NORTHEAST OHIO REGIONAL SEWER DISTRICT

2010 Nine-Mile Creek Environmental Monitoring
Biological, Water Quality and Habitat Survey Results

Prepared by
Water Quality and Industrial Surveillance Division

Introduction

During 2010, the Northeast Ohio Regional Sewer District (NEORSD) conducted water chemistry sampling, habitat assessments, and fish and benthic macroinvertebrate community surveys on Nine-Mile Creek at three locations. Nine-Mile Creek is an intensely urbanized stream in Cuyahoga County which runs through the cities of University Heights, South Euclid, Cleveland Heights, Cleveland and Bratenahl before emptying into Lake Erie. The majority of Nine-Mile Creek is culverted; however, sampling was conducted in open sections of the creek.

NEORSD construction work began in 2011 on the Tunnel Dewatering Pump Station (TDPS) project, which will reduce the number of overflows per year to Nine-Mile Creek and provide wet weather flow relief in the existing collection system through diversion into the Dugway East Interceptor Relief Sewer (DIERS) and Dugway Storage Tunnel (DST). Construction on the DIERS project began in the spring of 2009 and is expected to be completed by early 2012.

The purpose of the study was to establish baseline monitoring data prior to construction of the TDPS and before the completion of the DIERS project, as well as to identify point and nonpoint sources of pollution that may be influencing the water quality at each sample location. The baseline data will then be able to be compared with data collected after the completion of the TDPS and DIERS to evaluate any changes in water quality and biological community health from the reduction of overflows to Nine-Mile Creek. Sampling was conducted by NEORSD Level 3 Qualified Data Collectors certified by Ohio EPA in Fish Community and Benthic Macroinvertebrate Biology, Chemical Water Quality and Stream Habitat Assessments as explained in the NEORSD study plan approved by Ohio EPA on June 18, 2010 (*2010 Nine-Mile Creek Environmental Monitoring*).

Refer to Figure 1 for a map of the sampling locations. Table 1 indicates the sampling locations with respect to river mile (RM), latitude/longitude, description and surveys conducted. A digital photo catalog of the sampling locations is available upon request from NEORSD's Water Quality and Industrial Surveillance (WQIS) Department.

Figure 1. Map of Sampling Locations and Descriptions

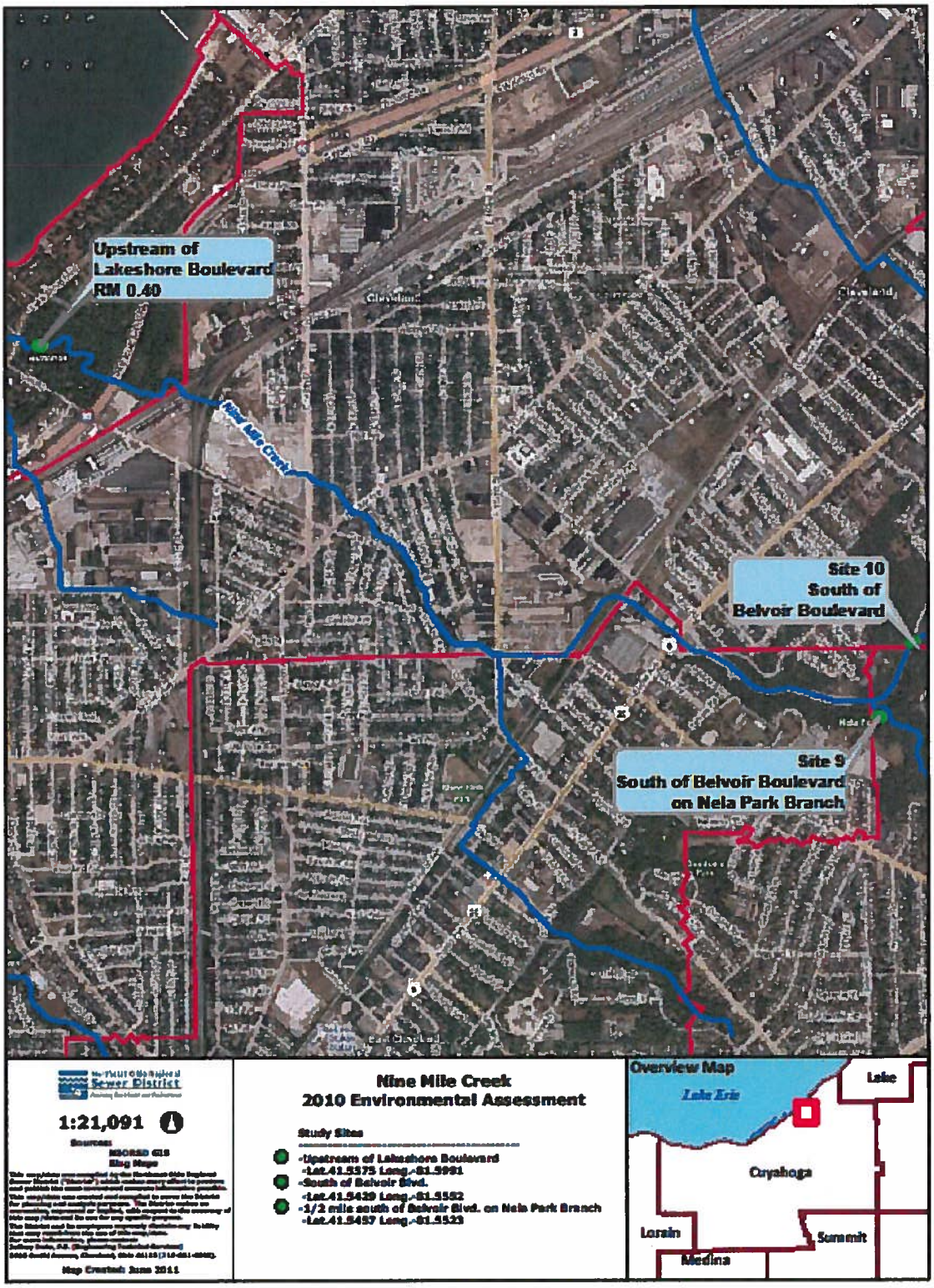


Table 1. Sampling Locations

Site Location	Latitude	Longitude	River Mile	Description	Quadrangle	Purpose
Nine-Mile Creek (Site 10)	41.54572967	81.55228433	N/A	South of Belvoir Boulevard	East Cleveland	Evaluate water chemistry, fish, habitat and macroinvertebrates
Nine-Mile Creek, Nela Park Branch (Site 9)	41.54290983	81.55521750	N/A	South of Belvoir Boulevard on Nela Park Branch	East Cleveland	Evaluate water chemistry, fish, habitat and macroinvertebrates
Nine-Mile Creek	41.5574565	81.59912283	0.40	Upstream of Lakeshore Boulevard	East Cleveland	Evaluate water chemistry, fish, habitat and macroinvertebrates

Water Chemistry and Bacteriological Sampling

Methods

Water chemistry and bacteriological samples were collected weekly during the macroinvertebrate colonization period from July 28, 2010 to August 25, 2010. Samples collected on August 4, 2010 were associated with wet weather[1], with 0.13 inches of rainfall. A total of 19 samples were collected, which included field duplicates and field blanks. Techniques used for water chemistry sample collection and chemical analyses followed the *Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices* (2009a). Field analyses included the use of an YSI 600XL Sonde multi-parameter meter during sampling. The sonde was calibrated weekly to measure dissolved oxygen, water temperature and conductivity, while pH was calibrated on a daily basis.

Water chemistry samples were collected in two 4-liter polyethylene Cubitainers, two 473-milliliter plastic bottles and one 500-milliliter sterilized bacteriological bottle. A NEORSD Surface Water Condition Sampling Field Data Form was completed with field parameters measured instream. Both 473-milliliter plastic bottles used to collect samples were field preserved with either trace nitric acid or trace sulfuric acid. Bacteriological samples were collected in a sterile 500-milliliter plastic bottle that was preserved with sodium thiosulfate. All samples were placed in a cooler with ice and stored in a locked NEORSD vehicle until the samples were transferred to the NEORSD's Analytical Services (AS) sample receiving, and released to an authorized AS employee with a Chain of Custody (COC). All COCs and Surface Water Condition Sampling Field Data Forms are available upon request from NEORSD's WQIS Division.

All Nine-Mile Creek sites are designated warmwater habitat (WWH), agricultural water supply, industrial water supply and primary contact recreation. However, these use designations are based on the Ohio Environmental Protection Agency (Ohio EPA) 1978 water quality standards. The 1978 water quality standards consisted of the following

[1] Wet weather: greater than 0.10 inches but less than 0.25 inches of rainfall, samples collected that day and the following day are considered "wet weather" samples; greater than 0.25 inches of rainfall, samples collected that day and the following two days are considered "wet weather" samples. Rainfall data taken from South Euclid (RSO).

tiered classification system for different aquatic life uses: warmwater, exceptional warmwater, and coldwater habitats. The criteria for each aquatic life use were solely chemical and physical based; narrative biological criteria were not developed until 1980 and numerical biological criteria were not developed until 1990 (DeShon, 1995). Although it seems there are no associated biological criteria, according to Ohio *Administrative Code* 3745-1-07, the most current aquatic life use standards still apply for Nine-Mile Creek (OEPA, 2009b). Additionally for the other designated uses, the current standards apply also.

The quality assurance and quality control of water sample collections included obtaining sample duplicates at a frequency not less than 10% of the total samples collected. Field blanks were collected at a frequency not less than 5% of the total samples collected. The two field blanks that were collected showed no signs of contamination during the sampling and transporting process.

A total of two sample duplicates were obtained during the sampling period on August 4 at RM 0.40 and August 11 at Site #9. The sample duplicate results were compared to the sample results using relative percent difference (RPD), see Formula 1.

Formula 1)

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

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

Each sample and sample duplicate was compared for each of the forty-three individual parameters reported on the Certificate of Analysis. After an RPD was calculated, any result greater than thirty percent was investigated to determine the reason for the discrepancy. A total of six potential discrepancies were found at RM 0.40 and another six potential discrepancies at Site #9. Two of the parameter values for RM 0.40 and two parameter values for Site #9 were less than ten times their respective practical quantitation limits (PQL), which are very low concentrations. Differences in very low concentrations can lead to high RPD values. The remaining four discrepancies were greater than ten times their PQLs and thus could not be explained (Table 2). A possible reason for the unexplained discrepancies could be due to a difference in time between the collection of the samples and the duplicates.

Table 2. Unexplained Water Quality Discrepancies

Stream	River Mile/Site	Date Collected	Parameter	Units	Sample Result	Duplicate Result	RPD Value %
Nine-Mile	0.40	8/4/2010	Total Suspended Solids	mg/L	19.30	12.20	45.08
Nine-Mile	0.40	8/4/2010	Turbidity	NTU	8.71	4.91	54.49
Nine-Mile	#9	8/11/2010	BOD	mg/L	7.80	11.00	34.04
Nine-Mile	#9	8/11/2010	*E. coli*	cfu/100mL	48000	26000	59.46

Results and Discussion

Site #10

Five weekly water chemistry samples were obtained at Nine-Mile Creek Site #10; however, the first sample collected on July 28 was inadvertently obtained from the wrong location. Therefore, the water chemistry results for July 28 are not included in the water chemistry discussion for Site #10.

Nine-Mile Creek Site #10 had a potential mercury exceedance of the water quality criteria for the Lake Erie drainage basin during the sampling period (Table 12). This was considered a potential exceedance due to samples with estimated mercury values between the MDL and PQL. Mercury potentially exceeded the human health nondrinking outside mixing zone average (OMZA) criterion and the wildlife OMZA criterion for all 30-day periods. Additionally, Site #10 also exceeded the class B primary contact recreation criterion with a seasonal geometric mean of 331 colony forming units/100mL (cfu/100mL) (Table 4). Two 30-day periods (67%) exceeded 523 cfu/100mL in more than 10% of the samples. Possible explanations of this exceedance include combined sewer overflows (CSO), sanitary sewer overflows (SSO) and urban and stormwater runoff. According to U.S. EPA's *The Quality of Our Nation's Waters* (2000), bacteria were found to be one of the most common pollutants affecting rivers and streams.

Table 12. Site #10 Mercury Results

Sample Date	Mercury				
	Form (units)	Concentration	30-day period	Average Concentration	OMZA Criterion (Nondrinking & Wildlife)
8/4/2010	TR (µg/L)	0.0025	8/4/10-9/3/10	0.0140	0.013
8/11/2010	TR (µg/L)	0.0025	8/11/10-9/10/10	0.0178	0.013
8/18/2010	TR (µg/L)	0.0080	8/18/10-9/17/10	0.0255	0.013
8/25/2010	TR (µg/L)	0.0430[a]	--	--	--

TR= Total Recoverable
[a] Estimated value between the MDL and PQL
Shading= 30-day period exceedance of the criterion

Site #9

Nine-Mile Creek Site #9 had a total of seven exceedances of the applicable Ohio Water Quality Standards, Ohio *Administrative Code* 3745-1-07 (2009b), during the sampling period, in which all exceedances may be attributed to the discovery of sanitary sewage entering the creek near Site #9. According to the response report titled "*Sanitary Sewage near Site 9 in Nine Mile Creek, Nela Park Branch*" from September 16, 2010, it was discovered on July 30 that sanitary sewage was entering Nine-Mile Creek through the Nela Court Outfall near Site #9. The *E. coli* density at the Nela Court Outfall was 258,000 cfu/100mL on August 5. An investigation revealed that an SSO owned by the City of East Cleveland was discharging sanitary sewage into a storm sewer that was tributary to Nine-Mile Creek, upstream of Site #9. The cause of the discharge was a blockage of the sanitary sewer line. The City of East Cleveland indicated that their jet-vac truck was not in operation and they did not have sufficient funds to fix the truck. Therefore, a NEORSD Sewer System Maintenance and Operation crew was deployed to the site to jet-vac the blocked sewer on August 27 (after the end of water chemistry sampling). On October 1, a sample was collected from the Nela Court Outfall, resulting in an *E. coli* density of 89 cfu/100mL (Table 5), indicating that the blockage was cleared. Additionally, Investigators verified that the creek at Site #9 was clear with no odor or evidence of sanitary sewage and that although the Nela Court Outfall still had flow, it was much reduced and did not have a sewage odor.

Table 5. Nine-Mile Creek Site #9 and Nela Park Outfall *E. coli* Densities

Location	Date	*E. coli* (cfu/100 ml)
Site #9	07/28/10	EC 59,200
Site #9	08/04/10	EC 139,000
Site #9	08/11/10	48,000
Site #9	08/18/10	EC 49,600
Site #9	08/25/10	EC 64,000
Site #9	10/01/10	500
Nela Court Outfall	08/05/10	EC 258,000
Nela Court Outfall	10/01/10	89

EC= Estimated Count

This sanitary sewage discharge is the most likely cause contributing to Site #9 failing to attain the class B primary contact recreation seasonal geometric mean for bacteria (Table 4). The seasonal geometric mean at this site for the sampling period was 62,667 cfu/100mL. Site #9 had the highest geometric mean for bacteria of the three locations on Nine-Mile Creek. Additionally, the percentage of samples exceeding the single sample maximum of 523 cfu/100mL was greater than 10% for all 30-day periods.

There was an exceedance of the protection of aquatic life outside mixing zone maximum (OMZM) criterion for cadmium on July 28, August 4, August 18 and August 25 (Table 6). This also resulted in non-attainment of the OMZA for all 30-day periods during which samples were collected. Similarly, copper and selenium both exceeded the water quality criteria for the protection of aquatic life OMZA for two 30-day periods (50%) (Tables 7 & 8). It is likely that the sanitary sewage that was discovered entering Nine-Mile Creek could have contributed to these exceedances. Other potential sources contributing to the cadmium non-attainment include runoff, weathering and erosion of soil and bedrock (ICA, 2009).

Table 6. Site #9 Cadmium Results

	Cadmium Hardness based						
Sample Date	Form (units)	Concentration	30-day period	Average Cd Concentration	Average $CaCO_3$ Concentration	OMZA Criterion	OMZM Criterion
7/28/2010	TR (µg/L)	21.26	7/28/10-8/27/10	18.25	177.90	3.87	7.89
8/4/2010	TR (µg/L)	10.19	8/4/10-9/3/10	17.50	181.38	3.93	7.78
8/11/2010	TR (µg/L)	5.72	8/11/10-9/10/10	19.94	187.83	4.04	8.68
8/18/2010	TR (µg/L)	29.64	8/18/10-9/17/10	27.24	192.50	4.12	10.1
8/25/2010	TR (µg/L)	24.83	--	--	--	--	8.82

TR= Total Recoverable
Shading= 30-day period exceedance of the criterion

Table 7. Site #9 Copper Results

	Copper Hardness based					
Sample Date	Form (units)	Concentration	30-day period	Average Cu Concentration	Average $CaCO_3$ Concentration	OMZA Criterion
7/28/2010	TR (µg/L)	18.82	7/28/10-8/27/10	15.34	177.90	15.26
8/4/2010	TR (µg/L)	11.66	8/4/10-9/3/10	14.47	181.38	15.51
8/11/2010	TR (µg/L)	8.77	8/11/10-9/10/10	15.41	187.83	15.79
8/18/2010	TR (µg/L)	20.17	8/18/10-9/17/10	18.73	192.50	15.82
8/25/2010	TR (µg/L)	17.29	--	--	--	

TR= Total Recoverable
Shading= 30-day period exceedance of the criterion

Table 8. Site #9 Selenium Results

Sample Date	Selenium				
	Form (units)	Concentration	30-day period	Average Concentration	OMZA Criterion
7/28/2010	TR (µg/L)	2.91	7/28/10-8/27/10	3.99	5.0
8/4/2010	TR (µg/L)	1.87	8/4/10-9/3/10	4.26	5.0
8/11/2010	TR (µg/L)	1.68	8/11/10-9/10/10	5.06	5.0
8/18/2010	TR (µg/L)	9.75	8/18/10-9/17/10	6.94	5.0
8/25/2010	TR (µg/L)	4.13	--	--	--

TR= Total Recoverable
Shading= 30-day period exceedance of the criterion

An exceedance of the WWH outside mixing zone 30-day average for ammonia occurred for two 30-day periods (50%) at Nine-Mile Creek Site #9 (Table 9). Ammonia most likely exceeded the criterion due to the sanitary sewage that was entering Nine-Mile Creek upstream of Site #9.

Table 9. Site #9 Ammonia Results

Sample Date	Ammonia									
	pH/temperature based									
	Form (units)	Ammonia Concentration	pH value (s.u.)	Temperature (°C)	30-day period	Average Ammonia Concentration	Average pH Value (s.u.)	Average Temperature (°C)	OMZA Criterion	OMZM Criterion
7/28/2010	T (mg/L)	2.366	7.52	20.10	7/28/10-8/27/10	2.27	7.41	--	2.2	13.0
8/4/2010	T (mg/L)	3.19	7.32	20.50	8/4/10-9/3/10	2.25	7.38	20.58	2.2	13.0
8/11/2010	T (mg/L)	2.798	7.32	21.80	8/11/10-9/10/10	1.93	7.40	20.60	2.2	13.0
8/18/2010	T (mg/L)	1.291	7.37	19.60	8/18/10-9/17/10	1.59	7.45	20.00	2.2	13.0
8/25/2010	T (mg/L)	1.896	7.52	20.4	--	--	--	--	--	--

T= Total

Nine-Mile Creek Site #9 failed to attain the WWH minimum OMZA for dissolved oxygen (Table 10) during three 30-day periods (75%), but did not exceed the OMZM for dissolved oxygen. Although there was only one value obtained in a 24-hour period, that value is taken as the 24-hour average and compared to the OMZA criterion. Sanitary sewage is the most probable explanation for this exceedance, since sewage has the potential to decrease levels of dissolved oxygen and contribute to organic enrichment.

Table 10. Site #9 Dissolved Oxygen Results

Sample Date	Dissolved Oxygen Criterion based on outside mixing zone minimum				
	Form (units)	Concentration	30-day period	24-Hour Value	OMZA Criterion
7/28/2010	T (mg/L)	7.32	7/28/10-8/27/10	7.32	5.0
8/4/2010	T (mg/L)	4.88	8/4/10-9/3/10	4.88	5.0
8/11/2010	T (mg/L)	4.37	8/11/10-9/10/10	4.37	5.0
8/18/2010	T (mg/L)	4.26	8/18/10-9/17/10	4.26	5.0
8/25/2010	T (mg/L)	5.65	--	5.65	--

T=Total
Shading= 24-hour period exceedance of the criterion

At Nine-Mile Creek Site #9, there was a potential and actual mercury exceedance of the water quality criteria for the Lake Erie drainage basin (Table 11). The potential non-attainment for mercury was exceeded during three 30-day periods for human health nondrinking and wildlife OMZA criteria. This potential exceedance was due to samples with estimated mercury values between the MDL and PQL. Since the MDL is greater than the mercury criterion, it cannot be said for certain whether there was an actual exceedance of the mercury criteria in these cases. However, the last 30-day period during sampling, starting on August 18, had an actual mercury exceedance for human health nondrinking and wildlife OMZA criteria. This is an actual non-attainment because the samples collected on August 18 and August 25 both had mercury values that were above the PQL.

Table 11. Site #9 Mercury Results

Sample Date	Mercury				
	Form (units)	Concentration	30-day period	Average Concentration	OMZA Criterion (Nondrinking & Wildlife)
7/28/2010	TR (µg/L)	0.051[a]	7/28/10-8/27/10	0.0520	0.013
8/4/2010	TR (µg/L)	0.034[a]	8/4/10-9/3/10	0.0523	0.013
8/11/2010	TR (µg/L)	0.018[a]	8/11/10-9/10/10	0.0583	0.013
8/18/2010	TR (µg/L)	0.083	8/18/10-9/17/10	0.0031	0.013
8/25/2010	TR (µg/L)	0.058	--	--	--

TR= Total Recoverable
[a] Estimated value between MDL and PQL
Shading= 30-day period exceedance of the criterion

RM 0.40

Nine-Mile Creek RM 0.40 had a potential exceedance of the human health nondrinking and wildlife OMZA criteria for mercury (Table 3). All 30-day periods were potentially in exceedance of the mercury criteria during the sampling, with two of the

samples having estimated mercury values that were between the MDL and PQL. However, since the MDL is greater than the mercury criteria, the exceedance is considered a potential non-attainment and it is unknown whether there was an actual exceedance of the criteria. Sources of mercury contamination may include sanitary sewage contamination from CSOs, SSOs, urban and stormwater runoff, and atmospheric deposition.

Table 3. RM 0.40 Mercury Results

Sample Date	Mercury				
	Form (units)	Concentration	30-day period	Average Concentration	OMZA Criterion (Nondrinking & Wildlife)
7/28/2010	TR (µg/L)	0.006[a]	7/28/10-8/27/10	0.0132	0.013
8/4/2010	TR (µg/L)	0.025	8/4/10-9/3/10	0.0150	0.013
8/11/2010	TR (µg/L)	0.025	8/11/10-9/10/10	0.0192	0.013
8/18/2010	TR (µg/L)	0.008	8/18/10-9/17/10	0.0275	0.013
8/25/2010	TR (µg/L)	0.047[a]	--	--	--

TR= Total Recoverable
[a] Estimated value between MDL and PQL
Shading= 30-day period exceedance of the criterion

Nine-Mile Creek RM 0.40 exceeded the class B primary contact recreation seasonal geometric mean for bacteria (Table 4). The seasonal geometric mean at RM 0.40 for the sampling period was 1,437 colony forming units per 100 milliliters (cfu/100mL), compared to a class B primary contact recreation seasonal geometric mean criterion of 161 cfu/100mL. Additionally, for all 30-day periods, the percentage of samples exceeding 523 cfu/100mL was greater than 10%. Therefore, this site exceeded the bacteriological criteria for class B primary contact recreation. Suspected causes of the high bacteriological densities include CSOs, SSOs and urban and stormwater runoff. Additionally, the discovery of sewage contamination upstream on the Nine-Mile Creek Nela Park Branch near Site #9 (which was discussed earlier), may have contributed to the increased bacteriological densities.

Although there was only one wet weather sampling day, CSOs discharging during wet weather non-sampling days may have affected water chemistry on sampling days, especially since a total of 2.86 inches of rain fell during the five-week sampling period. According to the article *Streams in the Urban Landscape* (2001), high bacteria counts during dry weather are not uncommon in urban streams, suggesting illicit discharges, contaminated storm sewers and chronic sewage leakages as possible causes.

Table 4. Nine-Mile Creek *E. coli* Densities

		E. coli Density (cfu/100mL)		
Sample Date	Seasonal Geometric Mean Criterion	RM 0.40	Site #9	Site #10
7/28/2010	--	800	EC 59,200	--
8/4/2010	--	4,975	EC 139,000	400
8/11/2010	--	1,560	37,000	680
8/18/2010	--	880	EC 496,000	205
8/25/2010	--	1,120	EC 64,000	215
Seasonal Geometric Mean	161	1,437	62,667	331

EC=Estimated Count
Shading= Season geometric mean exceedance

Habitat Assessment

Methods

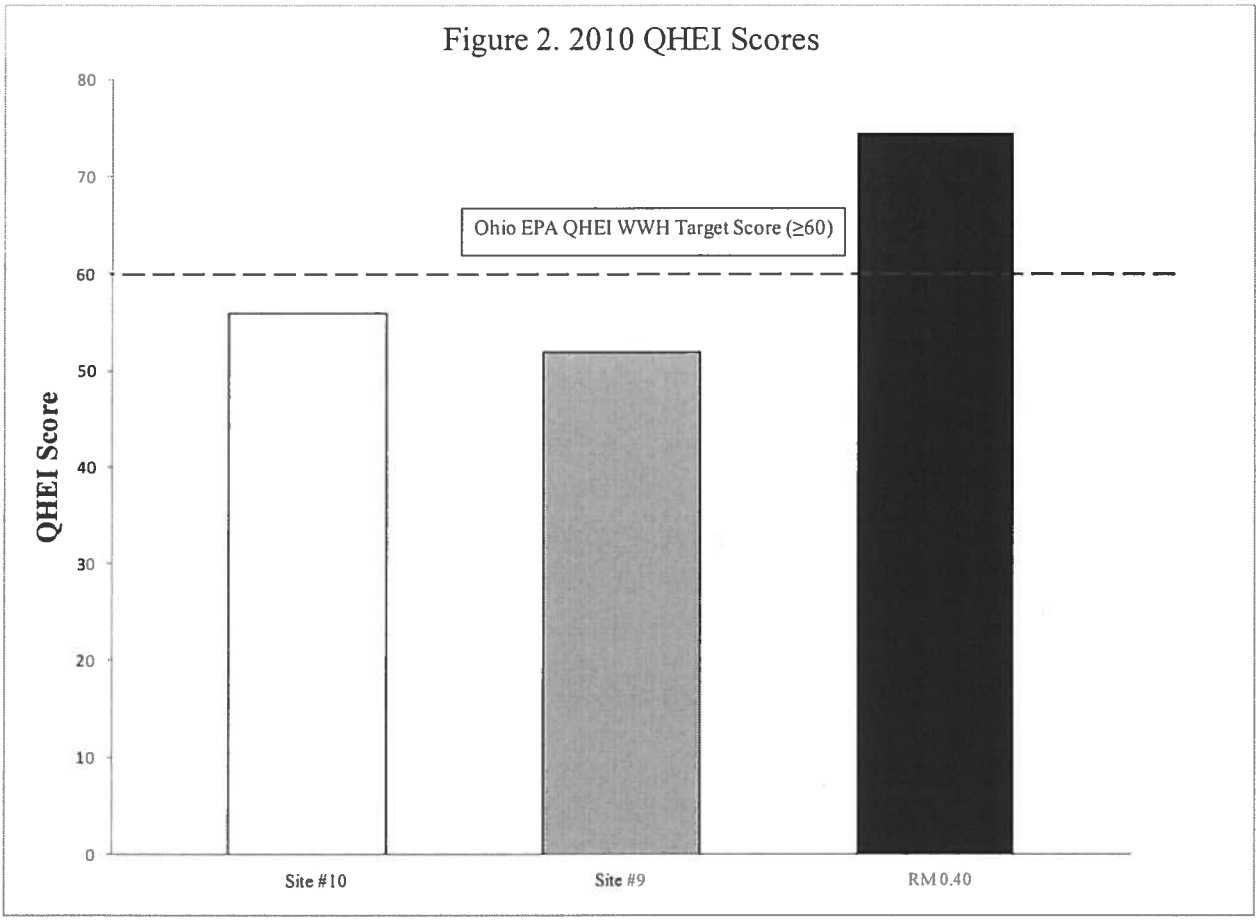
Qualitative Habitat Evaluation Index scores (QHEI) were determined for each site in 2010 following the techniques described in the Ohio EPA's (2006) *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)*. The QHEI measures the stream substrate, instream cover, stream channel morphology, riparian and bank condition, pool and riffle quality and stream gradient in relation to fish community health. The Ohio EPA has set a QHEI target score of 60 for WWH. A QHEI score ≥60 indicates that the stream has adequate habitat diversity and should be able to attain a WWH fish community as long as no other aquatic life use impairments exist (Rankin, 1989). QHEI field sheets from each site are available upon request from NEORSD's WQIS Division.

Results and Discussion

Site #10

Nine-Mile Creek Site #10, south of Belvoir Boulevard, obtained a QHEI score of 56 (*Good*) (Figure 2). Consisting mainly of gravel and bedrock, the site was free of silt with normal embeddedness. Instream cover was sparse, consisting of shallows, rootwads, boulders and woody debris. Channel development was poor due to the lack of deep pools and runs. Bank erosion was little to moderate and riparian width was wide to moderate. Although riffle and runs were stable to moderately stable, the riffles and runs tended to shift during elevated flows, due to the high gradient of the area. The site is surrounded by forest and residential/park/new field.

Figure 2. 2010 QHEI Scores



Site #9

Nine-Mile Creek Site #9, which is located on the Nela Park Branch, south of Belvoir Boulevard, scored a QHEI of 52 (*Fair*) (Figure 2). The predominant substrates were gravel and bedrock with normal silt quality and embeddedness. Instream cover was moderate to sparse, consisting of undercut banks, shallows, rootmats, rootwads, boulders and woody debris. Channel development was poor, mainly due to the lack of a functional riffle, deep pools (>70 cm) and deep runs. The channel is in a recovered state with low stability. However, bank erosion was little to none and the riparian width was greater than 50 meters.

RM 0.40

In 2010, Nine-Mile Creek RM 0.40, which is located upstream of Lakeshore Boulevard, received a QHEI score of 74.5 (*Excellent*) (Figure 2). The best substrate types were gravel and sand with sparse instream cover consisting of undercut banks, overhanging vegetation, shallows, deep pools (>70 cm), rootwads, boulders and woody debris. Channel development was good with deep runs and moderately stable riffles consisting of large gravel. Bank erosion was little to moderate, and riparian width was wide to moderate. The site is located within a forest/swamp area on river right and

residential/park/new field area on river left. This site met the Ohio EPA's target score of 60 for WWH streams.

Electrofishing

Methods

In 2010, electrofishing passes were conducted two times at each location (drainage area <20 square miles) and followed the Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volume III: Standardized Biological Field Sampling Laboratory Methods for Assessing Fish and Macroinvertebrate Communities* (1987).

At each site, longline electrofishing techniques were utilized to shock all habitat types within a sampling zone. The zones were 0.15 kilometers and shocking consisted of moving from downstream to upstream. Fish were identified to species level, counted and examined for the presence of external anomalies including deformities, erosions, lesions, and tumors (DELTs). Lists of the species, numbers, pollution tolerances and incidence of DELT anomalies are available upon request from NEORSD's WQIS Department.

Results from electrofishing sampling were used to calculate the Index of Biotic Integrity (IBI). The IBI, originally proposed by Karr (1981) is used to assess fish community health at a site. Twelve metrics comprise the IBI:

1. Number of Native Species
2. Number of Darter Species
3. Proportion of Headwater Species
4. Minnow Species
5. Sensitive Species
6. Proportion of Tolerant Species
7. Proportion of Omnivores
8. Proportion of Insectivores
9. Pioneering Species
10. Number of Individuals
11. Number of Simple Lithophilic Species
12. Proportion that are Deformed, have Eroded Fins, Lesions or Tumors (DELTs)

For WWH, the maximum possible IBI score is 60 and the minimum possible score is 12. The summation of the twelve individual metric scores provides a single-value IBI score, which corresponds to a narrative rating of *Exceptional, Good, Marginally Good, Fair, Poor* or *Very Poor.* An IBI score of ≥40 at headwater sites indicates attainment of the WWH biocriteria in the Erie Ontario Lake Plain ecoregion, with a non-significant departure of ≤4 IBI units. Therefore, an IBI score between 36 and 39 indicates the site is within non-significant departure of the WWH biocriteria for headwater sites and attains the WWH biocriterion for fish.

Results and Discussion

Site #10

The average IBI score at Site #10 was 21 (*Poor*) (Figure 3). The first electrofishing pass was on September 7 and an IBI score of 22 (*Poor*) was calculated for this site (Table 13). Only two species of fish were collected: common white sucker (2.61%) and creek chub (97.39%), both of which are highly pollution tolerant. Creek chubs favor a substrate of sand, gravel, boulders and bedrock (Trautman, 1981). The QHEI supports this species' habitat preference, with gravel and bedrock being the most prominent substrate types. The second electrofishing pass was on October 1 and obtained an IBI score of 20 (*Poor*) (Table 13). Creek chub was the only species collected during this pass. The QHEI at Site #10 was below the Ohio EPA target score of 60 (QHEI=56, *Good*); the site was not expected to support a community of warmwater habitat fish, which is evident by the low average IBI score that failed to meet the WWH IBI criterion. Additionally, CSO 212 (on Belvoir Boulevard, opposite Quilliams Avenue) which is approximately half a mile upstream of Site #10, averages an estimated 32 overflows per year. This suggests that contamination by sewage, usually accompanied by other pollutants, may also be preventing a healthy fish community at this site.

Table 13. IBI Scores

	IBI Scores				
River Mile/Site	Score			Narrative Rating	
	1st Pass	2nd Pass	Average	1st Pass	2nd Pass
Site #10	22	20	21	Poor	Poor
Site #9	12	12	12	Very Poor	Very Poor
RM 0.40	20	20	20	Poor	Poor

Site #9

Two electrofishing passes were conducted on Nine-Mile Creek Site #9, one on September 7 and another on October 1, resulting in an average IBI score of 12 and a narrative rating of *Very Poor* (Figure 3). In both instances, no fish were collected (Table 13). Habitat limitations may be a possible reason for the lack of fish, especially since the QHEI at this site was the lowest of all three sites (QHEI=52, *Fair*). The lack of a functional riffle and deep pools and poor channel morphology may have contributed to the complete lack of fish species collected. Additionally, the poor water chemistry results leading to seven exceedances of bacteria, cadmium, copper, selenium, ammonia, dissolved oxygen and mercury, may be another factor preventing a healthy fish community.

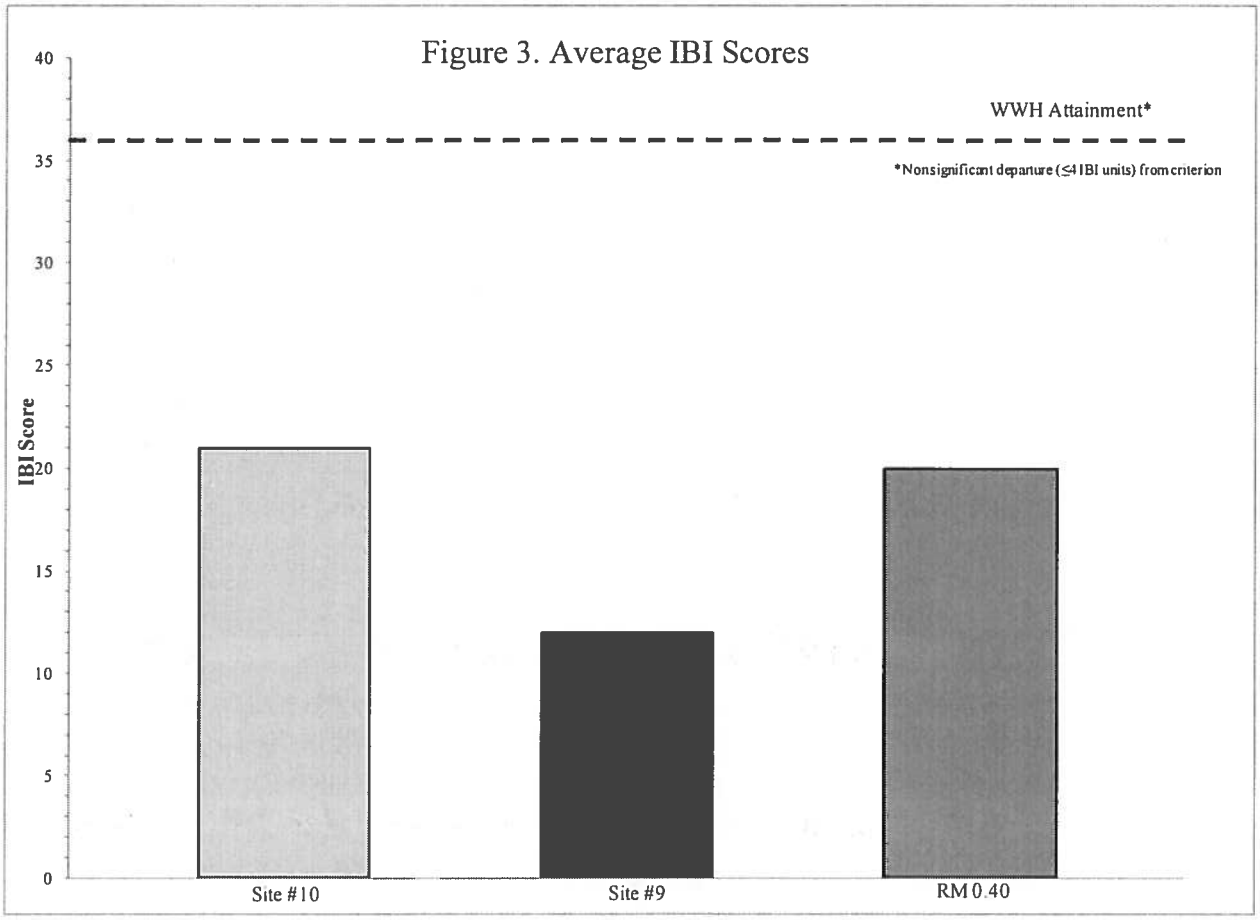
Average cadmium concentrations over the five sampling events at each site are shown in Table 14. Normal concentrations of total cadmium in rivers, streams and lakes range from 0.01 µg/L-0.07 µg/L (NPS, 1997). It is evident that all sites show higher than normal levels of total average cadmium; however, Site #9 was the only site in non-

attainment for all thirty-day periods. The high average concentration of cadmium at Site #9 may be one contributing factor in the deficient fish community.

Table 14. Nine-Mile Creek Average Cadmium Concentrations

Site	Average Cadmium Concentration (µg/L)
RM 0.40	0.668
Site #9	18.33
Site #10	0.101

Figure 3. Average IBI Scores



RM 0.40

During the first pass on Nine-Mile Creek at RM 0.40, which occurred on September 7, the fish community obtained a narrative IBI rating of *Poor* (Table 13). With an IBI score of 20, the majority of the fish collected consisted of highly tolerant and intermediately tolerant fish with the exception of a sand shiner, which is moderately intolerant and considered a sensitive species. Sand shiners prefer a habitat of sand and gravel with no silt. Additionally, this species is found in pools with considerable current

and avoids aquatic vegetation (Trautman, 1981). The QHEI results at this site support the habitat preferences of this species with gravel and sand being the most dominant substrate type, having moderate to normal silt quality and fast to slow current velocity with no aquatic vegetation present.

During the second electrofishing pass on Nine-Mile Creek RM 0.40, which occurred on September 30, the fish community obtained the same IBI score that was obtained on September 7 (IBI=20, *Poor*) (Table 13). Although no sand shiners were collected during the second pass, it did not affect the IBI score. The highest scoring metric for both passes was the Proportion with DELTs (metric=5). The *Poor* narrative rating, indicated by an average IBI score of 20, confirmed that the site failed to meet the WWH IBI (Figure 3). CSO 211 (east of Coit Road), which is located a little over half a mile upstream of RM 0.40, averages an estimated 77 overflows annually. Overflows from this CSO may discharge pollutants and bacteria that may be negatively impacting the fish community at this site.

Macroinvertebrate Sampling

Methods

Macroinvertebrates were sampled quantitatively for one six-week period in 2010 using a modified Hester-Dendy artificial substrate sampler (HD), in conjunction with a qualitative assessment performed during sampler retrieval. The modified HD is a type of passive sampling that has been utilized by the Ohio EPA since 1973 (DeShon, 1995). However, due to the loss of the HDs at all three sites on Nine-Mile Creek, quantitative sampling could not be performed. Qualitative samples were collected instead and compared to the Qualitative Community Tolerance Value (QCTV) score to help determine attainment status.

The QCTV score is the median pollution tolerance value calculated from the collected species that have an associated tolerance value recorded from a weighted ICI scoring. For an explanation on species tolerance values, refer to "Development and Application of the Invertebrate Community Index (ICI)" (DeShon, 1995). The QCTV score is used as a tool for assisting with the determination of attainment status. The QCTV score was obtained through hand calculation by Aquatic Macroinvertebrate Taxonomy (AMT) and based on the most recent Ohio EPA Macroinvertebrate Taxa List.

Higher QCTV scores are related to the presence of taxa associated with higher ICI scores. According to the Ohio EPA Technical Report MAS/1997-12-4 (1999), if the QCTV score in the Erie/Ontario Lake Plain (EOLP) ecoregion is greater than 37.15, it is associated with better water quality. A score between 37.15 (the 25th percentile) and 34.30 (the 75th percentile) implies that the attainment status cannot be determined from the QCTV score and instead, best professional judgment should be used to help determine attainment status. A score less than 34.30 indicates the presence of taxa seen

in waters that are typically associated with poorer water quality. Field sheets are available upon request from NEORSD's WQIS Division.

Macroinvertebrate qualitative samples were sent to AMT for identification and enumeration. Specimens were identified to the lowest practical taxonomic level as recommended in Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volume III* (1987, updated September 30, 1989; November 8, 2006; and August 26, 2008). The taxa lists and enumerations are available upon request from WQIS.

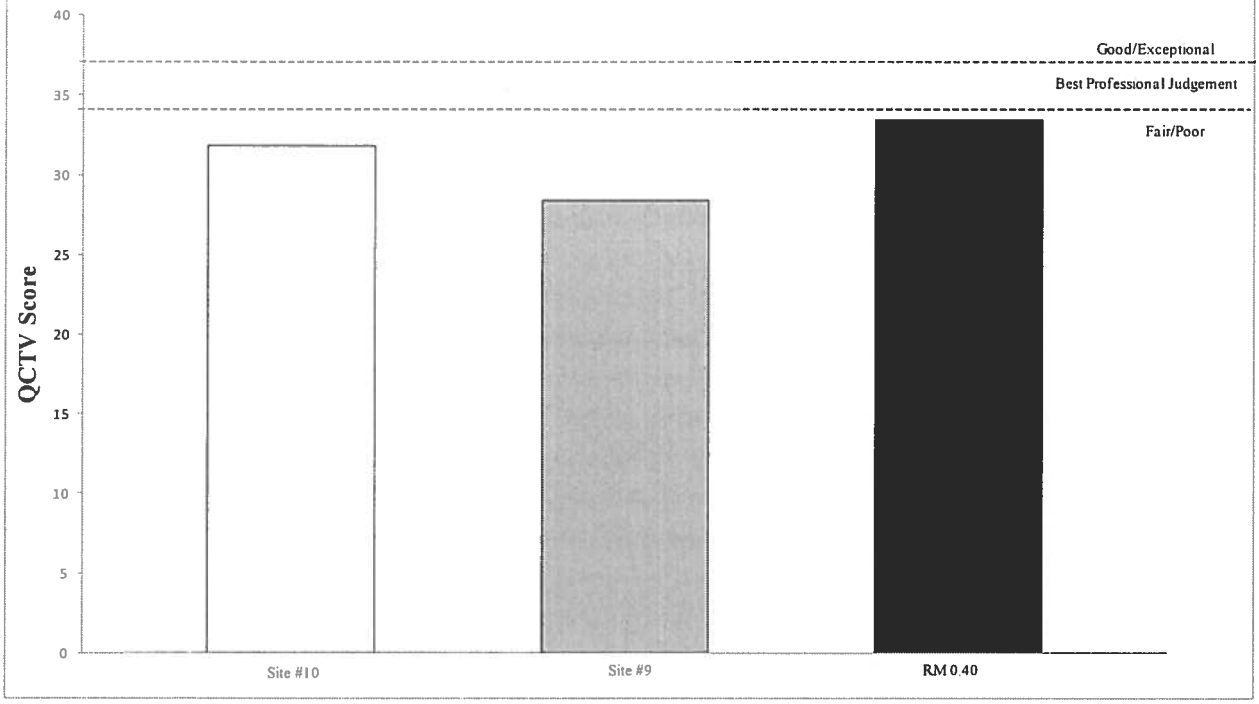
Results and Discussion

None of the three HDs that were installed could be located during HD retrieval. It is believed that the HDs either became buried or washed out during the colonization period. Therefore, qualitative macroinvertebrate sampling was performed at all sites on September 10. To help determine attainment status, a number of factors were considered, such as flow over the HD at the time of installation, comparison of the qualitative sample to the QCTV, water chemistry results, habitat quality and best professional judgment.

Site #10

Site #10 obtained a QCTV score of 31.85 (*Poor*) with a total of 15 taxa collected (Figure 4). One third of the sample consisted of EPT taxa, while the remainder was composed of dipterans and non-insects. Six taxa (40% of the sample) were considered pollution tolerant. Although riffle quality was fair (better than at RM 0.40 and Site #9), the margin quality was poor with a lack of suitable margin habitat to sample. Additionally, the site may not be ideal for a stable macroinvertebrate community as the riffles and runs tend to shift during elevated flows. This may cause the macroinvertebrate community to be easily scoured, thus reducing the chances of a population to properly colonize the site.

Figure 4. 2010 QCTV Scores



Site #9

A QCTV score of 28.4 (*Poor*) was obtained at Site #9 (Figure 4), with only three EPT taxa collected and the rest of the sample containing dipteran and non-insect taxa. With a total of 16 taxa collected, six were pollution tolerant (37.5% of the sample). Site #9 had the lowest QCTV score, which may be due to the poor riffle and margin quality, and/or the poor water chemistry results. Site #9 had seven water quality exceedances which were for *E. coli*, cadmium, copper, selenium, ammonia, dissolved oxygen and mercury. Benthic macroinvertebrates have been shown in a number of tests and studies to be negatively affected by metal contamination. Metals may cause toxicity to macroinvertebrates through individual level response, such as mortality, decreased growth and reproduction, as well as through community level responses, such as reduced density and species richness. Metals contamination may also cause a shift in the macroinvertebrate community to more tolerant organisms, which may be occurring at Site #9 (LeJeune et al., 2000).

RM 0.40

RM 0.40 obtained a QCTV score of 33.5 (*Fair/Poor*), which was the highest score of all the three sites (Figure 4). There were a total of 18 taxa collected during the qualitative sampling. Of these, only three were EPT taxa: *Baetis flavistriga, Cheumatopsyche* sp. and *Hydropsyche depravata* group. The remainder of the sample consisted of dipterans and non-insect organisms, except for two damselfly taxa. Eight taxa (44.4% of the sample) were considered pollution tolerant. The low QCTV score

may be due to the poor riffle and margin quality, possibly limiting the diversity of macroinvertebrates at this site.

Conclusions

The purpose of this study was to collect baseline data on Nine-Mile Creek before construction of the TDPS project and before the completion of the DIERS project. This data will be compared to data collected post-construction when the number of overflows per year to Nine-Mile Creek is expected to be reduced.

Water chemistry results at Nine-Mile Creek RM 0.40 and Site #10 indicate problems only with *E. coli* contamination and possible mercury exceedances. However, Site #9 had numerous water quality issues, which may be attributed to sanitary sewage entering the creek just upstream of the site. An investigation revealed that an SSO was discharging sanitary sewage to a storm sewer which was tributary to Nine-Mile Creek. The blockage was not cleared until after the completion of water chemistry sample collection, thus it is difficult to determine normal, baseline water quality at Site #9. However, a bacteriological sample collected after the blockage was cleared resulted in *E. coli* densities that were greatly reduced to a level below concern.

Habitat scores at Sites #9 and #10 were below Ohio EPA's WWH target score of 60. RM 0.40 was the only site to exceed the target goal, with a narrative rating of *Excellent*. The biological scores at all sites on Nine-Mile Creek were in non-attainment for both fish and macroinvertebrates.

It is anticipated that the water quality and biological scores will improve once construction is complete and the TDPS, DIERS and DST are fully in operation. Wet weather flow relief in the collection system, as well as a reduction of overflows as a result of these projects may help the biological and water quality of Nine-Mile Creek. Further environmental sampling may help determine the effectiveness of the projects and any improvement in water quality and biological communities.

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