Northeast Ohio Regional Sewer District

2024 Nine-Mile Creek Biological, Habitat, and Water Quality Assessment Study

Water Quality and Industrial Surveillance

Environmental Assessment Group

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Introduction

In 2024, the Northeast Ohio Regional Sewer District (NEORSD) conducted environmental monitoring at Nine-Mile Creek, a tributary to Lake Erie, as part of its general watershed monitoring program and in support of Ohio Environmental Protection Agency (EPA) Permit #3PA00002*JD. Water chemistry sampling, habitat assessments, and fish and benthic macroinvertebrate surveys were overseen by NEORSD's Environmental Assessment (EA) staff members. Water quality improvement in the Nine-Mile Creek drainage area has been one of several long-term targets of the NEORSD's "Project Clean Lake" infrastructure program. The specific infrastructure projects that have anticipated impacts on Nine-Mile Creek include the Dugway Storage Tunnel (DST) and the Euclid Creek Tunnel (ECT), among other associated relief sewer and regulator upgrades. The goal of these projects is the improved conveyance of wastewater and stormwater during wet-weather events and reducing the occurrence of combined sewer overflow (CSO) discharges to Lake Erie via its tributary streams. As of 2020, these projects were fully completed and are now receiving sanitary and stormwater flows.

Nine-Mile Creek is primarily culverted and is a heavily urbanized stream. It flows through the eastside suburbs of East Cleveland, Cleveland Heights and University Heights before flowing beneath Interstate 90, through Bratenahl, and discharging into Lake Erie. Sampling was conducted in open sections of the creek. Based on data previously collected by the Ohio EPA, it was recommended that Nine-Mile Creek receive the WWH aquatic life use designation (Ohio EPA, 2020) (Table 1).

Table 1. Beneficial Use Designations for Nine-Mile Creek													
	Beneficial Use Designation												
	Aquatic Life Habitat (ALU)							Water Supply			Recreation		
Stream	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR
Nine-Mile Creek		*/+							*/+	*/+		*/+	

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 Environmental Protection Agency

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 study plan *2024 East Side Tributaries Environmental Monitoring*. 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* (1987b). The results were evaluated using the Ohio EPA's Qualitative Habitat Evaluation Index (QHEI), Index of Biotic Integrity (IBI), Invertebrate Community Index (ICI), and NEORSD's Macroinvertebrate Threshold Model. Water chemistry data was validated per methods outlined by the Ohio EPA *Surface Water Field Sampling Manual for water quality parameters and flows* (2023a) and compared to the Ohio Water Quality Standards for their designated uses to determine attainment (Ohio EPA, 2021). An examination of the individual metrics that comprise the IBI, ICI, and NEORSD Macroinvertebrate Threshold Model was used in conjunction with the water chemistry data and QHEI scores to assess the health of the stream.

Figure 1 shows a map of the sampling locations, and Table 2 indicates the sampling locations with respect to stream, river mile (RM), drainage area, latitude and longitude, station identification where applicable, and description of surveys conducted. A digital photo catalog of the sampling locations is available upon request by contacting the NEORSD's Water Quality and Industrial Surveillance (WQIS) Division.
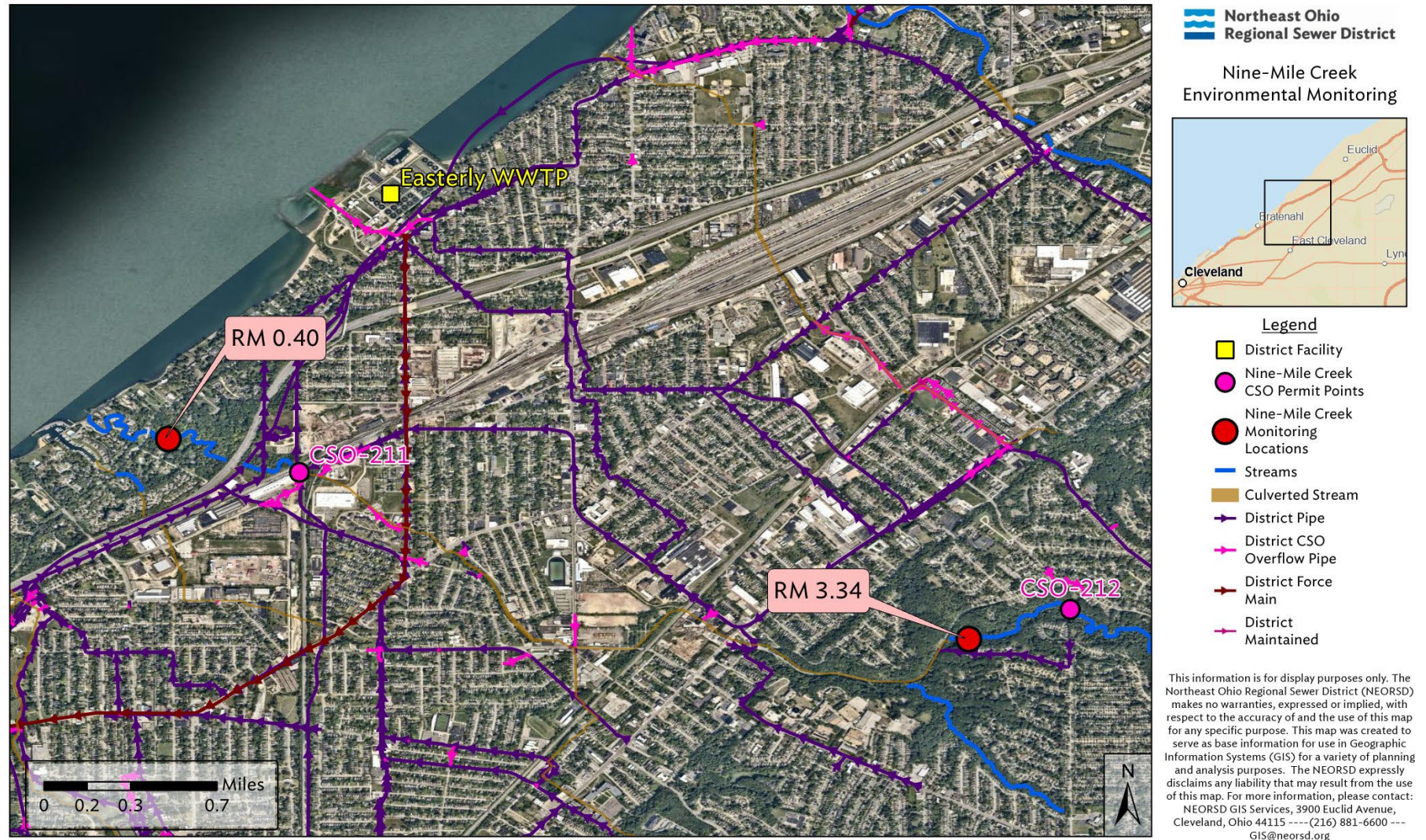
Figure 1. Sampling Locations Map

Table 2. 2024 Nine-Mile Creek Sampling Locations						
Location	River Mile	Station ID	Latitude	Longitude	Drainage Area (mi^2)	Sampling Conducted
Upstream of Belvoir Boulevard	3.34	301435	41.5457	-81.5531	0.70	F, M, C
Upstream of Lakeshore Boulevard	0.40	301432	41.5573	-81.5991	11.80	
F = Fish community biology (includes habitat assessment)						
M = Macroinvertebrate community biology						
C = Water chemistry						

Water Chemistry and Bacteriological Sampling

Methods

Water chemistry and bacteriological sampling on Nine-Mile Creek was conducted at each site five times between June 17 and July 17, 2024, and analyzed for all parameters. Techniques used for sampling and analyses followed the Ohio EPA *Surface Water Field Sampling Manual for water quality parameters and flows* (2023). 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, dissolved oxygen percent, pH, temperature, conductivity, and specific conductance were collected using a YSI EXO1 sonde. Replicate, duplicate, 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:   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.

Results and Discussion

Data Validation QA/QC Checks

Over the course of the five sampling events in 2024, two field blanks and one duplicate sample were collected and analyzed for all parameters. There were no parameters that showed possible contamination in the field blanks. This indicates that samples were collected and handled properly by EA and Analytical Services staff members.

For the duplicate sample, there was one instance that occurred in which the acceptable RPD was exceeded (Table 3) for turbidity. Potential reasons for this discrepancy include lack of precision and consistency in sample collection and/or analytical procedures, environmental heterogeneity, and/or improper handling of samples.

Table 3. Duplicate Samples with RPDs Greater than Acceptable					
River Mile	Date	Parameter	Result (Duplicate Result)	Acceptable RPD	Actual RPD
0.40	6/25/24	Turbidity	5.4 NTU (2.1 NTU)	40.0	88.0

The final QA/QC check was for paired parameters, or those parameters in which one is a subset of the other. There were no instances in which the data for the paired parameters were qualified because the sub-parameter value was greater than the parent value.

Open sections of Nine-Mile Creek are designated as a warmwater habitat (WWH) and primary contact recreation (PCR) according to the Ohio EPA Water Quality Standards (2021). Exceedances of the recreational bacteriological criteria for PCR occurred at both sites on Nine-Mile Creek during the 2024 sampling season. The recreational criteria for *E. coli* consist of two components: a 90-day geometric mean and a statistical threshold value (STV) not to be exceeded in more than 10% of the samples collected during a 90-day period. For streams designated as PCR, these criteria are 126 colony counts/100mL or most-probable number (MPN)/100mL and 410

colony counts/100mL or MPN/100mL, respectively. These calculations are formulated when there are at least five samples collected within a rolling 90-day period.

Both PCR criteria were exceeded at both sites for the 90-day periods starting when the first sample was collected. Therefore, both sites were in non-attainment of both criteria in 2024. Between both locations sampled during the study, the highest geometric mean value of 1982 MPN/100 mL with 100 percent of the samples exceeding the STV criterion occurred at RM 0.40. Table 5 provides a summary of the recreational use criteria exceedances for all sites assessed in 2024. Potential sources of bacteria inputs may include urban stormwater runoff, illicit discharges, domestic/wild animals, CSOs, and failing household sewage treatment systems (HSTS).

Table 4. *E. coli* Densities (MPN/100mL)		
Date	RM 3.34	RM 0.40
6/17/24	387	1046
6/25/24	980	1124.5
7/1/24	411	1986
7/9/24	613	866
7/17/24*	3840	15,110
90-day STV Exceedance (%)	80	100
90-day Geomean	818	1982

- ☐ Exceeds statistical threshold value of 410 MPN/100mL.
- ☐ Exceeds 90-day STV criterion of 10%.
- ☐ Exceeds 90-day geometric mean criterion of 126 MPN/100mL.

*Wet-weather Event: greater than 0.10 inches of rain, but less than 0.205 inches, samples collected that day and the following day are considered wet-weather samples; greater than 0.205 inches, the samples collected that day and the following two days are considered wet-weather samples.

Metals and Other Exceedance Data

Mercury was analyzed using EPA Method 245.1. Because the detection limit for this method is above the criteria for the Human Health and Protection of Wildlife OMZAs, it 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 streams. All the mercury results were below the MDL. It is expected that the use of a low-level mercury analysis like EPA Method 1631E, instead of EPA Method 245.1, may have resulted in exceedances of the criteria throughout the sampling period. It is possible that mercury may be introduced into these streams from urban runoff, industrial wastewater discharge, and atmospheric deposition within the watershed. There were no additional exceedances for the data collected during the 2024 sampling season on Nine-Mile Creek.

On July 17, 2024, elevated flows from recent rainfall caused the hardness concentration to drop and resulted in the Aquatic Life Tier I Outside Mixing Zone Maximum (OMZM) criterion being below the detection limit for silver. Because of this, it could not be determined if the 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 either site.

Nutrient Assessment Data

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).

Maintenance of low levels of nutrients such as nitrogen and phosphorus in Nine-Mile Creek will help limit loading to Lake Erie. An excess of nitrogen and phosphorus can lead to nutrient enrichment in the lake, fueling harmful algal blooms (HABs), which can contribute to hypoxic or anoxic (low or oxygen depleted) zones. Hypoxia degrades water quality, impacting biogeochemical cycling and can be fatal to aquatic life.

Table 6 shows the nutrient concentrations for all sampling sites in 2024. The results of dissolved inorganic nitrogen (DIN) and total phosphorous (TP) were compared to Table 2 listed in the SNAP document (Figure 4; Ohio EPA, 2015). According to this section of SNAP, Nine-Mile Creek RMs 3.34 and 0.40 received an ecological risk narrative described as "levels of typical enriched condition; low risk to beneficial use if allied responses are within normal ranges". Benthic chlorophyll *a* was not assessed by NEORSD in 2024, creating a potential limitation to the interpretation of risk presented using the provisional method.

Table 5. Nutrient Analysis (Geometric Means*)				
River Mile	DIN (mg/L)	NO$_3$-NO$_2$ (mg/L)	DRP (mg/L)	TP (mg/L)
3.34	0.81	0.79	0.13	0.14
0.40	1.02	0.96	0.22	0.26
☐ Data used in Table 2 of SNAP (Ohio EPA, 2015b)				
*n=5				

TP Conc. (mg/l)	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

← DECREASING RISK

DECREASING RISK →

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

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

Habitat Assessment

Methods

Instream habitat assessments were conducted at both 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 8). For headwater streams, a score greater than 55 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 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	
	QHEI Range
Narrative Rating	Headwaters (drainage ≤ 20 sq miles)
Excellent	≥70
Good	55–69
Fair	43–54
Poor	30–42
Very Poor	<30

Results and Discussion

QHEI assessments were performed at Nine-Mile Creek RM 3.34 and RM 0.40 in 2024. Both sites met the QHEI target for the respective stream size and should be of high enough quality to support fish assemblages. A narrative rating of *Good* was given to both Nine-Mile Creek RM 3.34 and RM 0.40.

The site at RM 3.34 had cobble and bedrock as the dominant substrate types. There was a normal amount of silt present, and the substrate embeddedness was considered to be normal as well. The sparse instream cover was only comprised of small rootmats and boulders. This section of stream had relatively low sinuosity and had fair development of the pool-riffle-run complexes, as the maximum pool depth was between 40 and 70 cm. Current velocity did not exceed "moderate" conditions. The maximum riffle depth was between 5 cm and 10 cm, and the riffles were stable. Embeddedness in those areas was considered low. Figure 3 shows that QHEI scores at RM 3.34 have remained relatively consistent over time.
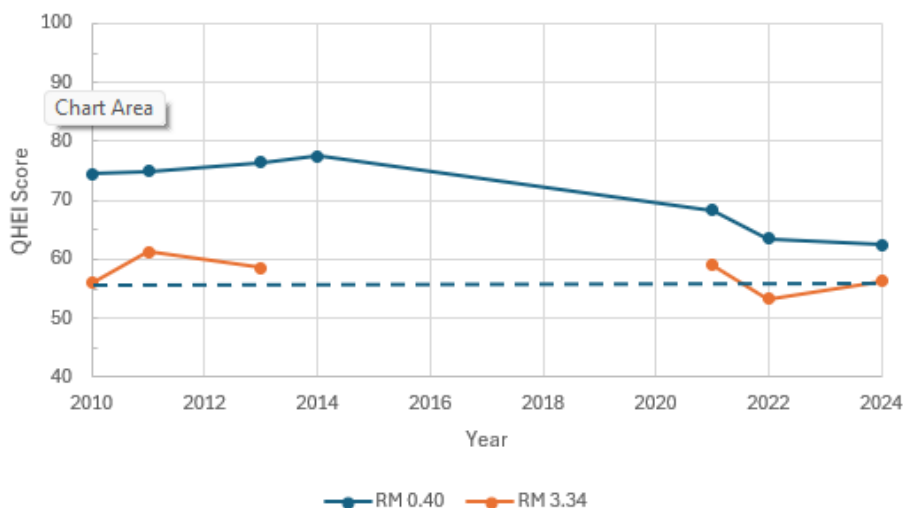

Figure 3. Historic QHEI scores for Nine-Mile Creek.
The dashed line represents the WWH target score of 55.

The site at RM 0.40 had sand and silt as the dominant substrate types with moderate to heavy silt cover and moderate to extensive embeddedness. The sparse amount of instream cover consisted of undercut banks, deep pools, boulders, shallows (in slow water), and logs/woody debris. The stream reach at RM 0.40 had moderate sinuosity, fair development, and was moderately stable. A streambank stabilization project was completed in 2023 at RM 0.40. It is likely that this section of Nine-Mile Creek is still in a transition phase after the construction project was completed. Pools greater than a meter as well as stable riffles could provide adequate habitat for various fish species. The riffles within the reach were 5 cm to 10 cm deep and had moderate embeddedness, likely due to the dominant sand and silt substrates.

Individual components of the QHEI can also be used to evaluate whether a site can meet its WWH designated use (Table 9). 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). The site at RM 3.34 in 2024 had one high-influence characteristic and four moderate-influence characteristics. The site at RM 0.40 had two high-influence characteristics and five moderate-influence characteristics. These indicate that there was a greater prevalence of characteristics that have the potential to prevent these sites from meeting WWH attainment.

Table 7. QHEI Scores and Physical Attributes

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 Attributes	(MWH H.I.+1) / (WWH+1) Ratio	(MWH M.I.+1) / (WWH+1) Ratio
			\<--- WWH Attributes ---\>											\<-- MWH High Influence --\>						\<------ MWH Moderate Influence ------\>														
3.34	56.25	Good	X	X						X	X	X	5				X		1					X	X	X		X				4	0.3	0.8
0.40	62.50	Good	X				X			X			3		X		X		2		X			X				X	X	X		5	0.8	1.5

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Fish Community Biology Assessment

Methods

Two quantitative electrofishing passes were conducted at Nine-Mile Creek RM 0.40 and one quantitative pass at RM 3.34 in 2024. A list of the dates when the surveys were completed is shown in Table 9. Sampling was conducted using longline electrofishing techniques and consisted of shocking all habitat types within a sampling zone while wading from downstream to upstream. The sampling zone at both headwater sites was 0.15 kilometers and followed the Ohio EPA 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). With drainage areas less than twenty square miles at both sites, the number of fish collected were counted following Ohio EPA headwater protocol. No weights of fish were documented. All fish were then released into the waters from which they were collected, except for vouchers and/or those that could not be easily identified in the field.

Table 8. Fish Survey Dates	
Date	Sites sampled
6/27/2024	RM 3.34
	RM 0.40
10/10/2024	RM 0.40

The electrofishing results were compiled and utilized to evaluate fish community health through the application of one of two Ohio EPA indices. With both sampling locations being classified as headwater sites, only the Index of Biotic Integrity (IBI) was utilized. The IBI incorporates twelve community metrics representing structural and functional attributes (Table 10). 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 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*.

Table 9. Headwater IBI Metrics
Number of indigenous fish species
Number of darter species
Number of headwater species
Number of minnow species
Number of sensitive species

Table 9. Headwater IBI Metrics
Percent tolerant species
Percent omnivore species
Percent insectivore species
Percent pioneering species
Number of individuals (minus tolerants)
Number of simple lithophilic species
Percent DELT anomalies

The streams evaluated are located completely within the Erie-Ontario Lake Plains (EOLP) ecoregion and follow the EOLP IBI metric scoring. The WWH IBI scoring criterion in the EOLP ecoregion is 40 for headwater sites. A site is within non-significant departure if the score falls within 4 IBI units (Table 11). 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
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 2024 IBI scores from each assessment location on Nine-Mile Creek are listed below in Table 13. Due to a variety of factors, neither site on Nine-Mile Creek was found to be in attainment of the WWH criterion.

Table 11. Fish Community Assessment Results				IBI		
River Mile	Total # of species	Relative # / less Tolerants	Predominant species (%)	1st pass	2nd pass	Average
3.34	1	37/0	Creek Chub (100)	20*	---	20*
0.40	5	1132/126	Common White Sucker (75.3) Creek Chub (13.6) Round Goby (9.5)	20*	18*	19*
*Significant departure from biocriterion (>4 IBI units). Underlined scores are in the *Poor* or *Very Poor* narrative range.						

During the 2024 sampling season, NEORSD conducted one survey at RM 3.34. Based on historical surveys, it was decided that an additional survey was unnecessary due to only one species of fish ever being collected at that site. An IBI score of 20 was calculated at RM 3.34, which resulted in a narrative rating of *Poor* and non-attainment of the fish community WWH criterion. The 2024 survey confirmed the one species collected at this site, the Creek Chub (*Semotilus atromaculatus*), which totaled 37 individuals. The Creek Chub is a highly pollution-tolerant, pioneering stream species with a preference for habitats similar to what is found at RM 3.34. The lack of species diversity including the absence of key taxa such as darters and headwater species, no sensitive species, and no insectivorous species negatively impacted the IBI score. No DELTS were observed during the sampling event, which positively contributed to the IBI score. This reach is predominantly bedrock, relatively shallow, and open, leaving no habitat for deeper-water species or species that require instream cover or interstitial spaces. It is likely that the overall location of the reach negatively impacted the fish score by limiting recruitment of other fish species. This stretch of Nine-Mile Creek is upstream of a culverted stretch of the stream, which likely prevents the migration of fish upstream to the site. The QHEI score of 56.25 (*Good*) also indicates that habitat conditions are decent but could be better and this may be influencing the absence of other fish species. This IBI score was comparable to what has been calculated in past surveys (Figure 4).
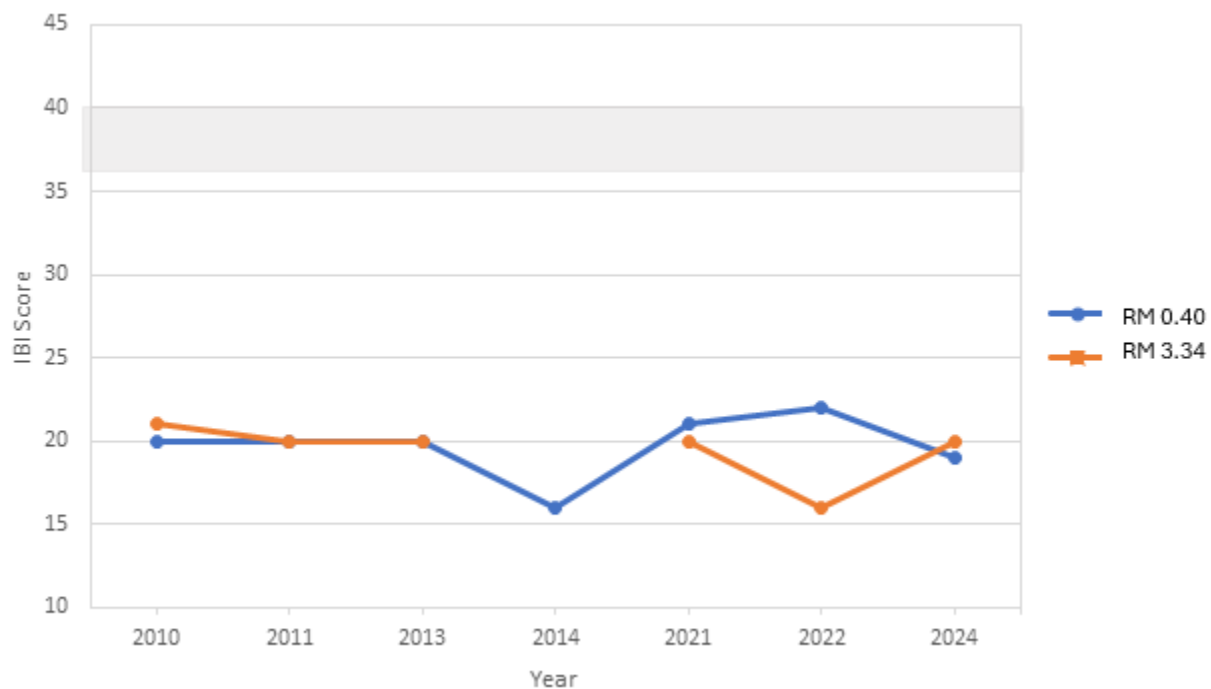

Figure 4. Historic IBI Scores for Nine-Mile Creek Headwater Sites. Gray box represents range of WWH attainment and NSD from headwater criterion.

For both passes at RM 0.40, the average IBI score was calculated at 19 (*Poor*) and was not in attainment of the WWH criterion. A total of five species were collected between the two electrofishing surveys. The most dominant fish collected was the highly tolerant Common White

Sucker (*Catostomus commersonii*), representing seventy-five percent of the total fish collected. With RM 0.40 being near the confluence of Lake Erie, IBI scores may be influenced by different fish populations migrating to and from the lake. The time of year will also have an impact on what species travel between the lake and creek. This can have a potential impact on IBI scores depending on when sampling takes place. Even with the influence of Lake Erie, the low number of total fish collected as well as low diversity during both surveys impacted the IBI scores. Although RM 0.40 received a QHEI score of 62.5 and a narrative rating of *Good*, the silt and muck are having a negative impact on available habitat. Due to the limited instream habitat conditions, including extensive embeddedness, heavy silt, and poor substrate quality, it is unlikely that the site can support a robust fish community. Combined with the present habitat, anthropogenic sources of pollution, the high percentage of impervious surface contributing to stormwater runoff, and CSO discharges may also be affecting the fish population negatively.

Macroinvertebrate Community Biology Assessment

Methods

Macroinvertebrates were only sampled at RM 0.40 quantitatively using modified Hester-Dendy (HD) samplers in 2024. Macroinvertebrates were not sampled quantitatively at RM 3.34 due to unsuitable conditions for HD installation. A qualitative sampling event at each site was conducted to assess Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) taxa within all available habitats within the stream reach. These taxa are also referred to as EPT taxa. Qualitative sampling was conducted at both locations listed in Table 13.

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 (1987b). Lists of the species collected during the qualitative sampling at each site are available upon request from NEORSD WQIS Division.

Table 12. Macroinvertebrate Sampling Dates		
River Mile	HD Installation Date(s)	HD Retrieval and Qualitative Sample Date
3.34	N/A*	7/8/24
0.40	6/17/24	8/1/24
*HD was not installed due to unsuitable stream conditions.		

The macroinvertebrate sampling methods followed Ohio EPA protocols as detailed in *Biological Criteria for the Protection of Aquatic Life, Volumes II* (1987a) and *III* (1987b). At RM 0.40, 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 14), 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 eco-region. The WWH ICI criterion in the EOLP ecoregion is 34 (Table 15) and a site is within non-significant departure if the score falls within 4 ICI units of the criterion.

Table 13. 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 14. 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

Table 15 shows the results for the macroinvertebrate assessments. For the 2024 sampling season, Nine-Mile Creek RM 0.40 was in non-attainment of the WWH criterion. Based off the narrative assessment, Nine-Mile Creek RM 3.34 was considered in non-significant departure of WWH attainment.

					Table 15. 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
3.34	---	24/---	7/2	---	Baetid mayflies, Simulidae	--	*Marginally Good*
0.40	245/L-M	31/39	4/0	23.6/0.8	Baetid mayflies, Simulidae	22	*Fair*

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*, no *Intolerant* taxa were collected.

A narrative rating assignment for Nine-Mile Creek RM 3.34 was determined from the results of a qualitative sample only. No HD was collected at this site as it is a small headwater with a drainage area of only 0.70 square miles. The qualitative sample data was compared to expectations developed by NEORSD using threshold limit models (NEORSD, 2023). These models were developed using QDC Level 3 macroinvertebrate data provided by the Ohio EPA from the Erie Ontario Lake Plain ecoregion (EOLP) from the ten-year period between 2005 and 2014 (threshold limit model analysis available upon request). Table 1 provides the expectation threshold limits for qualitative total taxa, qualitative EPT taxa, and qualitative sensitive taxa metrics, grouped by drainage area category. In addition to these threshold limits, field observations including, but not limited to, relative taxa abundance and field narrative rating as well as comparisons to historical data were considered in the assignment of the narrative rating.

Drainage Category	Designation	Qualitative Total Taxa	Qualitative EPT Taxa	Qualitative Sensitive Taxa
Table 16. NEORSD Recommended Expectation Threshold Limits for Narrative Rating Assignments in the EOLP				
Headwater (0-20 miles^2)	EWH	38	12	6
	WWH	27	7	2
	Fair	23	4	1
Wadable (20-200 miles^2)	EWH	51	18	12
	WWH	41	11	6
	Fair	33	8	2
Small River (200-1,000 miles^2)	EWH	44	16	10
	WWH	36	11	7
	Fair	29	9	5

Nine-Mile Creek RM 3.34 was assigned a narrative rating of *Marginally Good* in 2024. A total of 24 qualitative taxa were collected at the site, of which seven were EPT taxa and two were sensitive taxa. EPT taxa collected at the site included two Baetidae (*Acentrella turbida* and *Baetis flavistriga*), one Polycentropodidae (*Polycentropus sp*), three Hydropsychidae (*Cheumatopsyche*, *Hydropsyche sparna*, and *hydropsyche morosa group*), and one Hydroptilidae (*Hydroptila sp*). The number of total taxa collected at the site was between the Fair and WWH expectation, while the number of EPT taxa met the WWH expectation of seven. The number of sensitive taxa also met the WWH expectation of two taxa. Simulidae and Baetidae were noted as being the most abundant groups at this site in 2024. Historically, this site was assigned a narrative rating of *Marginally Good* in 2021 and 2022. Similar numbers of qualitative total, EPT, and sensitive taxa and similar dominant taxa groups by relative abundance were noted in these years. Taken together, this information supports the narrative rating assignment of *Marginally Good* in 2024.

Nine-Mile Creek RM 0.40 received an ICI score of 22 (*Fair*), which was not in attainment of the WWH criterion. This was a ten point drop in ICI score when compared to 2022 sampling at RM 0.40. This was likely due to poor macroinvertebrate colonization of the HD blocks that were 75% buried. This site has a drainage area of 11.8 square miles, placing it in the headwater drainage area category. A total of 31 taxa were collected in the qualitative sample, which scores above the WWH expectation of 27 for a headwater stream. Only four EPT taxa were collected, which meets the Fair expectation of four for the number of EPT taxa. EPT taxa included one mayfly species (*Baetis flavistriga*), two caddisfly taxa (*Hydropsyche depravata group* and *Hydropysche sparna*) and one Hydroptilidae (Hydroptila sp). Two sensitive taxa, the moderately intolerant water penny (*Psephenus herricki*) and crane fly (*Antocha sp*), were collected, which meets the Fair expectation of one for number of sensitive taxa. Field observations indicated that the most predominant group was Simuliidae followed by Baetidae, Amphipoda, and Oligochaeta.

Conclusions

The results of NEORSD's 2024 water chemistry sampling, habitat assessments, and fish and benthic macroinvertebrate community surveys indicate that despite Project Clean Lake infrastructure improvements, Nine-Mile Creek is likely still impacted by a variety of anthropogenic-driven habitat limitations and environmental stressors listed in Table 17.

River Mile	DA (mi²)	Attainment Status	IBI Score	ICI Score/ Narrative Rating	QHEI Score	Cause(s)	Source(s)
Table 17. 2024 Nine-Mile Creek ALU Attainment Status							
Nine-Mile Creek (WWH Existing)							
3.34 [H]	0.7	NON	20	*Marginally Good*	56.25	Sedimentation. Nutrient enrichment. Poor habitat development. Flow alterations.	Urbanization and urban runoff. Culverted stream reaches. Atmospheric deposition/urbanization.

Table 17. 2024 Nine-Mile Creek ALU Attainment Status							
River Mile	DA (mi^2)	Attainment Status	IBI Score	ICI Score/ Narrative Rating	QHEI Score	Cause(s)	Source(s)
0.40 [H]	11.8	NON	19	22	62.50	Sedimentation. Nutrient enrichment. Poor habitat development. Flow alterations.	Urbanization and urban runoff. Culverted stream reaches. Atmospheric deposition/urbanization.

[H] Headwater scoring criteria

Instream habitat at Nine-Mile Creek RM 3.34 is degraded and likely limited due to the culverted sections located downstream of the site. Poor habitat quality, a moderately embedded riffle, flow modifications, and the small drainage area are likely limiting factors contributing to the *Poor* and *Marginally Good* biological index scores for fish and macroinvertebrates, respectively. The pollution-tolerant Creek Chub was the only fish species collected during the one electrofishing pass. While the total number of EPT taxa collected during the qualitative sample at this reach met the threshold limit values designed by NEORSD, *E. coli* densities exceeded water quality criteria and were indicative of water quality impacts from urbanization.

In-stream habitat at Nine-Mile Creek RM 0.40 met WWH expectations with a *Good* habitat index score. Channel development was fair, and instream cover was moderate. Overall embeddedness and siltation also persisted throughout the stream reach. This was likely a reflection of the high percentage of impervious surface and anthropogenic sources of pollution contributing to water quality issues at the site. For both passes, fish scores were *Poor* and did not meet WWH expectations. The low diversity and abundance of species collected, which primarily included the pollution-tolerant Creek Chub and Common White Sucker, and the absence of key darter and headwater species highly influenced the scores. The macroinvertebrate ICI score at Nine-Mile Creek RM 0.40 was a 22 (*Fair*), in 2024. Of the 39 total number of taxa collected, only four species were considered EPT taxa and three were considered moderately intolerant of pollution. The HD blocks being mostly buried may have contributed to the low ICI score and species diversity. Urbanization in the region also resulted in exceedances of water quality criteria for *E. coli* as well.

Exceedances of both bacteriological criteria for primary contact recreation occurred at both sites during the 2024 recreation season. Potential sources of bacterial inputs may include stormwater runoff, illicit discharges, common trench sewer inflow and infiltration, failing household sewage treatment systems (HSTS), and CSOs. Overall, these potential sources may be continuing to impact the water quality in Nine-Mile Creek.

Acknowledgments

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