040	background levels typical of least disturbed conditions	levels typical of developed lands; little or no risk to beneficial uses	levels typical of modestly enriched condition in phosphorus limited systems; low risk to beneficial use if allied responses are within normal ranges	levels typical of enriched condition in phosphorus limited systems; moderate risk to beneficial use if allied responses are elevated	characteristic of tile-drained lands; otherwise atypical condition with moderate risk to beneficial use if allied responses are elevated (1.1% of observations)
0.040-<0.080	levels typical of developed lands; little or no risk to beneficial uses	levels typical of developed lands; little or no risk to beneficial uses	levels typical of working landscapes; low risk to beneficial use if allied responses are within normal ranges	levels typical of enriched condition in phosphorus limited systems; moderate risk to beneficial use if allied responses are elevated	characteristic of tile-drained lands; moderate risk to beneficial use if allied responses are elevated (1.1% of observations)
0.080-<0.131	levels typical of modestly enriched condition in nitrogen limited systems; low risk to beneficial use if allied responses are within normal ranges	levels typical of working landscapes; low risk to beneficial use if allied responses are within normal ranges	levels typical of working landscapes; low risk to beneficial use if allied responses are within normal ranges	characteristic of tile-drained lands; moderate risk to beneficial use if allied responses are elevated; increased risk with poor habitat	characteristic of tile-drained lands; moderate risk to beneficial use if allied responses are elevated (1.0% of observations)
0.131-<0.400	levels typical of modestly enriched condition in nitrogen limited systems; low risk to beneficial use if allied responses are within normal ranges	levels typical of enriched condition; low risk to beneficial use if allied responses are within normal ranges	levels typical of enriched condition; low risk to beneficial use if allied responses are within normal ranges; increased risk with poor habitat	enriched condition; generally high risk to beneficial uses; often co-occurring with multiple stressors; increased risk with poor habitat	enriched condition; generally high risk to beneficial uses; often co-occurring with multiple stressors
≥0.400	atypical condition (1.3% of observations)	atypical condition (1% of observations);	enriched condition; generally high risk to beneficial uses; often co-occurring with multiple stressors; increased risk with poor habitat	enriched condition; generally high risk to beneficial uses; often co-occurring with multiple stressors ; increased risk with poor habitat	enriched condition; generally high risk to beneficial uses; often co-occurring with multiple stressors

"allied responses" = allied response indicators (24-hour DO swing, benthic chlorophyll)

Figure 4. Table 2 of the Stream Nutrient Assessment Procedure (Ohio EPA, 2015b)

Habitat Assessment

Methods

An instream habitat assessment was conducted on Euclid Creek in 2020 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 values greater than 60 on streams greater than 20 square miles and 55 at streams less than 20 square miles suggests that sufficient habitat exists to support a warmwater fish community. Scores greater than 75 (70 for headwater sites) frequently demonstrate habitat conditions that can support exceptional warmwater faunas (Ohio EPA 2006). A more detailed description of the QHEI can be found in Ohio EPA's Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI) (2006). QHEI field sheets for each site are available upon request from the NEORSD WQIS Division.

Individual components of the QHEI can also be used to evaluate whether a site is capable of meeting its WWH designated use. This is done by categorizing specific attributes as indicative of either a WWH or modified warmwater habitat (MWH) (Rankin 1995). Attributes that are considered characteristic of MWH are further classified as being a moderate or high influence on fish communities. As modified habitat attributes increase to a MWH:WWH ratio at or greater than 1.0–1.5, the likelihood of achieving WWH attainment of the IBI scores declines (Yoder and Rankin, 1996).

Results and Discussion

The habitat for the stream segment at Euclid Creek RM 1.65 was assessed on June 29, 2020. A QHEI score of 76.75 was calculated with a narrative rating of *Excellent* (Table 6), well exceeding the target score of 60 for WWH. Important contributing factors to the attainment of WWH included the good development and the lack of channelization throughout the reach. The dominant substrates of cobble and gravel, with boulders and slabs throughout, is an additional characteristic that gave the segment a high score. Although the presence of diverse habitat types was indicated, these refugia were of marginal quality and limited in quantity, with only some boulders, rootwads, and a few pools available. Factors that negatively impacted the score were the lack of sinuosity, sparse to moderate amount of instream cover for resident or transient fish populations, and a diminished riparian corridor comprised of urban and industrial development. In an urban residential flood plain, like that surrounding Euclid Creek, a greater percentage of impervious surface can lead to excessive flow to the stream, which may magnify erosion issues and lead to greater sediment deposition in the stream. Despite scoring low in some areas, the overall QHEI assessment indicates that this stream reach is suitable to sustain a healthy fish community. The stream reach's inherent stability, development, and lack of channelization may be key in

maintaining positive channel morphology features and preventing erosion under elevated flow conditions.

The habitat for the stream segment at Euclid Creek RM 0.55 was also assessed on June 29, 2020. At this location, a QHEI score of 58.50 was calculated with a narrative rating of *Fair (*Table 6), failing to meet the target score of 60 for WWH. One high-influence MWH attribute that affected this score was the lack of instream cover. While a few types were present in the reach, including overhanging vegetation, deep pools, and boulders, the overall quality and quantity of cover was sparse to moderate, which can inhibit the establishment of fish communities. Additional important score impacts were a substrate dominated by sand and gravel, as well as the lack of a riffle. Riffles provide important areas of cover for young or small fish species and serve as habitat for macroinvertebrates, which are a food source for fish or other biota. Riffles also serve an important function in oxygenation of the stream, and without their presence, levels of dissolved oxygen are reduced, especially in slow moving water. The lack of a riffle at this site may be explained by lacustuary influence caused by elevated water levels observed in Lake Erie in recent years. The Lake Erie water level was at a historic high in 2020 with the annual average water level increased by 0.83 meters compared to levels in 2010 and by 0.72 meters compared to the period of record average (1918-2020) according to the National Oceanic and Atmospheric Administration (NOAA) Great Lakes Dashboard.

The reach also suffered from a small to nonexistent riparian buffer. The area surrounding RM 0.55 is predominantly residential and adjacent to a park with plenty of impervious surfaces; large rainstorms could very easily introduce sediment from the banks as well as pollutants from stormwater runoff. The low sinuosity and low gradient result in a slow current in this portion of the stream, allowing sediment to settle and contributing to the moderate substrate embeddedness and silt content. Because Euclid Creek RM 0.55 failed to meet the target score for QHEI, it could be expected that the reach may not be able to sustain a healthy biological community.

Table 6. 2020 Euclid Creek QHEI Scores and Physical Attributes

			WWH Attributes											MWH Attributes																
														High Influence						Moderate Influence												
River Mile	QHEI Score	Narrative 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	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	**Total High Influence Attributes**	Recovering Channel	Heavy/Moderate Silt Cover	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Total Moderate Influence**	**(MWH-H.I.+1) / (WWH+1) Ratio**	**(MWH M.I.+1) / (WWH+1) Ratio**
1.65	76.75	*Good*	X	X		X		X	X	X	X	X	**8**				X		**1**					X							**1**	0.2	0.2
0.55	58.50	*Fair*	X	X				X		X	X		**5**				X		**1**		X		X	X			X	X		X	**6**	0.3	1.2

Fish Community Biology Assessment

Methods

Two quantitative electrofishing passes were conducted at each sampling site on Euclid Creek for the 2020 sampling season. Sampling was conducted using longline or roller pram 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 for both RMs 1.65 and 0.55. The sampling techniques used followed Ohio EPA protocol methods as detailed in *Biological Criteria for the Protection of Aquatic Life, Volumes II* (1987a) and *III* (1987b). Fish collected during the surveys were identified and examined for the presence of anomalies including DELTs (deformities, eroded fins, lesions, and tumors). All fish were then released to the waters from which they were collected, except for voucher specimens 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 the Ohio EPA Index of Biotic Integrity (IBI). The IBI incorporates 12 community metrics representing structural and functional attributes. The structural attributes are based upon fish community aspects such as fish numbers and diversity. Functional attributes are based upon fish community aspects such as feeding strategies, environmental tolerances, and disease symptoms. These metrics are individually scored by comparing the data collected at the survey site with values expected at reference sites located in a similar geographical region. The maximum possible IBI score is 60 and the minimum possible score is 12. The summation of the 12 individual metrics scores provides a single-value IBI score, which corresponds to a narrative rating of *Exceptional, Good, Marginally Good, Fair, Poor,* or *Very Poor*.

The second fish index utilized by Ohio EPA is the Modified Index of Well-being (MIwb). The MIwb, Formula 3 listed below, incorporates four fish community measures: numbers of individuals, biomass, and the Shannon Diversity Index (*H*; Formula 4) 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

Euclid Creek is located completely within the Erie-Ontario Lake Plains (EOLP) ecoregion and follows the EOLP IBI metric scoring. The 12 IBI metrics utilized for wading sites are listed in Table 7 below. The WWH IBI scoring criterion in the EOLP is 38 and the WWH MIwb scoring criterion in the EOLP is 7.9 for wading sites. A site is considered to be within nonsignificant departure (NSD) if the score falls within 4 IBI units or 0.5 MIwb units of the criterion (Table 8).

Table 7. IBI Metrics
Wading Sites
Total Number of Native Species
Number of Darter Species
Number of Sunfish Species
Number of Sucker Species
Number of Intolerant Species
Proportion of Tolerant Species
Proportion of Omnivores
Proportion of Insectivores
Proportion of Top Carnivores
Number of Individuals (less Tolerant Organisms)
Proportion of Simple Lithophilic Species
Proportion of Individuals with DELTs

Table 8. Fish Community Biology Scores for the EOLP Ecoregion							
Ohio EPA Narrative	Very Poor	Poor	Fair	Marginally Good	Good	Very Good	Exceptional
IBI Score	12-17	18-27	28-33	34-37	38-45	46-49	50-60
MIwb Score	0-4.4	4.5-5.8	5.9-7.3	7.4-7.8	7.9-8.8	8.9-9.3	≥9.4
Ohio EPA Narrative	Non-Attainment			NSD	Attainment		
NSD – Non-Significant Departure of WWH attainment							

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

Results and Discussion

RM 1.65

Results from two 2020 electrofishing sampling events in the stream segment at Euclid Creek RM 1.65 averaged an IBI score of 24, and an MIwb score of 5.2, both narratively *Poor*, and therefore was not in attainment of either the IBI or MIwb WWH designated use criterion (Table 9 and Figure 5).

Table 9. 2020 Euclid Creek IBI and MIwb Results

River Mile	1st Pass			2nd Pass			Average	
	Date	IBI	MIwb	Date	IBI	MIwb	IBI	MIwb
1.65	6/29/2020	24*	4.8*	8/17/2020	24*	5.6*	24*	5.2*
0.55	6/29/2020	26*	6.2*	8/17/2020	32*	8.3	29*	7.3*

*Significant departure from biocriterion (>4IBI; >0.5 MIwb units). Underlined scores are in the *Poor* or *Very Poor* narrative range
ns non-significant departure from biocriterion (≤4IBI; ≤0.5 MIwb units)

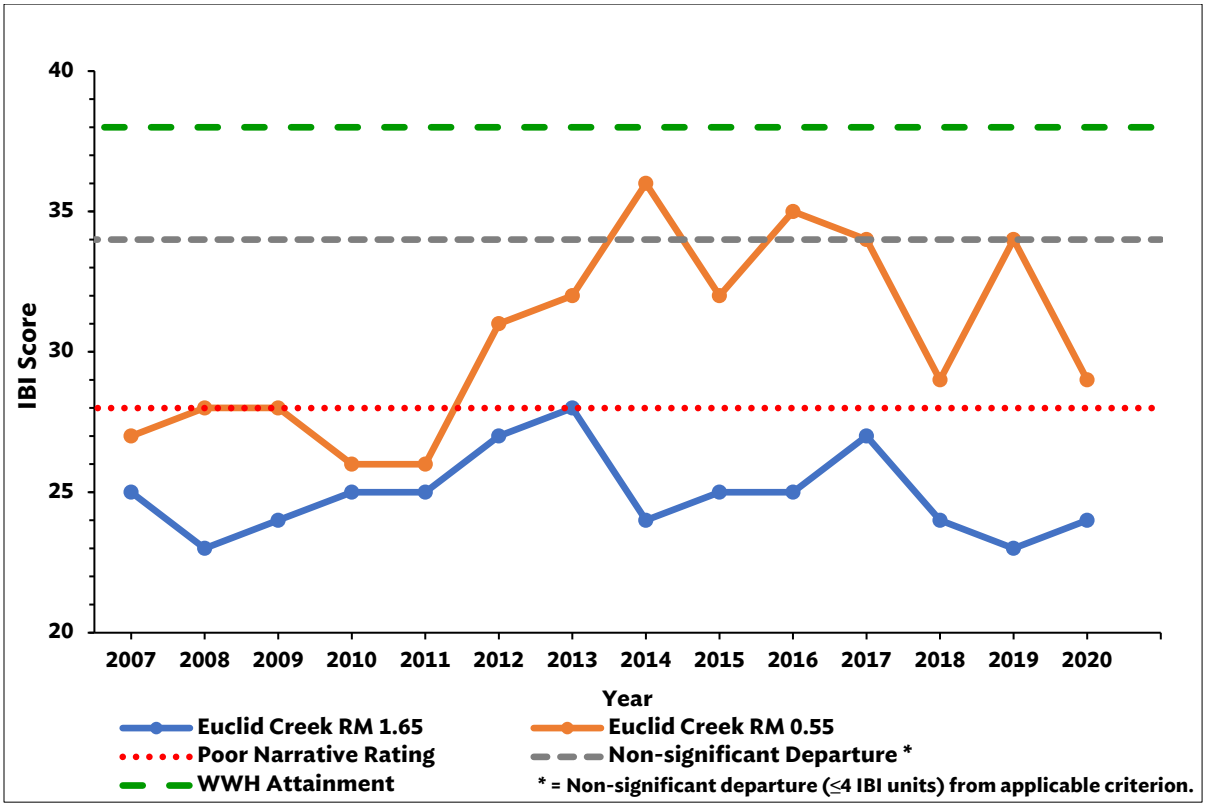

Figure 5. Euclid Creek Average IBI Scores 2007 - 2020

The first electrofishing pass, completed on June 29, 2020, resulted in an IBI score of 24, and an MIwb score of 4.8, and a narrative rating of *Poor*. Multiple factors contributed to RM 1.65 scoring

low in several metrics, including the absence of key taxa such as darters and suckers, a low number of intolerant species, as well a lack of top carnivore and insectivorous species. Only seven species of fish were collected during this sampling event, most of which are considered tolerant to pollution. Creek chubs were the predominantly collected species, with blacknose dace and central stoneroller minnows comprising much of the remaining sample. A bluegill sunfish, green sunfish, and common white suckers were also collected, with the presence of these species positively contributing to the IBI score. A low proportion of omnivorous taxa (9.8%) and no DELTs being observed in the sample population also provided for a positive contribution to the IBI score but did not ultimately influence attainment of the criterion.

The second electrofishing pass, completed on August 17, 2020, also resulted in a narrative rating of *Poor* for the IBI and MIwb indices, and not in attainment of either WWH criteria. While overall metric scoring was relatively similar, taxa diversity was reduced by 43% during this sampling event, causing a reduction in scoring in one sample metric. However, a more than one-hundred percent increase in the total density of individuals comprising the total sample number led to an increase in another metric score, totaling an IBI score equivalent to the first pass (24) and increasing the MIwb score to 5.6. Overall, there was three less taxa collected compared to the first sampling event; the bluegill sunfish, green sunfish, and common white sucker species were absent, with the sample population again being dominated by tolerant species, drawing attention to potential issues with water quality in the area.

The habitat assessment of Euclid Creek RM 1.65 indicated that the stream reach would be suitable to support a quality fish community. However, the low IBI score calculated in 2020 contradicts this QHEI score. While there has been no outright declining trend in IBI scores for RM 1.65 over time, the score has not improved, and remains in non-attainment of the WWH criterion (Figure 5). Given the "*Excellent*" QHEI habitat rating, the low IBI score may also be due to the inability for fish to reach this site.

A weir, known as the Euclid Creek Spillway, is located downstream at Euclid Creek RM 1.50 and stands as a significant barrier to the migration of fish to the reach at RM 1.65 (Figure 1). Removal of the Euclid Creek Spillway has been the subject of review by the NEORSD, local municipalities, and water quality advocates in Northeast Ohio for much of the last decade. In 2017, NEORSD requested that the United States Army Corps of Engineers (USACE) initiate a study to determine the feasibility of improving aquatic connectivity of Euclid Creek. In Fall 2019, the USACE published the results of the study detailing proposed actions, paving the way for restorative action. Elimination of this structure may allow for fish passage, increasing the likelihood for improved quality of the population composition, as well as an increase in population density.

For fish able to reach the area, minimal refugia may not support large species in times of low flow or small species from predation. Anthropogenic impacts including storm and combined sewer outfall discharges, while improved, may still also be affecting the fish population through the introduction of bacteria and sediment deposition. This may explain why the present population is dominated by tolerant taxa. Past monitoring downstream of the dam at RM 1.00 showed a similarly impacted fish community. Although more fish species were present at that location, the

community was still dominated by pollution-tolerant taxa, indicating that water quality impacts may be widespread throughout the stream.

RM 0.55

The sampling zone at Euclid Creek RM 0.55 in 2020 received a narrative rating of *Fair* for both the IBI and MIwb metrics with average scores of 29 and 7.3, respectively. Therefore, the stream segment at RM 0.55 did not reach attainment of the WWH criteria (Table 9 and Figure 5). The average MIwb score at RM 0.55 calculated nearly missed the 7.4 needed to achieve NSD and to be in partial attainment of the WWH criterion.

The first electrofishing pass, conducted on June 29, 2020, resulted in an IBI score of 26 with a narrative rating of *Poor* and an MIwb score of 6.2, a narrative rating of *Fair*, resulting in non-attainment status of both the IBI and MIwb criteria. More than twice as many species (16) were present in the RM 0.55 sample population compared to the first electrofishing event at RM 1.65, which may confirm the impact of the migration barrier at RM 1.50. Positively contributing to the IBI score was the presence of four different sunfish species, which included the green sunfish, bluegill sunfish, pumpkinseed sunfish, and the rock bass. Additional contributing factors to positive metric scoring were the presence of top carnivores and the large proportion of simple lithophills, which indicate the integrity of the sampling zone at RM 0.55 to sustain top feeders with suitable fish community reproduction. Field sampling reported lesions present on two brown bullheads. This moderate incidence (0.56% of fish) did result in a reduction of the IBI metric score but did not significantly impact the potential for RM 0.55 to reach WWH attainment. Only one species of darter was collected during this sampling event, providing a negative impact on the individual metric and overall scores. Darters prefer riffle habitats comprised of gravel and cobble, which offer cover as well as habitat for their common diet of aquatic macroinvertebrates. The lacustuary influence which has caused the absence of a riffle at this stream reach has effectively eliminated this habitat, and the likelihood that darters or similar fish will occupy the stream reach.

The June 29, 2020, sampling event at RM 0.55 was dominated by tolerant taxa comprising 75% of the fish collected, including the most dominant species, common white suckers, which contributed to nearly 49.4% of the sample population. Contained within the remaining sample were four species considered to be pollution sensitive: the northern logperch darter, sand shiner, mimic shiner, and smallmouth bass, but only one of these contributed to metric scoring as intolerant. Sampling also revealed the presence of two non-native species, the common carp and the round goby. Non-native or invasive species compete with native fish for resources, which can negatively affect the fish community composition.

The second electrofishing pass at Euclid Creek RM 0.55, completed on August 17, 2020, resulted in an IBI score of 32 (*Fair*), and an MIwb score of 8.3 (*Good*). The sampling zone at RM 0.55 was in attainment of the WWH criterion when using MIwb metric scoring but was calculated as being just below the NSD narrative range when utilizing the IBI (Table 9). The second sampling event indicated that taxa composition significantly shifted away from pollution-tolerant species and received a maximum IBI metric score based on the low percentage of these fish collected. Although the shift from tolerant taxa inherently improved multiple IBI metrics, the ratio of simple lithophils was vastly reduced and negatively impacted IBI scoring – the number of the pollution-

tolerant common white suckers collected in the second pass decreased by nearly a factor of ten in comparison to the first sampling event, with the species only contributing to 5.3% of the sample population. Eastern gizzard shad, which was absent in the first electrofishing pass, became the dominant species in place of the common white sucker. The second sampling event also added the largemouth bass to the species collected at RM 0.55 with fifteen of these specimens helping improve the percentage of top carnivores collected. Additionally, a second intolerant species, the rosyface shiner, was collected during the second electrofishing pass, further improving the IBI score. This was the first time during NEORSD surveys that the metric for intolerant species scored above a 1. In contrast to the first electrofishing pass at RM 0.55, more fish surveyed in the sample population were reported to have DELTs, with the ratio of affected individuals rising by a factor of two.

The stream habitat assessment of Euclid Creek RM 0.55 indicated a QHEI score that did not meet the WWH target, suggesting the reach had limited ability to sustain a healthy fish community. However, the presence of some pollution-sensitive taxa indicated that the stream may still be suitable for some species. Starting in 2014, the reach has scored within the NSD range of the WWH IBI criterion and achieved attainment status more times than not, suggesting that improvements to infrastructure, elimination of illicit discharges, and overall water quality may to some extent offset issues with habitat structure. The absence of a riffle at this location eliminates potential habitat for various fish species including darters. The logperch darter, which was represented in both sampling events, may be an exception, as it can be found in habitats other than riffles, including lakes and reservoirs. It is most likely that the fish in the sample population were transient from Lake Erie.

Macroinvertebrate Community Biology Assessment

Methods

Macroinvertebrates were sampled quantitatively using modified Hester-Dendy (HD) samplers in conjunction with a qualitative assessment of the presence of Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly) taxa, collectively referred to as EPT taxa, at the time of HD retrieval. Sampling was conducted at the Euclid Creek sampling locations listed in Table 1. Methods for sampling followed the Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volume III* (1987b). The recommended period for HD deployment is six weeks.

The macroinvertebrate samples were sent to Third Rock Consultants, LLC of Lexington, KY 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 are available upon request from the NEORSD WQIS Division.

The overall aquatic macroinvertebrate community in the stream was evaluated using Ohio EPA's Invertebrate Community Index (ICI) (Ohio EPA 1987b, DeShon 1995). 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

Table 11. ICI Range for EOLP Ecoregion								
Ohio EPA Narrative	Very Poor	Poor	Low Fair	Fair	Marginally Good	Good	Very Good	Exceptional
ICI Score	0-6	8-12	14-20	22-28	30-32	34-40	42-44	46-60
Ohio EPA Status	Non-Attainment				NSD	Attainment		
NSD – Non-Significant Departure of WWH attainment								

Results and Discussion

In 2020, HDs were installed at Euclid Creek RM 1.65 and 0.55 with qualitative sampling performed at both sites. Benthic macroinvertebrate sampling at RM 1.65 was calculated to have an ICI score of be 32 (*Marginally Good*), which did not significantly depart from the WWH attainment criterion, and therefore achieved WWH attainment status. The HD at RM 0.55 was mostly buried at the time of collection. This site was therefore assigned a narrative rating of *Low Fair*, which is considered in non-attainment of WWH status based on the qualitative sample (Table 12). Both stream segments scored significantly lower than recent sampling events and historical data can be viewed in Table 13 below.

Table 12. 2020 Euclid Creek Macroinvertebrate Results

River Mile	ICI Score	Density (Organisms per square foot)	Total Number of Taxa	Number of EPT Taxa	% Tolerant Organisms	% Sensitive Organisms	Narrative Rating
1.65	32	283	42	11	12.10	1.1	Marginally Good
0.55	--	--	34*	4	--	--	Low Fair*

*Based on qualitative sample only

Table 13. 2007-2020 Euclid Creek ICI Scores

Year	RM 1.65	RM 0.55
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
2018	**38**	Fair
2019	**46**	18
2020	*32*	Low Fair

Bold indicates attainment of WWH biocriterion

Italics indicates non-significant departure of WWH biocriterion

HD not collected; qualitative assessment used to assign narrative rating

Euclid Creek at RMs 1.65 and 0.55 has historically been evaluated for macroinvertebrates to determine the impact that NEORSD-owned CSOs may have on downstream biological communities (Figure 6). Starting in 2009, the stream segment at RM 1.65 has typically been in attainment of the WWH ICI biocriterion, excluding 2013 and 2014, which were also found to be the only two occasions that RM 0.55 achieved WWH attainment status since its monitoring began in 2002. The sampling zone at RM 0.55 is compositionally different than RM 1.65, whereby it lacks a functional riffle, which not only oxygenates stream waters, but also supports a population of riffle-

obligate species. RM 0.55 also has lacustuary influences that may impact the creek; during high lake levels or weather events, water from the lake flows upstream into the creek causing backflow and disrupting normal habitat. Both sampling zones are subject to illicit discharge, stormwater run-off, and CSO from the surrounding communities. The activation of the Euclid Creek Tunnel Project in 2018 has significantly reduced the number of CSO events from NEORSD-owned outfalls, and future monitoring will potentially reveal what long-term impacts this reduction has had on the local aquatic invertebrate community.

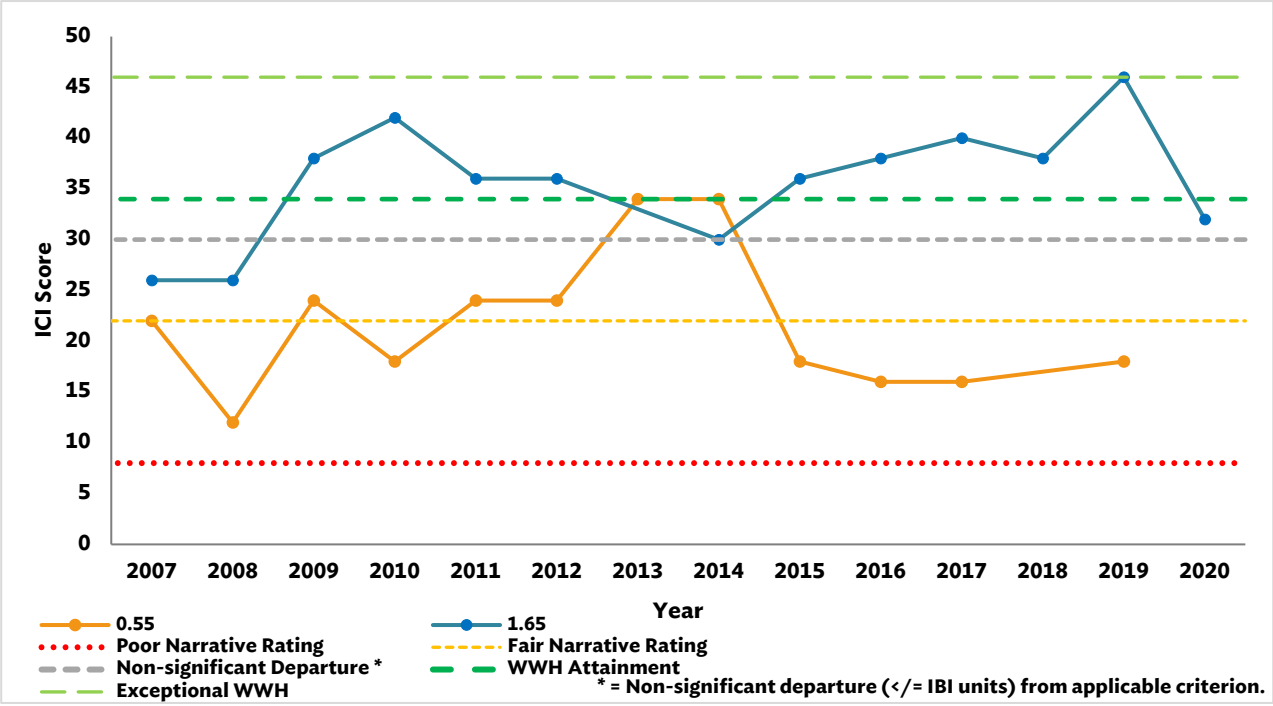

Figure 6. Historic ICI Scores at Euclid Creek RMs 1.65 and 0.55

During the 2020 field season, the sampling zone at Euclid Creek RM 1.65 saw a significant decrease in quality of macroinvertebrate community assemblage in comparison to 2019, when it achieved an ICI score of 46 and narrative rating of *Exceptional*. The 2020 ICI score was calculated at 32 and achieved attainment within the NSD range of the WWH criterion. Euclid Creek RM 1.65 has been sampled for macroinvertebrates since 2007 (Table 13); out of the thirteen years of sampling, nine of the years were in attainment of the WWH ICI biocriterion, with sampling conducted during 2020 indicating a steep downward trend in the health of the macroinvertebrate community biology. Factors that contributed to this decline were the increase in percentage of other Dipterans and non-insects, the decrease in the total number of Dipteran taxa, and the substantial reduction in the percentage of mayfly and caddisfly composition. Caddisfly and mayfly taxa composed 40.6 % of the species collected in 2019 whereas only 8.9% of the 2020 sample population was comprised of these indicator species (Figure 7) in which many of its members are generally considered to be pollution-sensitive and a gauge of good water quality. The 2020 macroinvertebrate sample also showed a decline from the previous year in the presence of two specific taxonomic groups: *Polypedilum (Uresipedilum) flavum* and *Hydropsyche depravata*. In the 2019 macroinvertebrate sample, *Polypedilum (Uresipedilum) flavum* contributed to 9.3% of the

population and *Hydropsyche depravata* comprised 16.4 %, while both groups combined to contribute less than 3% of the sample in the most recent survey.

While it is not known what specific environmental factors lead to the deterioration of macroinvertebrate assemblages in 2020, when compared to the previous six years of sampling, the ICI metric score was within one standard deviation of the mean ICI (Table 14) and would not be considered a statistical outlier or unexpected survey result. The ICI score was still within the NSD range of the WWH criterion and achieved WWH attainment status. Figure 7 shows historical macroinvertebrate community composition and fluctuation of taxa composition seen from 2014 through 2020; when the proportions of mayflies, caddisflies, and tribe *Tanytarsini*, are abundant and more equally dispersed, ICI scores increase. As seen in 2014 and 2020 survey results, the percentage of other organisms comprises over 70% of the sample population and produced the two lowest ICI scores in the previous ten years of macroinvertebrate assessments at RM 1.65.

Table 14. 2020 Euclid Creek RM 1.65 Historical ICI Scores

2014	2015	2016	2017	2018	2019	2020	Average	Standard Deviation
30	36	38	40	38	46	32	37	5

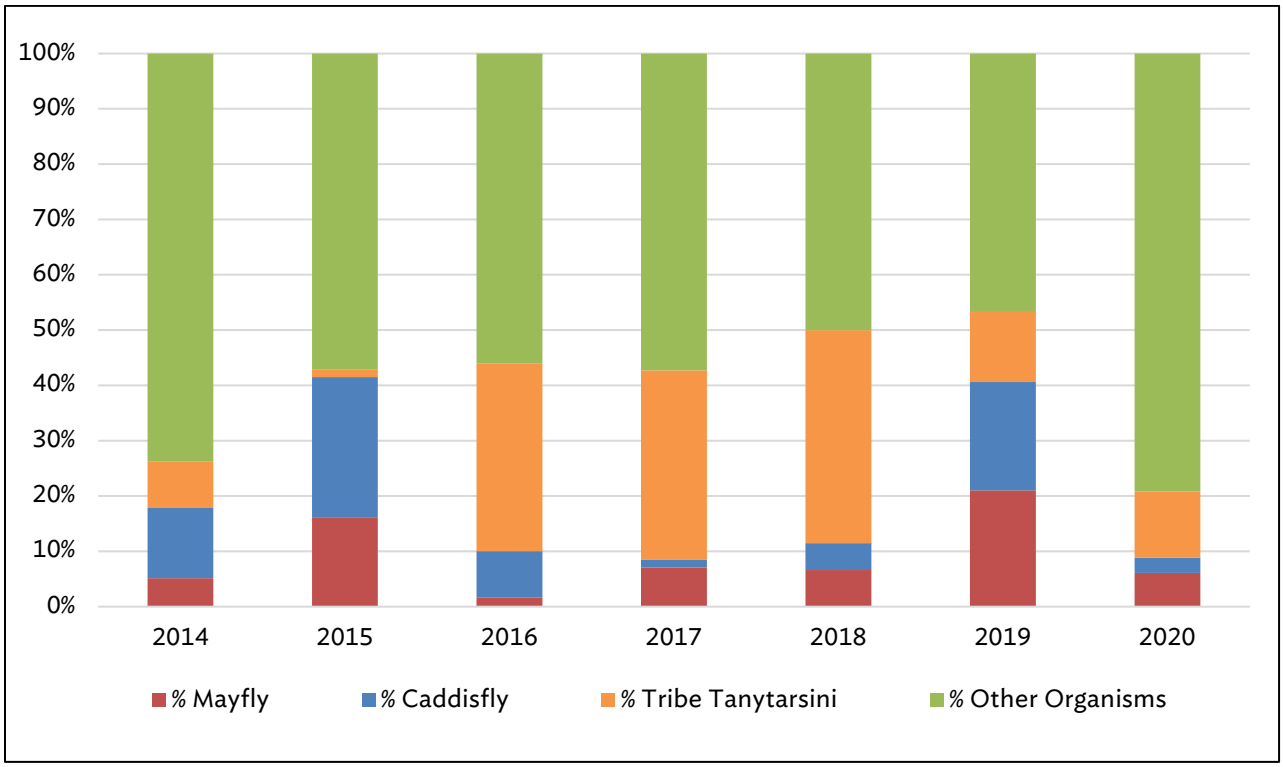

Figure 7. Euclid Creek RM 1.65 Macroinvertebrate Community Composition

The HD set at Euclid Creek RM 0.55 was found to be almost completely buried in sediment at the time of sample collection which was likely caused by a lack of downstream flow, natural

seiche from Lake Erie, and a series of heavy rain events that occurred over the 6-week installment period. Therefore, a narrative rating was assigned to this site based on results of the qualitative sample conducted on July 29, 2020. The site was assigned a narrative rating of *Low Fair* in 2020. Macroinvertebrate data provided by the Ohio EPA from the Erie/Ontario Lake Plain ecoregion (EOLP) from 2005 to 2014 was used for comparative purposes in the assignment of the narrative rating. Euclid Creek RM 0.55 has a drainage area of 23.0 square miles placing it in the "wadable" stream category with respect to drainage area according to the Ohio EPA Biocriteria Manual Volume III (Ohio EPA, 2015). The historical average numbers of qualitative taxa, qualitative EPT taxa, and qualitative sensitive taxa for wadable sites in the EOLP with ICI scores falling under each narrative rating category are provided in Figures 8-10.

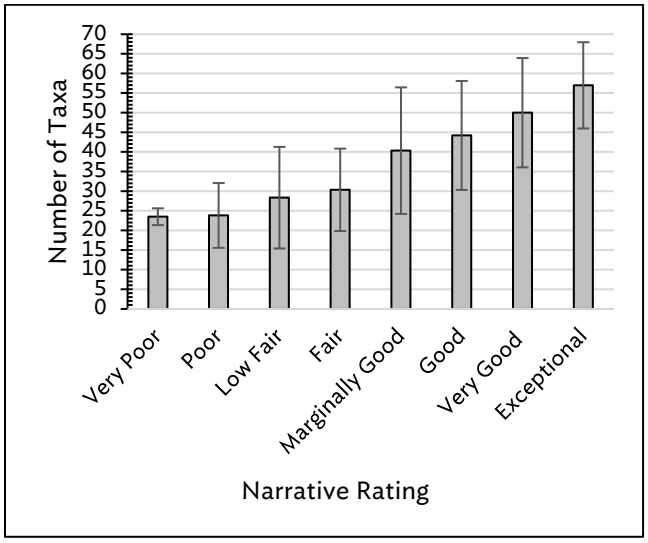

Figure 8. Average Number of Qualitative Taxa by Narrative Rating (EOLP Wadable)

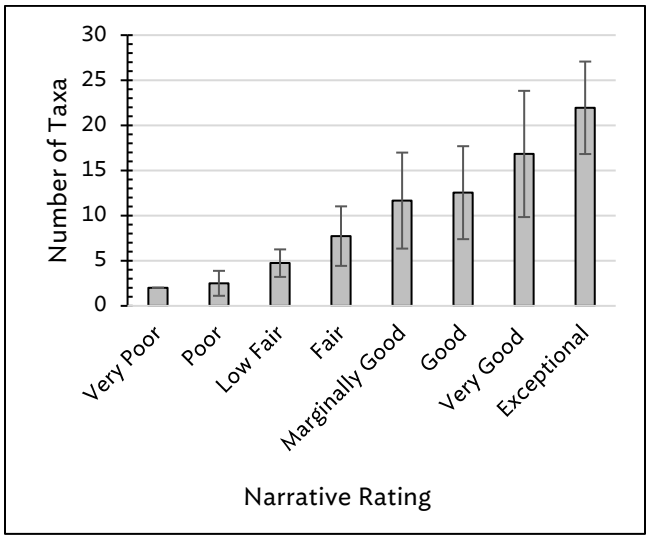

Figure 9. Average Number of Qualitative EPT Taxa by Narrative Rating (EOPL Wadable)

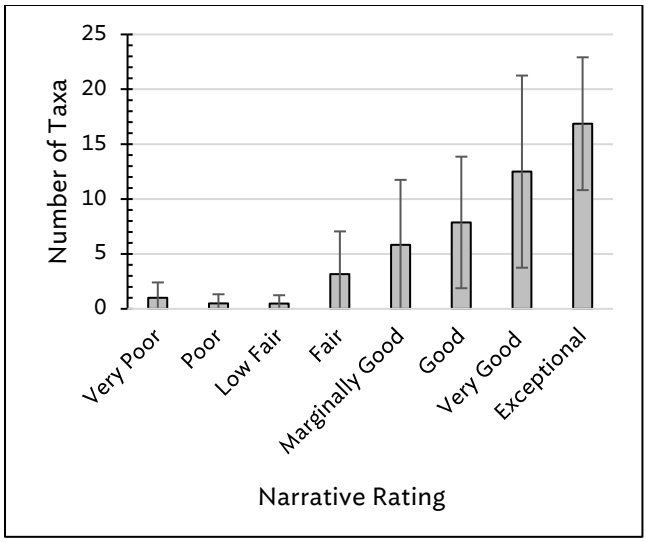

Figure 10. Average Number of Qualitative Sensitive Taxa by Narrative Rating (EOLP Wadable)

The total number of qualitative taxa present at the site was 32. This falls between the average number of qualitative taxa for wadable sites with historical narrative ratings of *Fair* and *Marginally Good* (Figure 8). Four EPT taxa were collected. This falls between the average number of qualitative EPT taxa for wadable sites with historical narrative ratings of *Poor* and *Low Fair* (Figure 9). One sensitive taxon, Polycentropus group (moderately intolerant), was present in the qualitative sample at this site. This falls between the average number of qualitative sensitive taxa for sites with historical narrative ratings of *Low Fair* and *Fair* (Figure 10).

The site was given an estimated field narrative rating of *Fair* at the time of sample collection, due to the low EPT diversity observed and the high abundance of tolerant groups including Chironomidae, Turbellaria, Amphipoda and Isopoda. The number of qualitative taxa, qualitative EPT taxa, and qualitative sensitive taxa were all near to average values observed at historical sites with narrative ratings between *Poor* and *Fair*. Therefore, the site was assigned a narrative rating of *Low Fair* in 2020. This site appeared to have lacustuary influences with low flow and no riffle due to elevated water levels in Lake Erie. This most likely increased lake influence at this site, negatively impacting the abundance of EPT and sensitive taxa by impacting flow regimes in 2020.

Conclusions

The results of NEORSD's water chemistry sampling, habitat assessments, and fish and benthic macroinvertebrate community surveys indicate that despite improvements to sewer and stormwater infrastructure, the Euclid Creek watershed is still impacted by a variety of aquatic habitat limitations and environmental stressors.

Neither stream reach at Euclid Creek RM 0.55 nor RM 1.65 were in attainment of WWH status due to low metric scoring. RM 1.65 did have an ICI within attainment range but due to *Poor*

narrative ratings in fish community metrics the site does not meet partial attainment status (Table 15). Exceedances of the recreational water quality standards for *E. coli* occurred at both Euclid Creek sites throughout the season, although a continued downward trend of *E. coli* densities can be observed since the activation of the Euclid Creek Tunnel in 2018 as seen in Figure 2. These *E. coli* exceedances may be due to sanitary sewage contamination with potential sources including CSOs, sanitary sewer overflows, failing HSTSs, illicit discharges, wildlife, and urban runoff. Nutrient levels show that the Euclid Creek displays levels typical of developed lands and are little or no risk to Euclid Creek beneficial uses.

Table 15. 2020 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	24 *(Poor)*	5.2 *(Poor)*	32* *(Marginally Good)*	76.75 *(Excellent)*	*E. coli*
0.55	NON	29 *(Fair)*	7.3 *(Fair)*	*(Low Fair)*	58.50 *(Fair)*	*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

The failure of the stream segment at RM 1.65 to reach full WWH attainment, despite having excellent habitat quality and possessing a marginally good macroinvertebrate community, is likely due to the fish barrier at RM 1.50 which prevents migration to the upper reaches of the watershed, driving the non-attainment of IBI and MIwb for RM 1.65. The 2020 sampling season did show a significant decline in macroinvertebrate community health at RM 1.65, likely due to poor macroinvertebrate community composition caused by low proportions of caddisflies, mayflies, and tribe *Tanytarsini* present in the sample. However, this did not correlate to fish community biology health, which saw a slight improvement compared to the previous year.

The failure of habitat, IBI, and MIwb attainment at RM 0.55 is likely most impacted by its lack of a riffle and lacustuary influences, while fish community diversity substantially improved later in the season, the stream reach still does not seem to be able to support a thriving assemblage. The increased quantity and diversity of fish collected on the second pass at RM 0.55 may be caused by seasonal variability in fish populations. The macroinvertebrate qualitative sampling on July 29, 2020, indicated that the stream segment received a *Low Fair* field narrative rating, which supports that no riffle and lacustuary influences may be negatively impacting this site.

Continued monitoring of both sites will determine whether the NEORSD's Project Clean Lake infrastructure improvements will have a significant, long-term impact on the biological communities and bacteriological loading of Euclid Creek. This combined with future stream remediation projects such as the potential removal of the dam at RM 1.50 will be integral in restoring the stream to warmwater habitat.

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