Northeast Ohio
Regional Sewer District

2024 Euclid Creek
Biological, Water Quality, and Habitat Study

Water Quality and Industrial Surveillance

Environmental Assessment Group

April 2025

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Introduction

In 2024, the Northeast Ohio Regional Sewer District (NEORSD) conducted environmental water quality assessments in the Euclid Creek watershed. This monitoring was performed as part of the NEORSD general watershed monitoring program. The intent of this program is to periodically assess all major watersheds in the NEORSD service area. Euclid Creek is a Lake Erie direct tributary that drains the communities of South Euclid, Lyndhurst, Willoughby Hills, Richmond Heights, Highland Heights, Euclid, and Cleveland.

Figure 1 shows a map of the sampling locations, and Table 1 indicates the sampling locations with respect to stream, river mile (RM), latitude and longitude. These sites all are located in the Euclid Creek 041100030503 HUC-12. Table 2 indicates the Beneficial Use Designations with respect to stream. Sites were located on the Euclid Creek Mainstem (EC) and a Euclid Creek East Branch tributary at RM 1.55, also known as Claribel Creek (CC). Additionally, the sites at river miles 1.65 and 0.55 were assessed in support of Ohio Environmental Protection Agency (EPA) Permit #3PA00002*JD. A digital photo catalog of the sampling locations is available upon request by contacting the NEORSD's Water Quality and Industrial Surveillance (WQIS) Division.

The entire Euclid Creek watershed is included in the Cuyahoga River Area of Concern (AOC). Current beneficial use impairments (BUIs) listed for the Cuyahoga River AOC include loss of fish habitat, fish populations, and benthos (macroinvertebrate community). Data collected by the NEORSD can be utilized to assess the current BUI status moving forward. There are numerous ongoing management action projects in the Euclid Creek watershed, one of which is discussed in this report.

Previous studies on Euclid Creek indicated that sanitary sewage contamination is a primary cause of the recreational water quality impairments on Euclid Creek. Possible sources of sanitary sewage contamination include common trench sewer (where both sanitary and storm sewers are in the same trench) inflow and infiltration, illicit discharges, combined sewer overflows, and local sanitary sewer overflows. Water quality improvements in Euclid Creek have been a long-term target of the NEORSD "Project Clean Lake" infrastructure investments. These projects utilize large underground storage tunnels to capture combined sewer overflow (CSO) discharges during wet weather for subsequent treatment. The NEORSD completed the construction of the Euclid Creek Tunnel (ECT), a massive underground CSO storage tunnel, in 2015. The Tunnel was fully operational following completion of the ECT Dewatering Pump Station in 2019. This has resulted in a significant reduction in the quantity of NEORSD-operated CSO discharges to Euclid Creek beginning in the recreational season of 2019.

Claribel Creek is a tributary to the East Branch of Euclid Creek at RM 1.55. A full biological assessment was performed on Claribel Creek at RM 1.00 to document baseline conditions prior to a potential stream restoration project. The RM 1.00 location is directly upstream of the impoundment that creates Mayfair Lake. Potential restoration efforts planned for this section of

Claribel Creek include the removal of the Mayfair Lake dam as well as stream habitat improvements.

Sampling was conducted by NEORSD Level 3 Qualified Data Collectors (QDCs) certified by the Ohio EPA in Fish Community Biology, Benthic Macroinvertebrate Biology, Chemical Water Quality, and Stream Habitat Assessments as explained in the NEORSD *2024 East Side Tributaries Environmental Monitoring* study plan. All sampling and environmental assessments occurred between June 15, 2024, and September 30, 2024 (through October 15 for fish sampling assessments), as required in the Ohio EPA *Biological Criteria for the Protection of Aquatic Life Volume III* (1987a). The results were evaluated using the Ohio EPA's Qualitative Habitat Evaluation Index (QHEI), Index of Biotic Integrity (IBI), Modified Index of Well-Being (MIwb), and the Invertebrate Community Index (ICI). Water chemistry data was validated per methods outlined by the Ohio EPA *Surface Water Field Sampling Manual for water quality parameters and flows* (Ohio EPA, 2023a) and compared to the Ohio Water Quality Standards (WQS) for their designated use to determine attainment (Ohio EPA, 2024). An examination of the individual metrics that comprise the IBI, MIwb, and ICI was used in conjunction with the water chemistry data and QHEI scores to assess the health of the stream.

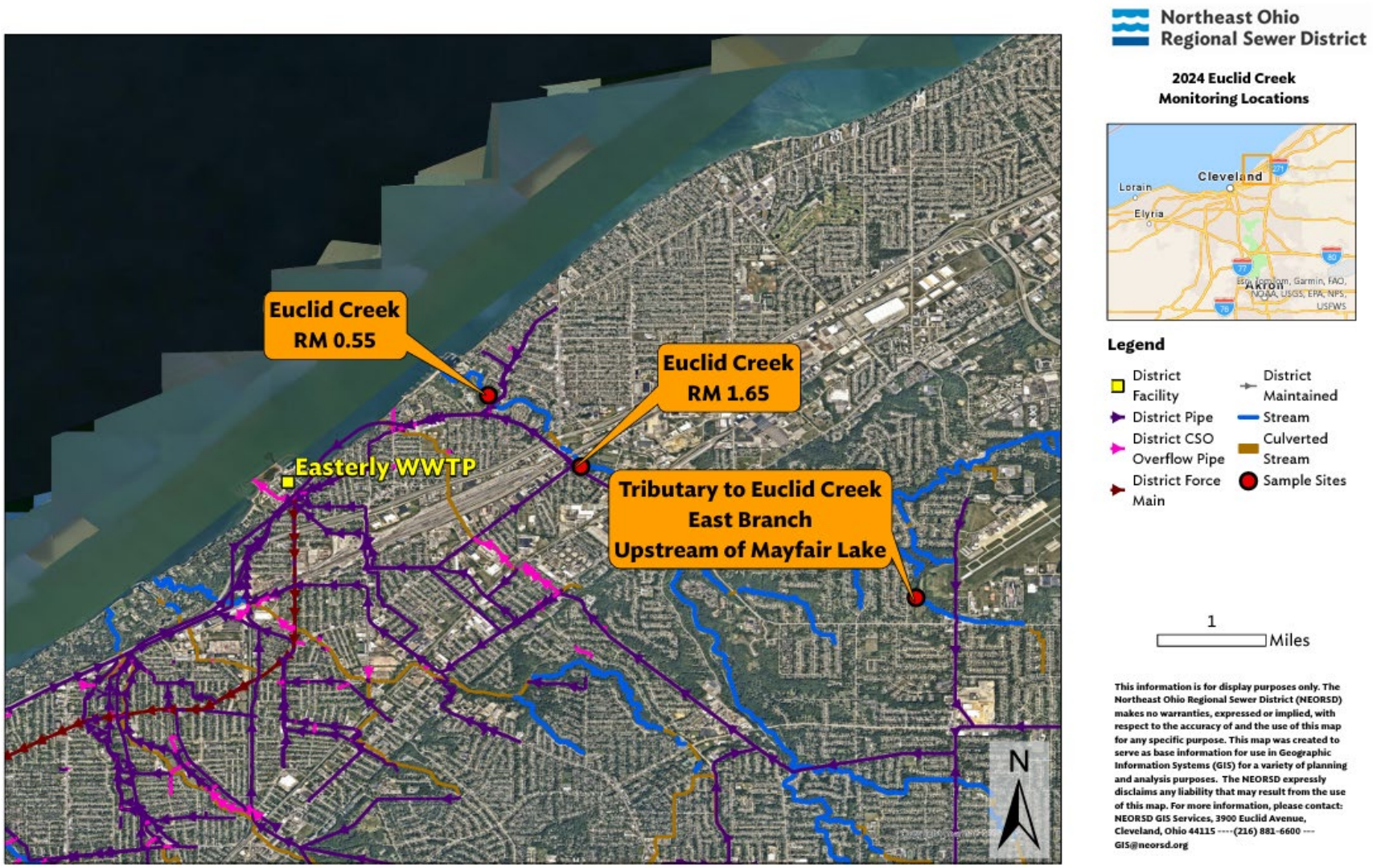

Figure 1. Sampling Locations Map

Table 1. 2024 Euclid Creek Sampling Locations

Location	River Mile	Station ID	Latitude	Longitude	Drainage Area (mi^2)	Sampling Conducted
Euclid Creek (19-041-000)						
Upstream of St. Clair Ave.*	1.65[W]	504250	41.5738	-81.5470	21.80	F, M, C
Downstream of Lakeshore Blvd.*	0.55[W]	F01A47	41.5841	-81.5602	23.00	
Claribel Creek (19-041-002)						
Upstream of Mayfair Lake	1.00[H]	200145	41.5563	-81.7116	0.88	F, M, C

*Sampling locations are required by Ohio EPA Permit 3PA0002*JD
[H] - Headwater site (draining ≤20 $miles^2$)
[W] – Wading site (non-boat site draining >20 $miles^2$)
F = Fish community biology (includes habitat assessment)
M = Macroinvertebrate community biology
C = Water Chemistry

The Ohio EPA assigns designated uses to establish minimum water quality requirements for surface waters. These requirements represent measurable criteria for assessing the chemical, physical, and biological integrity of Ohio's surface waters consistent with Clean Water Act requirements. The beneficial use designations for the Euclid Creek watershed are listed below in Table 2 (Ohio EPA, 2024).

Table 2. Beneficial Use Designations for Euclid Creek

Water Body Segment	Beneficial Use Designation												
	Aquatic Life Habitat (ALU)							Water Supply			Recreation		
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR
Euclid Creek-Anderson Road (RM 5.6) to U.S. Rte. 20 (RM 2.4)	*	+							+	+		+	
-all other segments		+							+	+		+	
East branch (Euclid Creek RM 3.2)		+							+	+		+	
Unnamed tributary (Claribel Creek; East Branch RM 1.55)							+		+	+			+

SRW = state resource water; WWH = warmwater habitat; EWH = exceptional warmwater habitat;
MWH = modified warmwater habitat; SSH = seasonal salmonid habitat; CWH = coldwater habitat;
LRW = limited resource water; PWS = public water supply; AWS = agricultural water supply; IWS = industrial water supply;
BW = bathing water; PCR = primary contact recreation; SCR = secondary contact recreation.
*Designated use based on the 1978 water quality standards.
+Designated use based on the results of a biological field assessment performed by the Ohio EPA (OAC 3745-1-26).

Water Chemistry and Bacteriological Sampling

Methods

Water chemistry and bacteriological sampling were conducted five times at each site between June 20 and July 18, 2024. Techniques used for sampling and analyses followed the Ohio EPA *Surface Water Field Sampling Manual for water quality parameters and flows* (Ohio EPA, 2023a). 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 250-mL sterilized plastic bottles. At the time of sampling, measurements for dissolved oxygen (DO), DO percent, pH, temperature, conductivity, and specific conductance were collected using a YSI EXO1 sonde. Duplicate/replicate and field blank samples 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/replicate 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/replicate sample

The acceptable percent RPD is based on the ratio of the sample concentration and detection limit (Formula 2) (Ohio EPA, 2019).

Formula 2:

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

X = sample/detection limit ratio

Those RPDs that were 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.

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

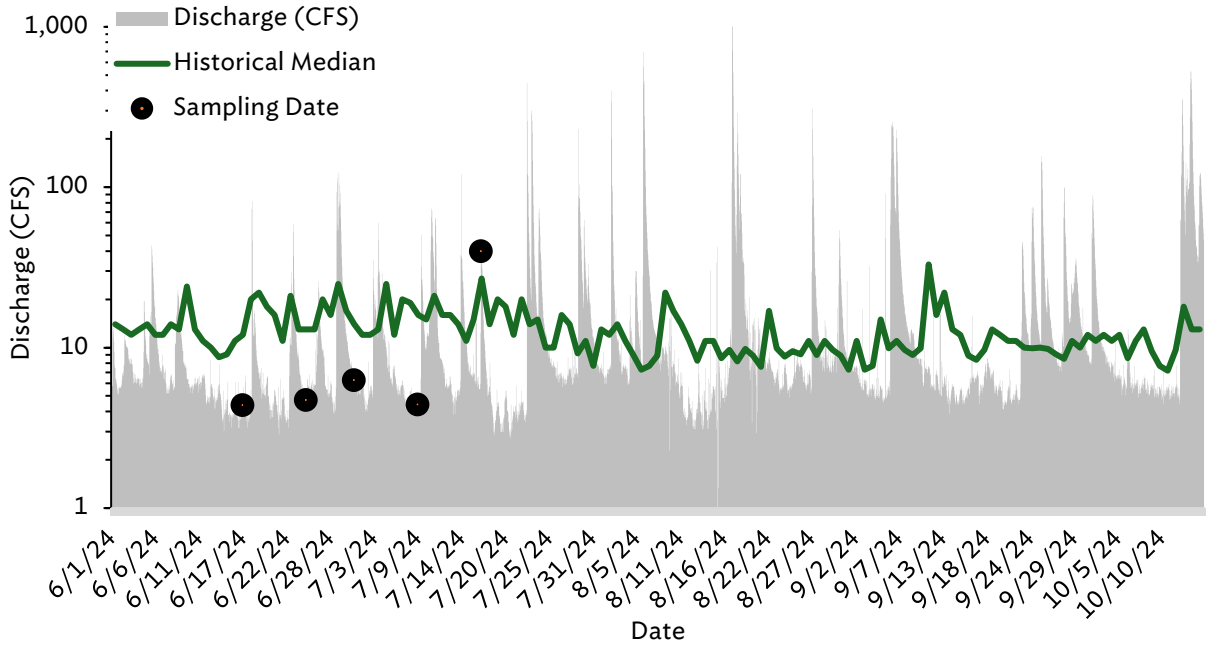

Figure 2. Water chemistry sampling dates compared to flow data from Euclid Creek Station 04208700.

Results and Discussion

Data Validation QA/QC Checks

One replicate and two field blanks were collected in support of quality assurance and quality control (QA/QC) guidelines (Ohio EPA 2023a). The replicate sample was collected at Euclid Creek RM 1.65 on July 9, 2024. All replicate sample results were within the required RPD and were therefore validated. The field blanks were collected on July 1 and July 17, 2024. The results from the field blanks indicated that no parameters were affected by possible contamination. Paired parameters, wherein one parameter is a subset of another, were also evaluated in accordance with QA/QC protocols. Table 3 lists parameters that had subset parameter results larger than the parent parameter results but are within the acceptable RPD range. Some sample results for total phosphorus (TP), dissolved reactive phosphorus (DRP), total solids (TS) and total dissolved solids (TDS) were qualified as "estimated" because of this. No additional QA/QC qualifiers were observed.

Table 3. Paired Parameter Qualifiers						
River Mile	Date	Parent Parameter (Result*)	Sub Parameter (Result*)	Acceptable RPD	Actual RPD	Qualifier
Euclid Creek (19-041-000)						
0.55	6/17/24	TS (506.5)	TDS (538.0)	24.3	6.0	Estimated (J)
Claribel Creek (19-041-002)						
1.00	6/25/24	TP (0.257)	DRP (0.260)	36.3	1.2	Estimated (J)
	7/1/24	TP (0.236)	DRP (0.238)	37.2	0.8	Estimated (J)
	7/17/24	TP (0.183)	DRP (0.188)	40.2	2.7	Estimated (J)
* Results in mg/L						

Bacteriological Exceedances

Escherichia coli (*E. coli*), a fecal-indicator bacteria commonly found in the intestinal tract and feces of warm-blooded animals, is used to measure the potential for pathogens in surface waters (USEPA, 2012)]. Euclid Creek mainstem is designated primary contact recreation (PCR) and Claribel Creek is designated secondary contact recreation (SCR). The PCR criteria include an *E. coli* criterion not to exceed a Statistical Threshold Value (STV) of 410 colony counts or most-probable number (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 or MPN per 100mL (Ohio EPA, 2024). The SCR criteria include an *E. coli* criterion not to exceed a STV and 90-day geomean of 1030 MPN/100mL. In accordance with Ohio EPA procedure and practice to qualify *E. coli* exceedances for the PCR and SCR criteria, the geometric mean and STV are only calculated and compared when a minimum of five bacteriological samples have been collected.

The two Euclid Creek mainstem sites exceeded both the PCR STV and 90-day geomean criteria during the 2024 recreation season (Table 4). The 90-day geomean was calculated at 1,208 and 1,148 and 100% of the samples exceeded the 410 MPN/100mL STV. The RM 0.55 sampling location is also sampled daily as a part of the NEORSD beach monitoring program. A total of 134 daily samples were taken at this location, resulting in an *E. coli* seasonal geomean of 1,199 MPN/100mL and 88.4% of the samples greater than the STV (Figure 3), both of which are in exceedance of the PCR WQS criteria. Claribel Creek met the SCR recreational use criteria for seasonal geomean, but 20% of the days sampled were greater than the STV causing impairment of the recreational use.

Table 4. *E. coli* Densities (MPN/100mL)			
	Euclid Creek		Claribel Creek
	PCR		SCR
Date	RM 1.65	RM 0.55	RM 1.00
6/17/24	687	1,203	548
6/25/24	579	921	192
7/1/24	727	1,414	365
7/9/24	2,420	1,300	517
7/17/24*	3,680	980	7,330
90-day STV Exceedance (%)	100	100	20
90-day geomean	1,208	1,148	680

Exceeds statistical threshold value for designated use.
Exceeds 90-day STV criterion of 10%.
Exceeds 90-day geometric mean criterion for designated use.

*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.

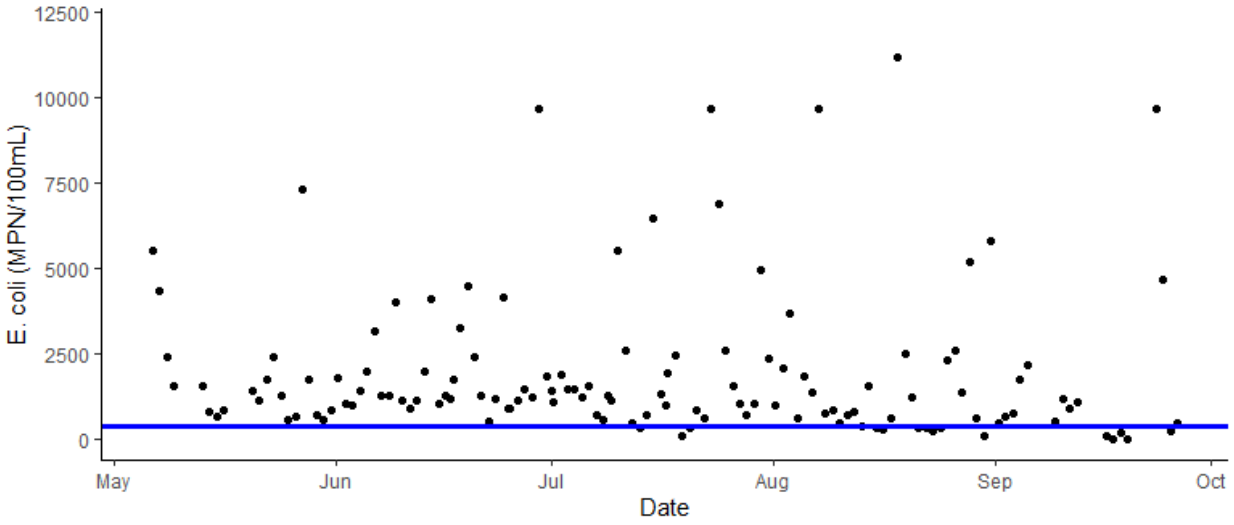

Figure 3. Euclid Creek RM 0.55 *E. coli* densities by date. The solid blue line represents the STV WQS threshold of 410 MPN/100mL.

One of the five sampling dates was following a wet-weather event, which may have led to elevated *E. coli* densities due to urban runoff, combined and sanitary sewer overflows, illicit discharges, and common trench sewers which are common in the Euclid Creek mainstem watershed. Leaking common trench sewers are likely contributing the highest baseline *E. coli*

densities to Euclid Creek (Zgnelic, 2016). Elevated *E. coli* densities may also have significant contributions from domestic and/or wild animal waste.

Water Column Chemistry Results and Discussion

Mercury analysis for all the sampling events was done using EPA Method 245.1. Because the detection limit for this method is above the criteria for the Human Health Nondrinking and Protection of Wildlife Outside Mixing Zone Averages (OMZA), it generally cannot be determined if the 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. Mercury was not detected in any sample above the detection limit in 2024; however, it has been periodically detected in past samples from Euclid Creek.

On July 17, 2024, elevated flows from recent rainfall caused the hardness concentration to drop from an average four-day total of 162.6 ug/L between all three sites, to concentrations below 35 ug/L. This drop in hardness at Euclid Creek RM 1.65 and Claribel Creek RM 1.00 caused the Aquatic Life Tier I Outside Mixing Zone Maximum (OMZM) criterion for silver to be below the detection limit. Because of this, it could not be determined if those sites were in attainment of the criterion on that day. However, based on data collected during the other sampling events and past studies, it is not expected that silver contamination is a significant issue at any of the sites.

Stream Nutrient Assessment

The Ohio EPA uses causal associations to determine the risk association between nutrients [total phosphorus (TP) and dissolved inorganic nitrogen (DIN)] shown in Table 5, dissolved oxygen (DO), chlorophyll a, and biological performance. Figure 4 displays the TP and DIN results along with the mean value compared to the risk category (Ohio EPA, 2015) for Euclid Creek (EC) and Claribel Creek (CC). Claribel Creek displayed a moderate risk only for TP, while all other locations were classified in the low-risk range.

Table 5. Biological Performance Risk Categories for TP and DIN

Risk Category	Total Phosphorus	DIN
Low	<0.131	<3.6
Medium	≥0.131 and <0.4	<3.6
High	≥0.4	≥3.6

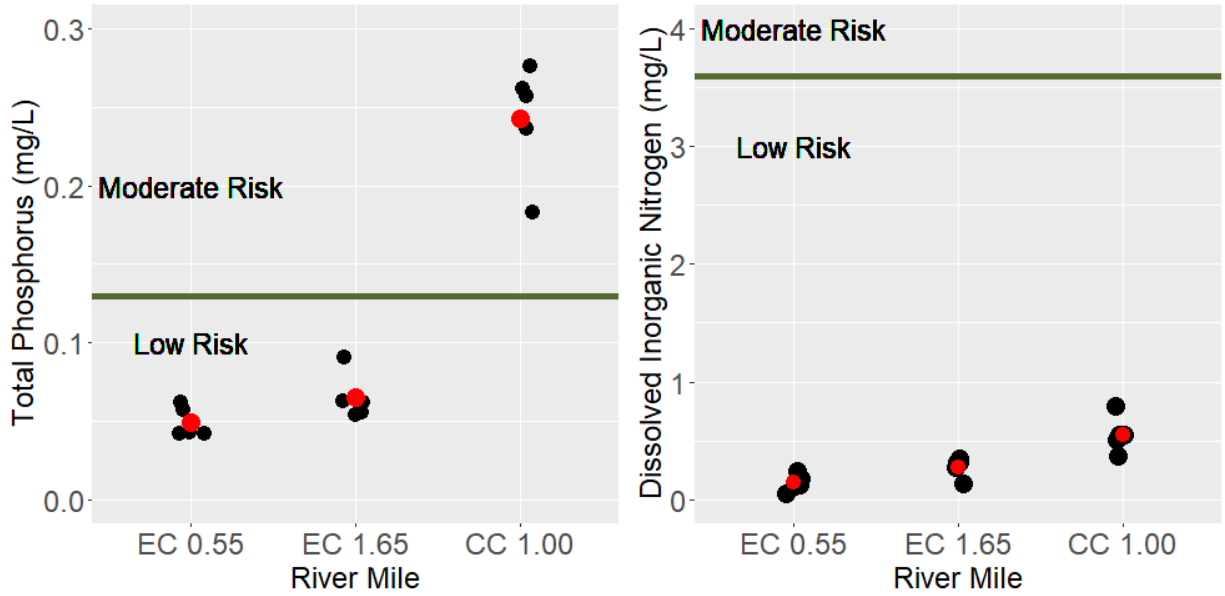

Figure 4. TP and DIN Scatterplot for Euclid Creek. The red dots represent mean values, and the green line represents the nutrient low-risk benchmark for biological performance.

A datasonde maintained by the NEORSD is located on Euclid Creek near RM 0.60. This datasonde measures DO, conductivity, temperature, and pH in 15-minute intervals. DO can be used to measure algal biomass by measuring daily oxygen production and consumption. The Ohio EPA has developed risk categories for daily diel DO swings with high risk beginning in streams with swings greater than 6.5 mg/L. Data from June 15-October 31, 2024, was pulled and demonstrated diel DO swings greater than 6.5 mg/L on 38.2% of the days (n=102) where data was collected for a continuous 24 hours. DO saturation values are also a good indicator of over-enrichment when values exceed 120% (Ohio EPA, 2023b). The Euclid Creek sonde had maximum daily DO saturation values greater than 120% for 79.4% of the days (n=102). An alarming 9.8% of the days had DO saturation values greater than 180%. Although nutrient concentrations were classified in the low-risk category at both lower Euclid Creek locations, the wide diel DO swings and DO super-saturation values are reflected of highly stimulated algal productivity. These issues were likely exacerbated due to summertime low flows and the mild drought that the area experienced during the summer months.

Habitat Assessment

Methods

Instream habitat assessments were conducted at all stream sites 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, with slightly different narrative ranges for streams based

on total drainage area (Table 5). For headwater streams, a score greater than 55 for headwaters and 60 for larger streams suggests that sufficient habitat exists to support a fish community that attains the warmwater habitat criterion (Ohio EPA, 2006). Scores greater than 70 for headwaters and 75 for larger streams frequently demonstrate habitat conditions that can support exceptional warmwater fauna. 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.

Table 6. Narrative Ranges Assigned to QHEI Scores

Narrative Rating	QHEI Range	
	Headwaters (drainage ≤ 20 sq miles)	Larger Streams (drainage > 20 sq miles)
Excellent	≥70	≥75
Good	55-69	60-74
Fair	43-54	45-59
Poor	30-42	30-44
Very Poor	<30	<30

Results and Discussion

Two of the three sampling locations met the Ohio EPA QHEI WWH target for their respective stream sizes, indicating that sufficient habitat quality exists to support a WWH fish assemblage at these locations. Euclid Creek is made up of three distinct geological areas that define the local stream habitat. The Appalachian Plateau comprises the upper watershed and headwaters, including Claribel Creek. Euclid Creek then flows through the Portage Escarpment, which is a high gradient section of the stream that cuts through shale and sandstone, creating vast shale cliffs and many waterfalls. Finally, the lower watershed meets the flat, lake-affected Lake Plain region near its confluence with Lake Erie.

Euclid Creek RM 0.55 received the lowest QHEI narrative rating of *Fair*. This section of stream is within the low gradient Erie Plain ecoregion and its flows are highly affected by Lake Erie water levels. This caused a lack of a riffle habitat, fair development of riffle, run, and pool sequences, and solids to start settling out within this zone leading to heavy-moderate silt and overall embeddedness. In-stream cover was also sparse, consisting of small amounts of various cover types. Euclid Creek RM 0.55 also received the highest number of modified warmwater attributes listed in Table 6.

The RM 1.65 sampling location is located within the lower portion of the Euclid Creek gorge, where the stream has eroded deep into the alluvial soil down to shale bedrock. The gorge area of Euclid Creek flows through the Portage Escarpment where gradient values are the highest in the watershed. Habitat at RM 1.65 consisted of an array of substrate types (Figure 5), higher gradient, and defined riffle and pool complexes, which were reflected by the *Excellent* QHEI score of 74.5.

Figure 5. Shale, cobble and boulder substrate at RM 1.65 typical of the Euclid Creek gorge area.

Claribel Creek originates on the Allegheny Plateau, where the stream is flatter with broad, shallow streambeds before entering the deep valleys formed throughout the Portage Escarpment. Claribel Creek at RM 1.00 has a watershed drainage area of <1.0 mi^2, which can lead to a lower overall QHEI score based on the size of the stream. The floodplain surrounding this section of stream is grassy fields with some wooded areas. This property previously housed a country club which comprised approximately 20 acres. The dam creating Mayfair Lake that is being evaluated for a potential restoration project was built in 1942 and used as a swimming pond for members (USEPA, 1988). This impoundment has had a history of nutrient enrichment, sedimentation, and has been involved in legal disputes to resolve deterioration of the dam structure.

Claribel Creek scored an *Excellent* QHEI score of 70.5. Although much smaller than the other two Euclid Creek locations, this section of stream contains deep pools, is highly sinuous, contains a variety of substrate types, and had normal-low substrate embeddedness. Unlike the two downstream Euclid Creek sites, the predominate substrate was clay hardpan with cobble. The bridge over Claribel Creek to the old country club has collapsed, causing moderate stream channel stability and eroding banks due to the stream downcutting into the clay hardpan and becoming incised (Figure 6).

Figure 6. Claribel Creek with hardpan and boulder substrates. Note the incised channel and riparian grasses providing little bank stability.

Individual components of the QHEI can also be used to evaluate whether a site can meet 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. The presence of one high or four moderate influence characteristics has been found to result in lower IBI scores, with a greater prevalence of these characteristics usually preventing a site from meeting WWH attainment (Ohio EPA, 2006).

Table 6 characterizes QHEI scores and physical attributes for each stream segment and determines the influence each parameter as on the QHEI score. Typically, as MWH/WWH ratios increase above 2:1, the potential for instream habitat to cause biological impairment increases. Euclid Creek RM 0.55 contained the highest MWH/WWH ratio at 1.8, reflected in the lowest overall QHEI score. Euclid Creek RM 1.65 and Claribel Creek RM 1.00 scored well for WWH/MWH attributes with ratios less than 1.0.

Table 7. 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 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 Substrates (Boat)	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**
Euclid Creek (19-041-000)																																		
1.65	74.5	*Excellent*	X	X		X		X	X		X		**6**				X		**1**		X			X	X				X	X		**5**	**0.3**	**0.9**
0.55	55.0	*Fair*	X	X							X		**3**				X		**1**		X			X	X			X	X		X	**6**	**0.5**	**1.8**
Claribel Creek (19-041-002)																																		
1.00	70.5	*Excellent*	X	X		X	X	X	X	X	X	X	**9**						**0**				X	X								**2**	**0.1**	**0.3**

Fish Community Biology Assessment

Methods

Two quantitative electrofishing passes were conducted at each site in 2024. A list of the dates when the surveys were completed including stream discharge at the USGS gauge station located at Lakeshore Boulevard (Station ID 04208700) are shown in Table 8. Sampling was conducted using longline electrofishing equipment and consisted of shocking all habitat types within a sampling zone. Sites were sampled by wading through the stream while electrofishing shoreline and submerged habitat. The sampling zone was 0.15 kilometers for the headwater site and 0.20 kilometers for the wading sites. All sampling followed the Ohio EPA methods as detailed in Biological Criteria for the Protection of Aquatic Life, Volumes II (1987b) and III (1987a). Fish collected during the surveys were identified and examined for the presence of anomalies, including DELTs (deformities, eroded fins, lesions, and tumors). Fish collected at streams with a drainage area greater than twenty square miles were weighed and counted, while those at the site with a drainage area less than twenty square miles were counted only. 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. Fish Survey Dates and Stream Flows

Date	Location	Stream Discharge at USGS Gauge Station 04208700 (cfs)
6/20/24	CC RM 1.00	4.79
6/27/24	EC RM 1.65	9.49
7/5/24	EC RM 0.55	9.07
8/21/24	CC RM 1.00	8.14
	EC RM 1.65	
	EC RM 0.55	

The electrofishing results were compiled and utilized to evaluate fish community health through the application of two Ohio EPA indices. The first index, the Index of Biotic Integrity (IBI), incorporates twelve community metrics representing structural and functional attributes (Table 9). The structural attributes are based upon fish community aspects such as fish abundance and diversity. The 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 with values expected at reference sites located in a similar geographical region. Fish IBI scores range from 12 (*Very Poor*) – 60 (*Exceptional*). The summation of the 12 individual metrics scores provides a single-value IBI score, which corresponds to a narrative rating (Table 10).

Table 9. IBI Metrics	
Wading Sites	Headwater Sites (<20 sq. miles)
Number of indigenous fish species	Number of indigenous fish species
Number of darter species	Number of darter species
Number of sunfish species	Number of headwater species
Number of sucker species	Number of minnow species
Number of intolerant species	Number of sensitive species
Percent tolerant species	Percent tolerant species
Percent omnivore species	Percent omnivore species
Percent insectivore species	Percent insectivore species
Percent of top carnivore species	Percent pioneering species
Number of individuals (minus tolerants)	Number of individuals (minus tolerants)
Percent of simple lithophilic spawners	Number of simple lithophilic species
Percent DELT anomalies	Percent DELT anomalies

The second fish index used by the Ohio EPA is the Modified Index of Well-being (MIwb). The MIwb (calculated using Formula 1 below) incorporates four fish community measures: numbers of individuals, biomass, and a Shannon Diversity Index ($\bar{H}$) (Formula 2 below) score based on relative abundance and relative weights of fish collected.

Formula 1: $$MIwb = 0.5\ lnN + 0.5\ lnB + \bar{H}(No.) + \bar{H}(Wt.)$$

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

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

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

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

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

n_i = Relative numbers or weight of species

N = Total number or weight of the sample

Euclid Creek is located completely within the Erie-Ontario Lake Plains (EOLP) ecoregion and follows the EOLP IBI metric scoring. The WWH scoring criterion in the EOLP ecoregion for wading sites is 38 (IBI) and 7.9 (MIwb) with non-significant departure being scores within 4 (IBI) and 0.5 (MIwb) units (Table 10). This scoring is used for the two Euclid Creek mainstem locations, as they have a WWH ALU designation. Claribel Creek is designated as an LRW, which, although not specified in the Ohio EPA WQS, has a target of biological scores meeting the *Poor* (IBI ≥ 18)

narrative range. Lists of the species diversity, abundance, pollution tolerances, and incidence of DELT anomalies for fish collected during the electrofishing passes at each site are available upon request from the NEORSD WQIS Division.

Table 10. Fish Community Biology Scores in the EOLP Ecoregion

Ohio EPA Narrative	Very Poor	Poor	Fair	Marginally Good	Good	Very Good	Exceptional
Wading							
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
LIBI	0-16	17-30	31-41	NA	42-49	NA	50-60
Headwaters							
IBI Score	12-17	18-27	28-35	36-39	40-45	46-49	50-60
Ohio EPA Status	Non-Attainment			NSD	Attainment		
NSD: Non-Significant Departure of WWH attainment							

Results and Discussion

The NEORSD collected 2,547 fish among 28 unique species while surveying these three sampling locations. Fish community biology scores in the Euclid Creek watershed ranged from *Poor* to *Marginally Good*. Table 10 lists a summary of the fish community biological scores for all three sample locations.

Table 11. Fish Community Assessment Results

River Mile	Total # of species	Relative # / less Tolerants	Predominant species (%)	IBI / MIwb		
				1st pass	2nd pass	Average
Euclid Creek (19-041-000)						
1.65	9	1,992 / 536	Blacknose Dace (56.6) Central Stoneroller Minnow (26.6) Creek Chub (9.9)	26*/4.7*	26*/5.7*	26*/5.2*
0.55	27	1,614/662	White Sucker (25.0) Creek Chub (18.3) Central Stoneroller Minnow (9.4)	34NS/7.5NS	30*/7.6NS	32*/7.6NS
Claribel Creek (19-041-002)						
1.00	2	215/0	Creek Chub (64.3) Green Sunfish (35.7)	20*	24*	22*
*Significant departure from biocriterion (>4 IBI units; >0.5 MIwb units). Underlined scores are in the *Poor* or *Very Poor* narrative range. NS non-significant departure from biocriterion (≤4 IBI units; ≤0.5 MIwb units).						

The lowest section of Euclid Creek consisted of the highest fish IBI and MIwb scores, as well as the highest species richness. Fish community biology scores in 2024 were consistent with scores since 2007 (Figure 7). Numerous factors contribute to the composition of the fish communities at each location. Euclid Creek at RM 0.55 is within the lacustuary portion and fish from Lake Erie can colonize this section easily. Moving upstream on Euclid Creek, compounding issues like fish barriers, historical pollution, channelization, urbanization, and the natural geology of Euclid Creek affect the observed populations. The section upstream of Lakeshore Boulevard (RM 1.00-1.50) has been channelized by the Army Corp of Engineers with concrete-lined banks to reduce flooding caused by the developing upstream watershed. This section of stream is also dredged of important benthic substrate to allow maximum flow conveyance, leaving a scoured concrete-lined bottom.

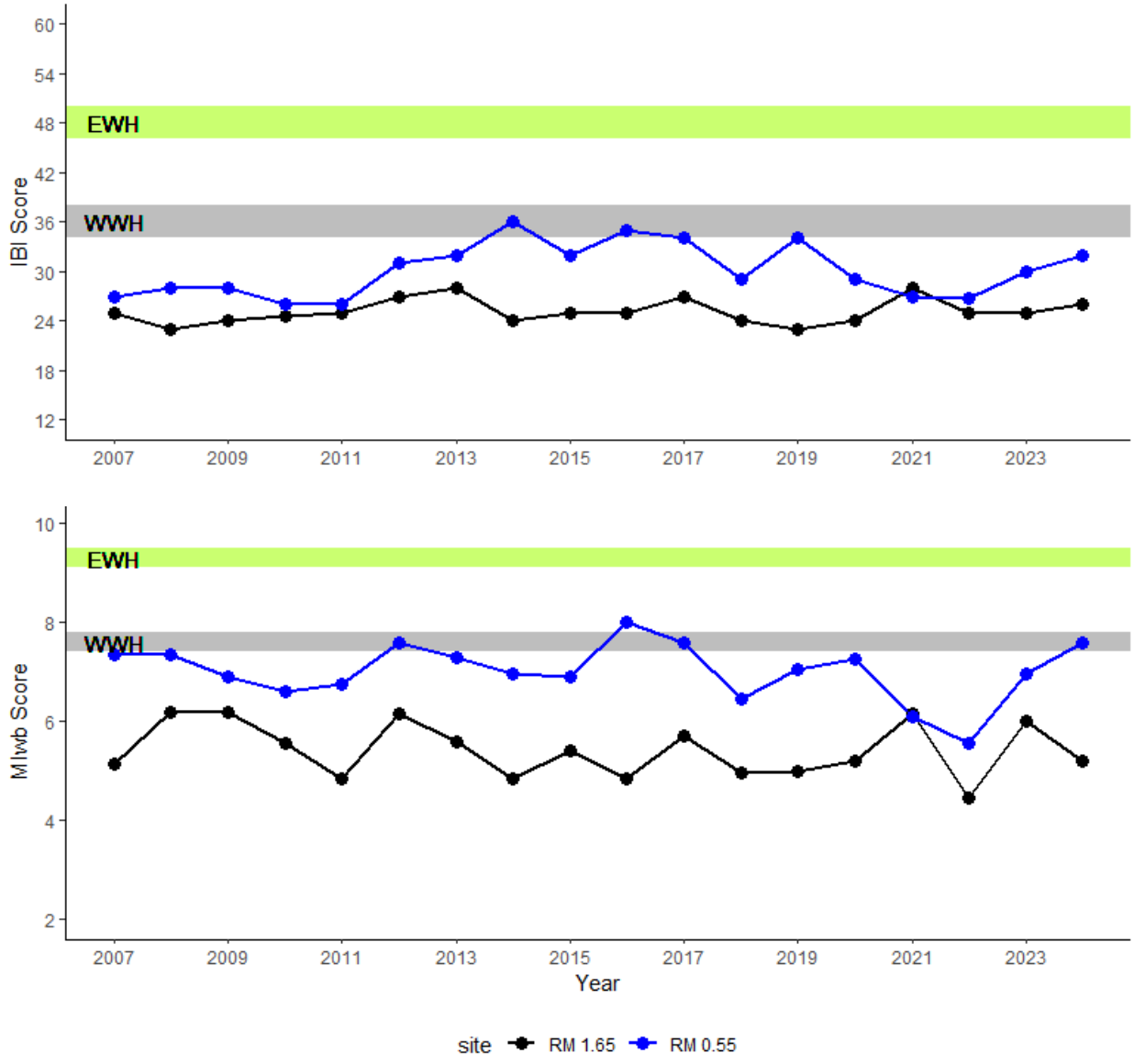

Figure 7. Euclid Creek IBI and MIwb scores by year for RMs 1.65 and 0.55.

A low-head dam preventing fish from passing upstream is also present at RM 1.50. The fish community in the lower river is much more robust, containing a total of 27 species, compared to nine species collected between the two upstream locations. Historically, Euclid Creek was grossly polluted throughout the watershed due to inadequate wastewater collection and treatment. Federal funds in the 1980s helped fund the planning and construction of the NEORSD Heights-Hilltop interceptor that removed three wastewater treatment plants (WWTP) and one undersized sewage pump station from polluting Euclid Creek with raw or poorly treated wastewater. Decades of wastewater pollution throughout Euclid Creek still lingers today as higher quality fish were most certainly extirpated from the watershed. A 1988 Environmental Impact Statement lists the most common fish species as Creek Chub (*Semotilus atromaculatus*), Blacknose Dace (*Rhinicthys atratulus*), Central Stoneroller Minnow (*Campostoma anomalum*), Common Shiner (*Notropis cornutus*), and Emerald Shiner (*Notropis atherinoides*) (USEPA). This list has not changed much over the past 40 years, as highly tolerant fish species such as Blacknose Dace, Creek Chub, Central Stoneroller Minnow, and Bluntnose Minnow (*Pimephales notatus*) still dominate the community.

Darter species are completely absent from the Euclid Creek watershed, with the exception being logperch darters, which likely migrate into the lower river from Lake Erie. White suckers were the only species of suckers in the watershed, as all other important redhorse species were absent. Top carnivores were also missing upstream of the fish passage barriers, leading to an unbalanced food web dynamic.

Claribel Creek is assigned an LRW-channel modified aquatic life use (ALU) designation. Streams designated LRW demonstrate substantially degraded fauna and the potential for recovery to any other aquatic life habitat is realistically precluded due to human-induced conditions (channel modification). LRW-designated waters have a target to exceed *Very Poor* biological scores to meet the ALU WQS (Ohio EPA 1987a). The 2024 fish community averaged an IBI score of 22 and received a *Poor* narrative. Therefore, this location met attainment of the ALU WQS, even though only two highly tolerant fish species were collected.

The Cuyahoga River AOC currently has plans to install a boulder sill fishway in the coming years to act as a fish ladder and allow species to pass the low-head dam at RM 1.50. Design considerations are being made for both the weakest (minnows) and strongest (Rainbow Trout *Oncorhynchus mykiss*) swimming species. Even with a fish ladder installed at this low-head dam, Euclid Creek is one of the most urbanized watersheds along the Ohio Lake Erie coastline (Euclid Creek Watershed Council et. al, 2023) and unlikely to support a fish community that will achieve attainment of the WQS.

Lake Erie water level affects the Euclid Creek RM 0.55 location by fluctuating current velocity, water level, and available fish habitat. The water level does not seem to affect the fish community performance, however. Figure 8 below demonstrates the fish IBI and MIwb index scores plotted against average Lake Erie water level. The fish community at this location likely reflects a mix of Lake Erie resident fish that migrate into the Euclid Creek lacustuary zone to spawn, and resident Euclid Creek fish from the free-flowing portions.

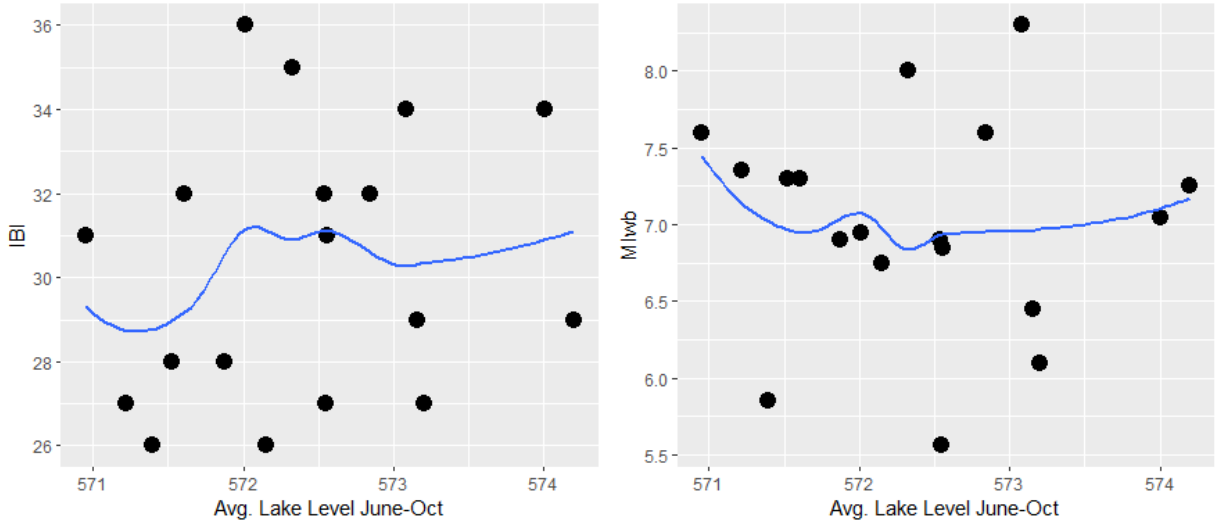

Figure 8. Euclid Creek RM 0.55 fish community biology scores compared to average Lake Erie water level from June-October from 2006-2024. The blue line represents a loess average.

Macroinvertebrate Community Biology Assessment

Methods

Macroinvertebrates were sampled quantitatively using modified Hester-Dendy (HD) samplers and performing a qualitative assessment of macroinvertebrates inhabiting available habitats at the time of HD retrieval. Sampling was conducted at all locations listed in Table 1. The recommended period for HDs to be installed is six weeks. The macroinvertebrate samples were sent to Third Rock Consultants, LLC for identification and enumeration. Specimens were identified to the lowest practical taxonomic level as defined by the Ohio EPA (1987a). Lists of the species collected during the quantitative and qualitative sampling at each site are available upon request from NEORSD WQIS Division.

The macroinvertebrate sampling methods followed Ohio EPA protocols as detailed in *Biological Criteria for the Protection of Aquatic Life, Volumes II* (1987b) and *III* (1987a). The overall aquatic macroinvertebrate community in the stream was evaluated using Ohio EPA's Invertebrate Community Index (ICI). 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 collected. The sum of the individual metric scores results in the overall ICI score. This scoring evaluates the macroinvertebrate community against Ohio EPA's reference sites for each specific ecoregion. The WWH ICI criterion in the EOLP ecoregion is 34 (Table 13) and a site is within non-significant departure if the score falls within 4 ICI units of the criterion. This scoring is used for the two Euclid Creek mainstem locations, as they have a WWH ALU designation.

Claribel Creek is designated as an LRW, which has a target of biological scores meeting the *Poor* (ICI ≥12) narrative range (Ohio EPA 1987a).

Table 12. ICI Metrics
Total Number of Taxa
Number of Mayfly taxa
Number of Caddisfly taxa
Number of Dipteran taxa
Percent Mayflies
Percent Caddisflies
Percent Tanytarsini Midges
Percent Other Diptera and Non-Insects
Percent Tolerant Organisms (as defined)
Number of Qualitative EPT Taxa

Table 13. 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

The NEORSD collected 5,677 individual macroinvertebrates among 53 unique taxa from artificial substrates. Additionally, 71 unique taxa were collected from natural substrates, combined for a total taxa count of 82. Table 14 lists a summary of the macroinvertebrate community biological scores for all three sample locations. All sampling locations met the applicable water quality standards for the macroinvertebrate community component with ICI scores ranging from 30 (*Marginally Good*) to 44 (*Very Good*).

Table 14. Macroinvertebrate Community Assessment Results

River Mile	Density Qt. (ft^2) /Ql.	Ql./ Total Taxa	Ql. EPT/ sensitive Taxa	Qt. % Tolerant/ % Sensitive taxa	Predominant orgs. on natural substrates	ICI	Narrative Rating
Euclid Creek (19-041-000)							
1.65	500	40 / 53	12 / 7	2.44/10.55	Baetid mayflies, flatworms, midges, scuds, polycentropodid caddisflies	44	*Very Good*
0.55	517	50 / 56	13 / 6	22.2/0.04	Baetid mayflies, midges, flatworms, water mites	30	*Marginally Good*
Claribel Creek (19-041-002)							
1.00	118	36 / 47	9 / 3	3.89/1.02	Blackfly, baetid mayflies, midges, flatworms	30	*Marginally Good*

Qt. Quantitative sample collected on Hester-Dendy artificial substrates.
Ql. Qualitative sample collected from natural stream substrates.
Qualitative sample relative density: L=Low, M=Moderate, H=High
Sensitive Taxa: Taxa listed on the Ohio EPA Macroinvertebrate Taxa List (2019) as *Moderately Intolerant*, or *Intolerant*.

Macroinvertebrates can be combined into taxonomic groups to determine overall composition. Figure 9 displays the community composition of mayflies, caddisflies, tribe tanytarsini midges, and other organisms which includes non-tanytarsini midges, other diptera, and non-insects. Higher quality macroinvertebrate communities are typically represented by a higher proportion of mayflies and caddisflies, which are in the EPT families.

At the smallest headwater site, Claribel Creek, the community was dominated by other diptera and non-insects, followed by mayflies and tribe tanytarsini midges. The low proportion of caddisflies at this location is not abnormal, as these species are typically collector-feeding insects and found in more abundance in slightly larger streams. Euclid Creek RM 1.65 is a larger free-flowing stream and contained the most balanced community. The macroinvertebrate community was made up of 27.7% caddisflies, 18.6% tribe tanytarsini midges, and 3.8% mayflies. As Euclid Creek approaches its confluence with Lake Erie at RM 0.55, the lower gradient and loss of a true riffle habitat explain the loss of caddisflies (0.12%) and mayflies (0.04%).

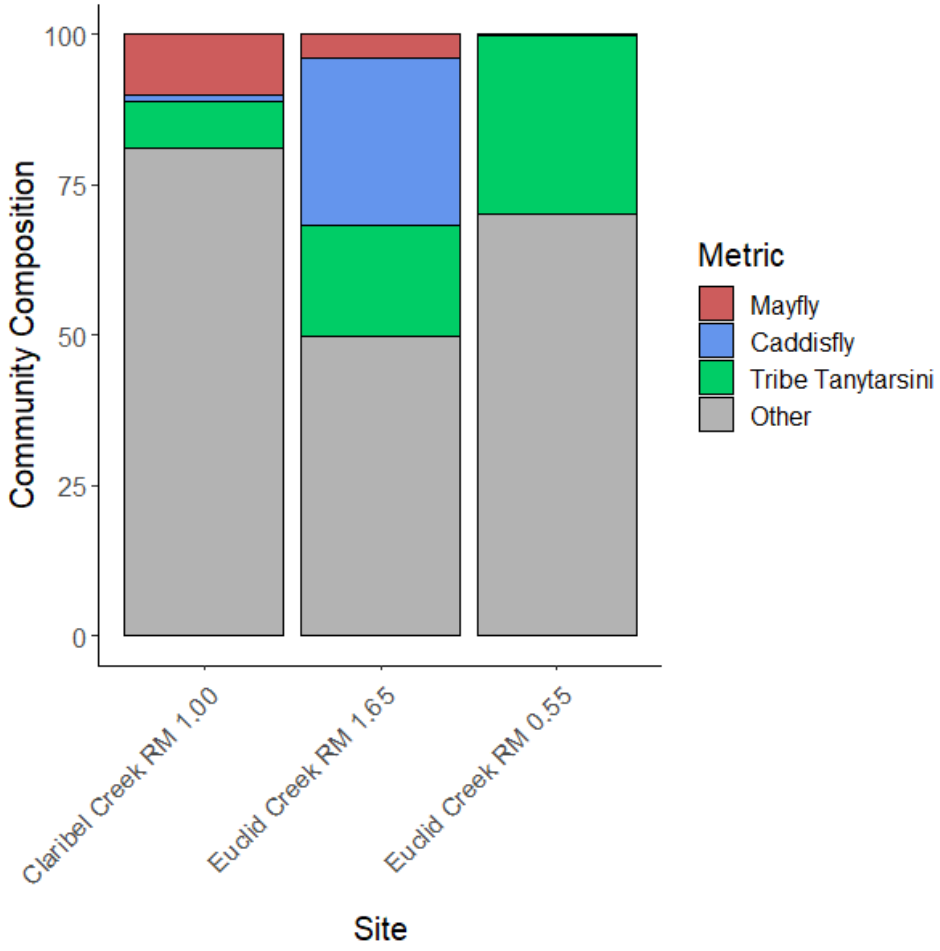

Figure 9. Euclid Creek macroinvertebrate community composition by site.

Monitoring at Euclid Creek RMs 1.65 and 0.55 are required by the NEORSD CSO NPDES permit and have been assessed annually as a part of the Ohio EPA Credible Date Program by the NEORSD since 2006. Figure 10 details the trends in ICI scores from 2006-2024. Euclid Creek at RM 1.65 has consistently met the WWH ALU, with only two years falling below the standard. Euclid Creek at RM 0.55 has had variable results, which may be due to lake influences on stream habitat or impacts to the artificial HD substrate (ex: embedded or debris).

Certain metrics can be used as a general indicator of water quality. Specifically, the number of total taxa, qualitative taxa, qualitative EPT taxa, and qualitative sensitive taxa can help assess improving water quality trends as these biodiversity measurements increase. Figure 11 displays these annual metric scores from 2006-2024. The last two years have shown an upward trend in macroinvertebrate community health. The 2024 macroinvertebrate assessment at RM 0.55 set NEORSD record numbers for all four metrics listed in Figure 11. Additionally, RM 1.65 also had a record number of total taxa and qualitative EPT taxa.

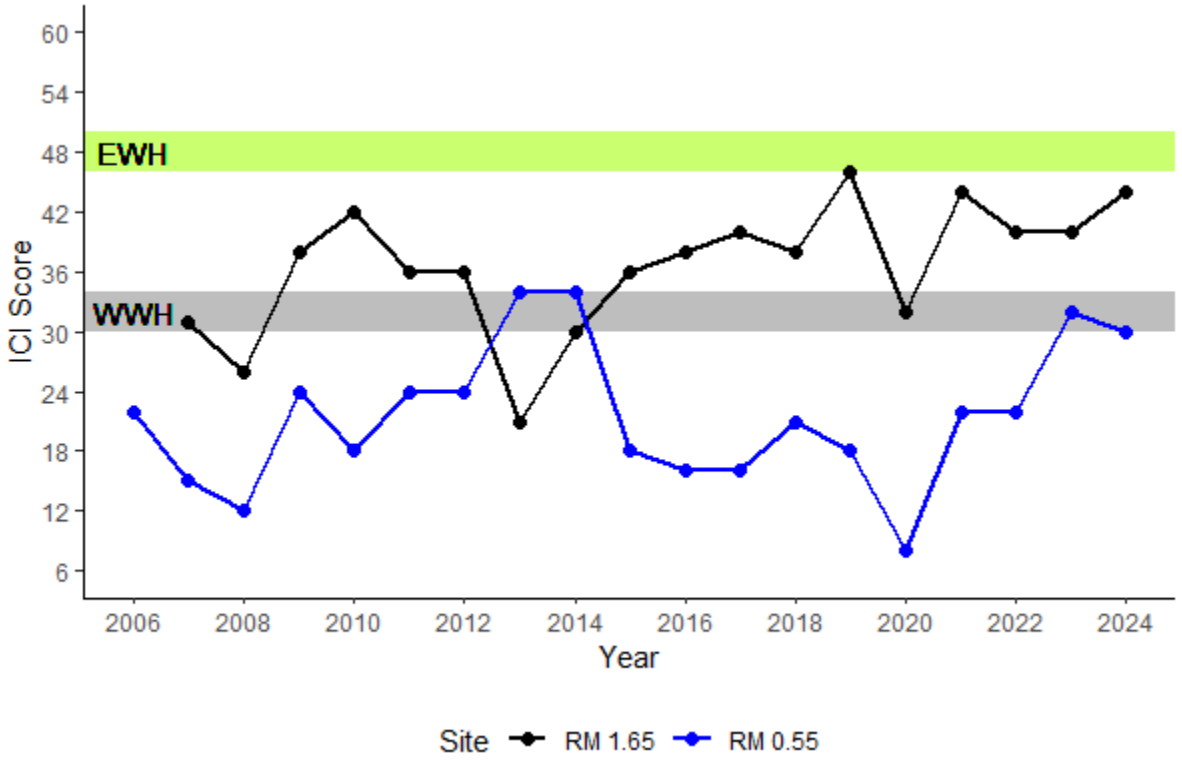

Figure 10. Euclid Creek RMs 1.65 and 0.55 ICI scores by year

Recent macroinvertebrate community performance has drastically improved compared to the mid-1900s. During this timeframe, population growth within the region led to the previously mentioned organic enrichment due to wastewater contamination in Euclid Creek. Before wastewater treatment was regionalized and flows were redirected to the NEORSD Easterly WWTP via the Heights/Hilltop interceptor in 1990, the macroinvertebrate community had low species diversity and was dominated by a few pollution-tolerant species. A 1988 report even indicated that many of the organisms collected were decomposing and had fungal growths (USEPA, 1988).

Lake Erie water level is thought to affect the macroinvertebrate community at Euclid Creek RM 0.55. During periods of higher Lake Erie water level, the lacustuary zone of Euclid Creek moves upstream, reducing streamflow velocity and increasing overall stream depth at Euclid Creek RM 0.55. Figure 12 below plots key macroinvertebrate metrics compared to the average Lake Erie water level during the field season (June-October). ICI scores show the most drastic decrease when Lake Erie water levels are highest. The other metrics demonstrate a slight decline with increasing Lake Erie water levels, but do not necessarily represent a strong correlation. Qualitative EPT taxa do not seem as effected by the Lake Erie water level, as many EPT taxa can be collected outside of the defined riffle habitat, which is inundated by the Lake Erie backwaters during higher water levels.

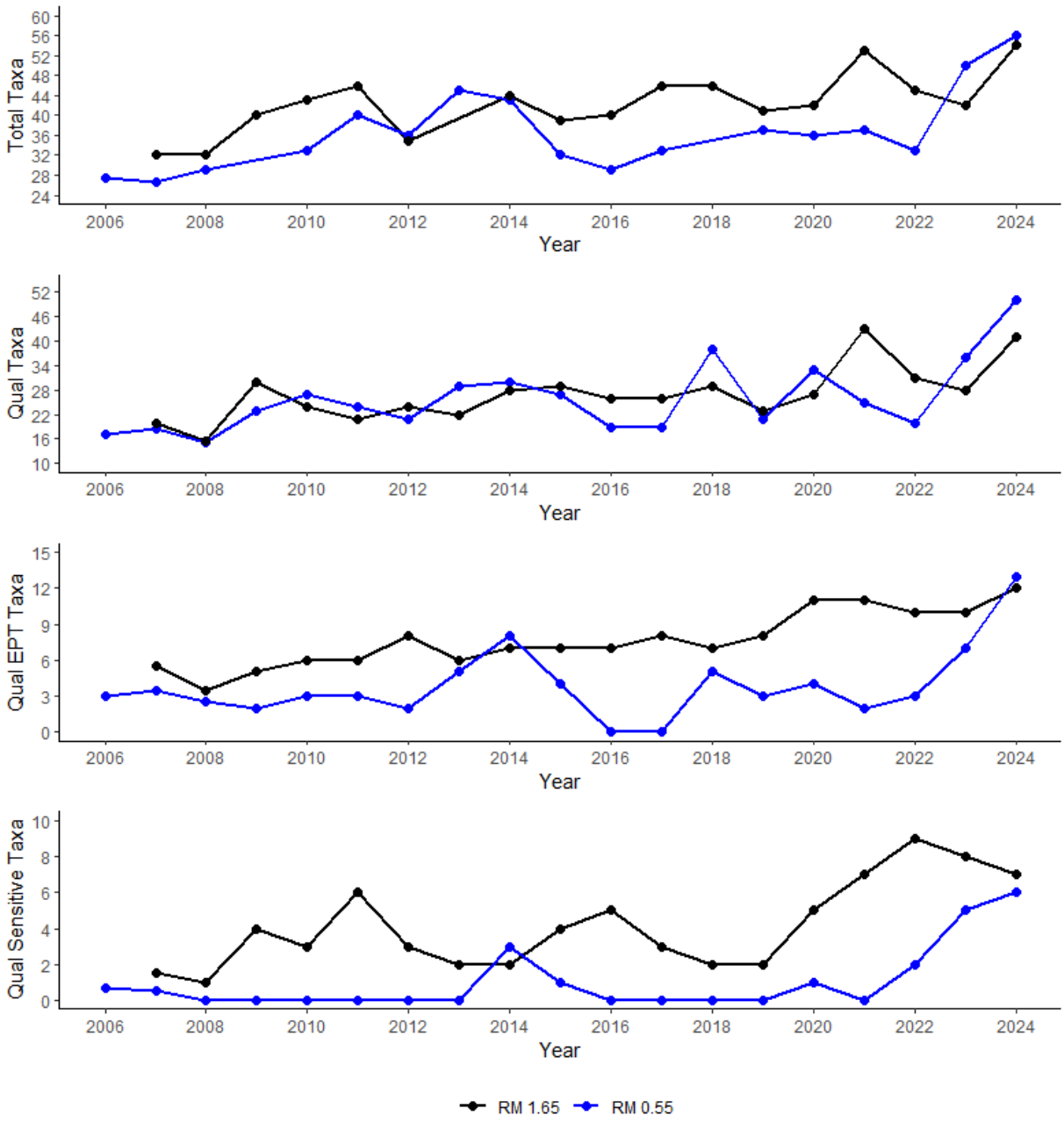

Figure 11. Euclid Creek historical macroinvertebrate metric scores for RMs 1.65 and 0.55.

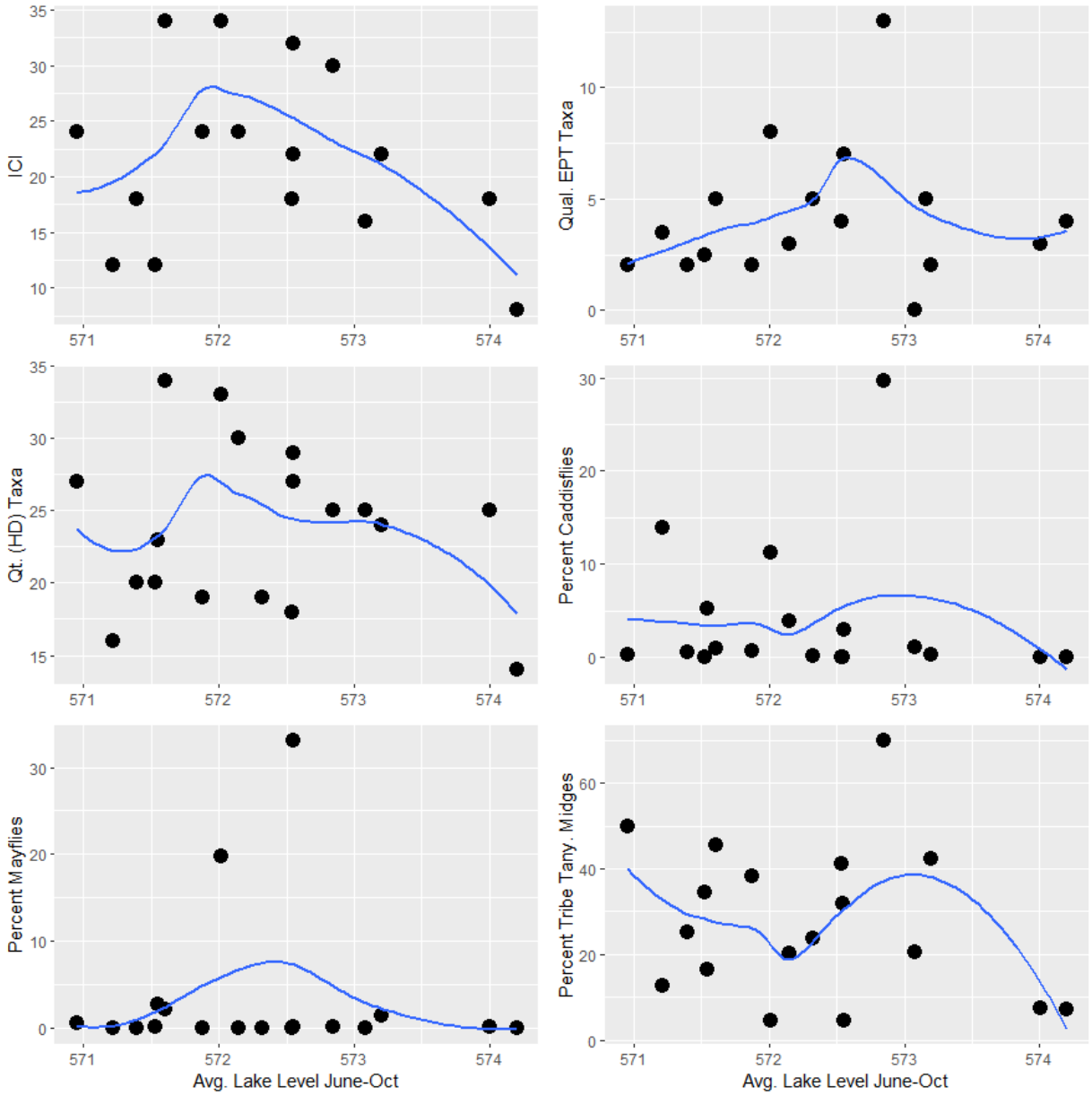

Figure 12. Euclid Creek RM 0.55 macroinvertebrate metrics compared to average Lake Erie water level from June-October from 2006-2024. The blue line represents a loess average.

Impact of CSO Control by the Euclid Creek Tunnel on Biological Community Metrics

In 2019, the ECT began collecting combined sewage that would previously have been discharged into Euclid Creek. A comparison of biological communities can be made based on sample location (RM 1.65 and 0.55) and time period (before and after CSO capture). The Euclid Creek RM 1.65 location is used as a reference location in this instance, as it is located upstream of all NEORSD CSOs. Figure 13 below displays boxplots of fish IBI and MIwb index scores at both

Euclid Creek RM 1.65 and 0.55, comparing the time periods before (2006-2017) and after (2019-2024) the ECT completion.

The reference location at RM 1.65 has remained consistent with a *Fair* or *Poor* narrative rating, which is likely due to the fish barrier downstream that simplifies the upstream fish community. The downstream location at RM 0.55 has seen a non-significant decrease in overall fish community metrics since the beginning of CSO capture. Other environmental factors, such as lake levels affecting the flow regime, are likely driving this variation in fish community biology scores at the RM 0.55 location.

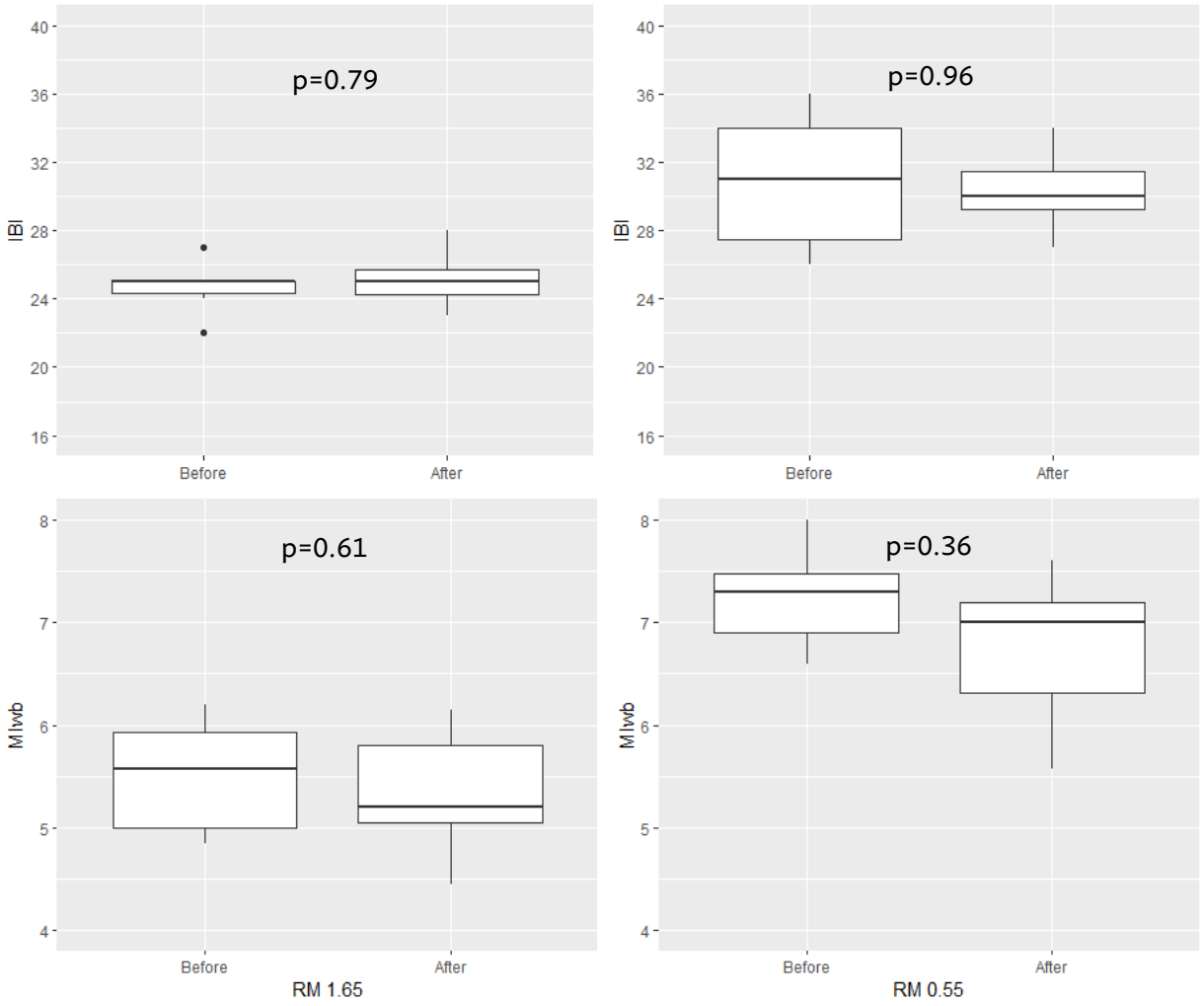

Figure 13. Euclid Creek RM 1.65 and 0.55 fish community biology boxplot comparisons before and after ECT activation in 2019. Note: 2018 data was omitted from this database due to ECT being partially online.

The macroinvertebrate communities at both locations have seen improvement in every metric shown in Figure 14. The highest increase in these scores occurred at the upstream reference location at RM 1.65, with all four metrics having increased significantly. This improvement in macroinvertebrate community performance may not be primarily due to the capture of combined

sewage by the ECT since improvements are seen at the reference location as well and may be reflective more of an overall improvement in watershed health than any specific project.

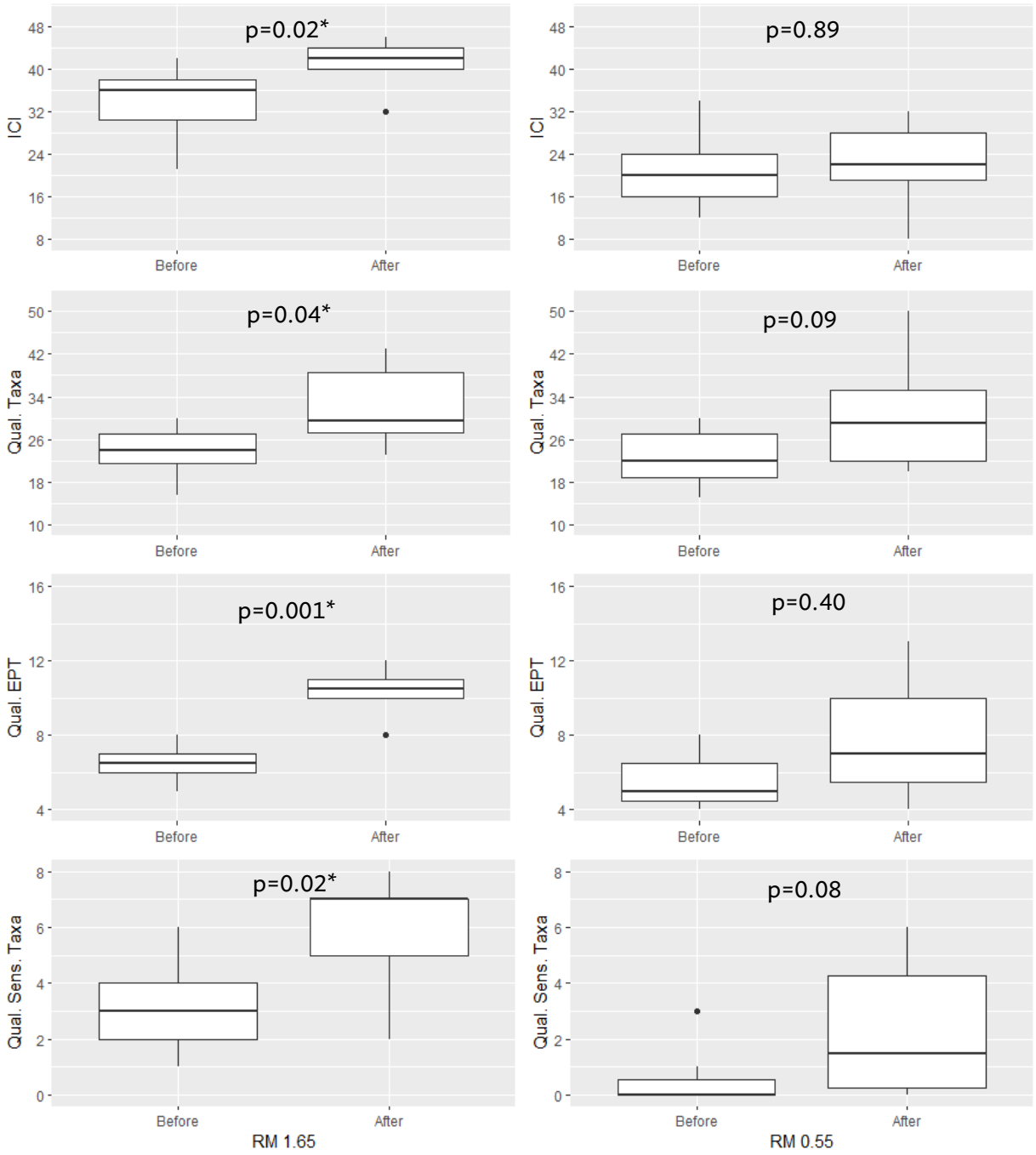

Figure 14. Euclid Creek RM 1.65 and 0.55 macroinvertebrate community biology boxplot comparisons before and after ECT activation in 2019. Note: 2018 data was omitted from this database due to ECT being partially online.

Key water chemistry parameters that would likely be reduced due to the removal of CSOs to Euclid Creek include *E. coli*, ammonia (NH_3), and TP. Numerous NEORSD studies that have collected these parameters as a part of data objectives include the annual Lake Erie Nutrient Study, annual Euclid Creek Watershed Monitoring, US EPA consent decree sampling, and annual Beach Monitoring. Figure 15 below displays boxplots of these parameters before and after ECT was fully collecting CSOs. *E. coli* and NH3 were both calculated as non-significant differences between the means using a Wilcoxon ranked sum test. TP results show a significantly higher TP value after ECT began collecting and preventing CSOs from entering Euclid Creek. This supports findings from previous NEORSD studies that indicated that NEORSD CSOs are not the primary source of *E. coli* in Euclid Creek (NEORSD 2018 and 2022). This also demonstrates that nutrient concentrations indicative of sanitary sewage contamination have not significantly decreased since total NEORSD CSO capture. The urbanization of the watershed and local sanitary sewer issues are likely significantly contributing to the elevated background levels of bacteria. Nutrient concentrations are not significantly elevated and are not reflective of over-enrichment based on Ohio EPA benchmarks.

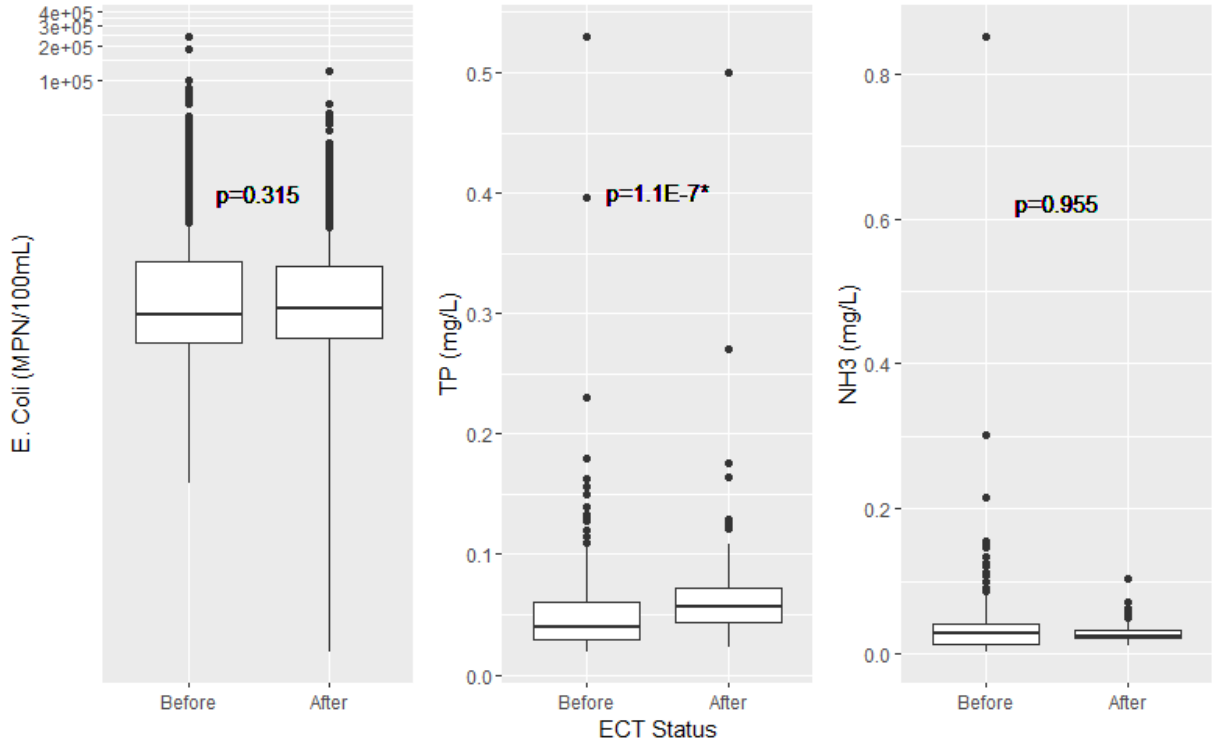

Figure 15. Euclid Creek *E. coli*, TP, and NH3 concentrations boxplots before (2006-2017) and after (2018-2024) from multiple NEORSD studies. Wilcoxon ranked sum p-values are shown for each parameter.

Conclusions

A summary of the 2024 Euclid Creek water quality survey results is provided in Table 15. The two downstream locations were in exceedance of both the PCR STV and geomean recreational criteria for *E. coli* (Table 4), while Claribel Creek was only in exceedance of the SCR STV criterion. Nutrient concentrations at all sites posed a low to moderate risk to aquatic life (Figure 4). However, diel DO concentrations and DO supersaturation values collected from the permanent datasonde at RM 0.60 are typical of highly stimulated algae productivity. The elevated levels of sanitary sewage contamination in this watershed, in combination with urban runoff, are most likely the greatest contributors to elevated *E. coli* and wide diel DO swings in the watershed.

Euclid Creek at RM 0.55 was the only site to achieve partial attainment of the WWH ALU (Table 15). Claribel Creek at RM 1.00 was in full attainment of the LRW ALU designation and should be considered for a redesignation to a higher aquatic life use based on these results. Macroinvertebrate community scores met the WWH ALU criterion at all three locations. However, the fish community was poor at both Euclid Creek RM 1.65 and Claribel Creek RM 1.00, resulting in the non-attainment status at Euclid Creek RM 1.65. Primary causes for the ALU impairment include the fish passage barrier that limits fish recolonization of upper Euclid Creek and urbanization of the watershed. Historical surface water pollution from small package plants and undersized wastewater infrastructure have likely locally extirpated higher quality fish species from upper Euclid Creek.

Table 15. 2024 Euclid Creek ALU Attainment Status

River Mile	DA (mi^2)	Attainment Status	IBI Score	MIwb Score	ICI Score	QHEI Score	Cause(s)	Source(s)
Euclid Creek (19-041-000) - WWH								
1.65[W]	21.8	NON	26*	5.2*	44	74.5	Fish passage barrier, Urbanization	Hydromodifications, Flow regime alterations
0.55[W]	23.0	PARTIAL	32*	7.6[NS]	30[NS]	55.0	Natural causes	Lacustrine influence
Claribel Creek (19-041-002) - LRW								
1.00[H L]	0.88	FULL	22*	---	30	70.5		

[NS] Non-significant departure from WWH biocriterion (≤ 4ICI; ≤ 4IBI; ≤ 0.5 MIwb units)
*Significant departure from WWH biocriterion (>4ICI; > 4IBI; > 0.5 MIwb units).
Underlined scores are in the *Poor* narrative range
[H] Headwater scoring criteria
[W] Wading scoring criteria
[L] Scores above *Very Poor* are considered to meet criteria

Habitat scores met WWH expectations at all sites, except the RM 0.55 location, which is largely affected by Lake Erie water levels. RM 0.55 was, however, the only site to achieve partial attainment of the WWH biocriteria. The fish metric scores, along with fish species diversity, drop drastically upstream of the low-head dam at RM 1.50. Plans to install the fish ladder at the low-head dam may allow some species to pass upstream. Rainbow trout have already been documented upstream of this dam, but these species are among the strongest swimmers in Ohio.

Claribel Creek was more incised due to a poorly wooded riparian buffer area but was not representative of a modified channel as the ALU designation states. Macroinvertebrate scores were typical of warmwater habitat streams, and the fish community is clearly limited by the historical pollution compounded by the fish passage barrier in the lower river.

Macroinvertebrate community index scores have increased since the NEORSD ECT storage tunnel began capturing CSOs. This upward trend on Euclid Creek seems independent of the CSO capture, as the location upstream of NEORSD CSOs has seen a more significant increase in macroinvertebrate scores. The fish community scores have not seen improvement since the ECT completion due to the fish passage barrier at RM 1.50 that limits fish from recolonizing the upstream sections of Euclid Creek. The influence of Lake Erie on the RM 0.55 location has seemed to affect the macroinvertebrate artificial substrate community scores more than the fish community scores at this location when lake levels are higher than normal.

Future monitoring of locations upstream of the proposed fish ladder will document whether certain fish species can swim through the fish ladder, as designed, and determine any improvements in biological metric scores. Compounding issues in the upstream watershed including extensive development, common trench sewers, and channelization limit the biological potential of Euclid Creek.

Bacteria contamination from human sewage has been a well-known issue in Euclid Creek. The ECT has captured a significant portion of sewage from entering Euclid Creek but has not made a significant reduction in bacteria values (Figure 12). Ammonia concentrations have also not seen a reduction and TP concentrations have significantly increased since 2018, demonstrating that the NEORSD CSOs were not significantly contributing to baseline nutrient concentrations.

Local sanitary sewage contamination issues need to be addressed in the Euclid Creek watershed. Aging sanitary sewers have been calculated to contribute up to 73% of the *E. coli* load in Euclid Creek. A large portion of the Euclid Creek watershed is located outside of the NEORSD service area and sanitary services are managed by the local municipality. Local planning efforts from the Euclid Creek Watershed Council can help with the extensive urbanization of the watershed by creating green spaces where water can be slowed down or infiltrated. Several of these plans are already stated in the Euclid Creek Nonpoint Source Implementation Strategic Plan (Euclid Creek Watershed Council et al., 2023).

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