

NORTHEAST OHIO REGIONAL SEWER DISTRICT

2008 West Creek Fish, Habitat, Benthic Macroinvertebrate, and Water Chemistry Baseline Survey Results



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Water Quality and Industrial Surveillances
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Introduction

During 2008, the Northeast Ohio Regional Sewer District¹ (NEORS) completed baseline assessments at sites on West Creek, a tributary to the Cuyahoga River (Figure 1). The baseline assessments in the creek were to assess the conditions of the creek prior to restoration activities that will start in 2009. The goals of these restoration projects are to improve existing in-stream habitat, construct additional in-stream habitat, remove or alter existing permanent structures that are preventing fish migration, and re-stabilize eroding stream banks utilizing bioengineered technology and natural channel design techniques. In 2006, sampling was conducted on West Creek that consisted of habitat and qualitative macroinvertebrate evaluations. The 2007 and 2008 sampling included electrofishing, benthic macroinvertebrate, water chemistry sampling, and habitat assessments. Sampling will again be performed once construction is complete to determine the effectiveness of the restoration. Figure 1 is a map of the sampling locations on West Creek, and Table 1 indicates the sampling locations and includes river mile (RM), latitude/longitude, description and the types of surveys conducted.

¹ Sampling was conducted by NEORS 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 NEORS study plan approved by Ohio EPA on July 2, 2008, *2008 West Creek Restoration Evaluation*. Data submitted to the Ohio EPA via the United States Postal Service on August 28, 2009.

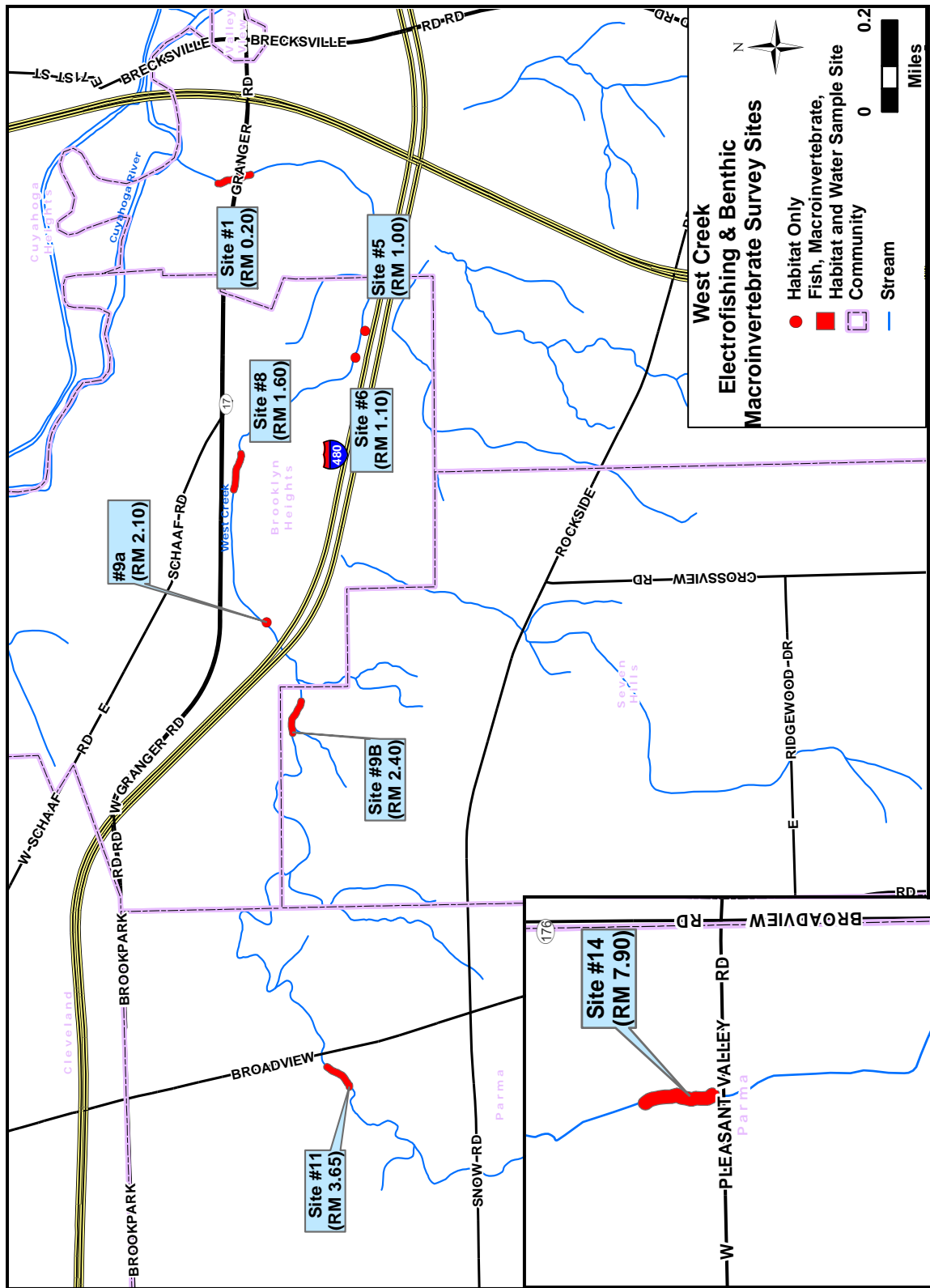


Figure 1. NEORS West Creek Biological, Habitat and Water Chemistry Sites

West Creek Fish, Habitat Baseline Survey Results
November 9, 2009

Table 1. 2008 West Creek Locations						
Location	Latitude	Longitude	River Mile	Description	Quadrangle	Purpose
Site #14	41.3630°N	81.6894°W	7.90	Downstream from West Pleasant Valley Road	Broadview Heights	Evaluate habitat, fish, & macroinvertebrate prior to restoration
Site #11	41.4122°N	81.6754°W	3.65	Upstream of Broadview Road	Cleveland South	Evaluate habitat, fish, & macroinvertebrate prior to restoration and removal of structure acting as fish migration barrier
Site #9B	41.4120°N	81.6747°W	2.40	Brooklyn Heights Park, upstream from I-480	Cleveland South	Evaluate habitat, fish, & macroinvertebrate prior to restoration and removal of structure acting as fish migration barrier
Site #9A	41.4134°N	81.7606°W	2.10	Downstream from I-480	Cleveland South	Evaluate habitat changes prior to restoration and removal of structure acting as fish migration barrier
Site #8	41.4144°N	81.6619°W	1.60	Downstream from Lancaster Drive Bridge	Cleveland South	Evaluate habitat, fish, & macroinvertebrate changes prior to restoration and removal of structure acting as fish migration barrier
Site #6	41.4097°N	81.6570°W	1.10	ODOT Concrete Flume	Cleveland South	Evaluate habitat changes prior to restoration and removal of structure acting as fish migration barrier
Site #5	41.4093°N	81.6556°W	1.00	Adjacent to Mercomp Landfill	Cleveland South	Evaluate habitat changes prior to restoration
Site #1	41.4152°N	81.6479°W	0.20	Between Granger & Schaaf Roads	Cleveland South	Evaluate habitat, fish, & macroinvertebrate changes prior to restoration

Water Chemistry Sampling

In 2008, water quality samples were collected from West Creek RMs 7.90, 3.65, 2.40, 1.60 and 0.20. The water quality samples were collected to determine base line data prior to the start of restoration activities in 2009. A total of thirty-five samples were collected from June 16, 2008, to July 30, 2008, at the five locations. All of the water chemistry sampling followed the *Manual of Ohio Environmental Protection Agency's*

(Ohio EPA) *Surveillance Methods and Quality Assurance Practices* (2006). This ensured that all the samples were collected in a consistent manner. Water quality monitoring of West Creek prior to the restoration will provide a baseline data set which after the restoration additional sampling will demonstrate any effect that the habitat improvement had on its ability to assimilate the different chemistry and the aquatic life encountered.

West Creek is in an urbanized area having one combined sewer overflow entering the creek at RM 2.0, Permit No. 3PA00002 063 (Ohio EPA 1997). The Ohio EPA has stated that the major chemical constraints to West Creek seem to be linked to storm water runoff, construction and failing household waste treatment systems (Ohio EPA 2003). There are approximately 700 household waste treatment systems in the West Creek Watershed (West Creek Preservation Committee [WCPC] 2005). The Ohio Department of Health (ODH) estimates a failure rate of the on-site waste treatment systems around twenty-five percent (ODH 2007). All of the communities surrounding West Creek are currently in the process of either eliminating the on-site waste treatment systems or are in the planning stages of connection to a sanitary collection system (WCPC 2005).

For each water quality sampling event a sample was collected in one 4-liter disposable polyethylene Cubitainer with disposable polypropylene lid and two 473-mL plastic bottles. Field parameters were measured in stream, when flow conditions permitted. A Surface Water Condition Sampling Field Data Form was completed for each sample collected. The plastic bottles were field preserved with either trace nitric acid or trace sulfuric acid. All samples were placed in a cooler with ice and stored on the locked vehicle until the samples were transferred to the NEORSD's Analytical Services sample receiving. All samples were released to an authorized Analytical Services employee with a Chain of Custody.

Field analyses included the use of a YSI-556 MPS Multi-Parameter Water Quality Meter to measure dissolved oxygen, water temperature, specific conductance and pH at the time of sampling. During the study it was necessary to utilize a Hanna HI 98129 for pH when the calibration on the YSI-556 MPS failed to meet quality assurance and quality control (QA/QC) requirements.

The quality assurance and quality control of water sample collections included obtaining a sample duplicate and a field blank during each sampling event. All seven of the field blanks appeared to be normal, and did not show signs of contamination from transporting the samples. The relative percent difference (RPD) for the duplicate samples was calculated using Formula 1 as follows:

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 site was analyzed for 42 chemical parameters, plus the field measurements. The sample and the sample duplicate were compared for each of the 40 individual parameters reported on the Certificate of Analysis. Only hardness and nitrate+nitrite parameters were not compared because they are calculated from other parameters. After an RPD was calculated, any difference greater than 30 percent was investigated as to the possible discrepancy. A total of 21 possible discrepancies were found. Seventeen of the possible discrepancies were less than 10 times the practical quantitation limit which is used to determine that the results were relatively small numbers and the slightest concentration value difference caused an increased RPD value. The remaining four (4) parameter discrepancies were associated with a wet weather sampling day².

No samples collected in 2007 and 2008 showed excursions from the applicable criteria of the Ohio Water Quality Standards. All Certificate of Analysis sheets and Surface Water Condition Sampling Field Data Forms are available for review from the NEORSD Water Quality and Industrial Surveillance, Environmental Assessment Group.

Habitat Assessment

Qualitative Habitat Evaluation Index (QHEI) scores were determined for eight proposed restoration sites in 2008. QHEI's were performed at RMs 0.20, 1.00, 1.10, 1.60, 2.10, 2.40, 3.65, and 7.90. The QHEI, developed by Ohio EPA, is used to assess the aquatic habitat conditions at each sample location by providing an evaluation of the physical components of a stream. The index is based on six metrics: stream substrate, instream cover, stream channel morphology, riparian and bank condition, pool and riffle quality and stream gradient. These metrics describe the physical attributes of a stream and may be important in explaining why fish species are present or absent. A more detailed description of the QHEI can be found in Ohio EPA's (2006), *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index*

² Wet weather sampling events: greater than 0.10 inches of rain but less than 0.25 inches, samples collected that day and the following day are considered wet weather samples; greater than 0.25 inches, the samples collected that day and the following two days were considered wet weather samples.

(*QHEI*). The *QHEI* results for 2006, 2007 and 2008 are provided in Table 2. *QHEI* field sheets for each site are available upon request.

Table 2. West Creek <i>QHEI</i> Scores				
Location	RM	2006	2007	2008
Downstream from West Pleasant Valley Road	7.90	61.75 (G)	55.00(G)	53.50 (F)
Upstream of Broadview Road	3.65	43.50 (F)	43.75 (F)	48.50 (F)
Brooklyn Heights Park, upstream from I-480	2.40	51.25 (F)	48.00 (F)	47.00 (F)
Downstream from I-480	2.10	42.50 (F)	48.50 (F)	47.00 (F)
Downstream from Lancaster Drive Bridge	1.60	48.25 (F)	60.50(G)	73.00 (E)
ODOT Concrete Flume	1.10	38.75 (P)	42.25 (P)	41.75 (P)
Adjacent to Mercomp Landfill	1.00	61.00 (G)	63.25(G)	47.50 (F)
Adjacent to I-480 and Independence Concrete Recycling	0.56	51.00 (F)	---	---
Adjacent to Independence Concrete Recycling	0.40	60.25 (G)	---	---
Upstream of Schaaf Road	0.25	51.25 (F)	---	---
Between Granger & Schaaf Roads	0.20	56.00 (G)	51.50 (F)	55.00(G)
(E)-Excellent (G)-Good (F)-Fair (P)-Poor				

RM 0.20 Granger Road and Schaaf Road

This site obtained a *QHEI* score of 55.00 in the *Good* range. The habitat zone begins under the Schaaf Road Bridge and extends beyond the Granger Road Bridge. This section of West Creek was primarily a gravel sand substrate with instream cover consisting of overhanging vegetation, shallows, rootmats, boulders and woody debris. Little erosion was noted along both banks which were at steep angles. The land use in the area is primarily urban and industrial and the riparian habitat width is very narrow.

RM 1.00 Adjacent to Mercomp Landfill

This site obtained a *QHEI* score of 47.50 in the *Fair* range. This straightened section of stream is bordered by a landfill on river left and Interstate 480 on river right. The instream habitat cover consisted of undercut banks, shallows, rootmats, and boulders. A moderate stable channel with low sinuosity also contributed to lower scores. Cobble and gravel were the main substrate types and the creek had only a few, shallow pool areas. This urban/industrial setting site had no riparian width.

RM 1.10 ODOT Concrete Flume

This site obtained *QHEI* score of 41.75 in the *Poor* range. Although this site contains more than four types of substrate, the predominant type was artificial since a concrete flume is located within this section of stream. This site is bordered by a landfill

on river left and Interstate 480 on river right. The flume precludes development of riffle/pool complexes. Sparse amounts of instream cover of marginal quality were noted at this site.

RM 1.60 Downstream of Lancaster Drive

This site obtained a QHEI score of 73.00 in the *Excellent* range. This site is located downstream of Lancaster Drive. Moderate amounts of instream cover consisting of undercut banks, overhanging vegetation, shallows, rootmats, deep pools, rootwads, boulders, aquatic macrophytes and woody debris were all present in 2008. The bank on river right, which abuts a commercial development, was steep with areas of severe erosion. The bank on river left borders Granger Road, but offers a wider riparian habitat width of better flood plain quality.

RM 2.10 Downstream from I-480

This site obtained a QHEI score of 47.00 in the *Fair* range. This site begins where the creek exits the culvert under Interstate 480. The predominant substrate type in this section was bedrock. The habitat was primarily a shallow run/glide with sparse amounts of marginal quality instream cover types and no overhanging vegetation present. The riffle/pool complexes were poorly developed and both banks exhibited moderate to severe erosion. Commercial development borders the southeast banks, eliminating the riparian habitat. The riparian habitat along the northwest bank varies in width and land use.

RM 2.40 Brooklyn Heights Park upstream of I-480

This site obtained a QHEI score of 47.00 in the *Fair* range. This section of creek has a 'very high' gradient (63.6 feet per mile) with a predominant bedrock substrate. The instream cover types were limited to overhanging vegetation, rootmats, shallows, boulders, and logs or woody debris. Moderate erosion was noted along both banks. A break in the stream water, acting as a riffle, was present however, this was caused by the bedrock cut along the bottom. A zero was scored for the riffle metric. This site is located within the City of Brooklyn Heights Park and possesses a wide riparian width consisting of a forest, residential/park flood plain quality.

RM 3.65 Upstream of Broadview Road

This site obtained a QHEI score of 48.50 in the *Fair* range. This site, located upstream of Broadview Road, has a predominant bedrock substrate throughout the creek. Instream cover consisting of rootmats, boulders, shallows, overhanging vegetation and woody debris were observed in the creek. This site lacked well-defined pools and riffles and was predominately a shallow run habitat. Since the substrate consisted of bedrock,

no functional riffles were present. The surrounding land use in the area is primarily residential and urban.

RM 7.90 Pleasant Valley Road

This site obtained a QHEI score of 53.50 in the *Fair* range. Located downstream of West Pleasant Valley Road, this site exhibited moderate amounts of instream habitat cover. Sand and bedrock were the main substrate types. This section of the creek had a slow current velocity and was predominately a pool and glide habitat. The surrounding land use consists of residential and forest habitat.

Electrofishing

Electrofishing Methods

Electrofishing was conducted one time at each site in 2008. Sampling was conducted using longline electrofishing techniques and consisted of shocking all habitat types within a sampling zone, which was 0.15 kilometers in length, while moving from downstream to upstream. The methods that were used followed Ohio EPA protocol methods described in *Biological Criteria for the Protection of Aquatic Life, Volume III: Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities* (1987). Fish were identified to species level, counted, and examined for the presence of external anomalies including deformities, erosions, lesions, and tumors (DELTs). The results from this sampling were used to calculate Index of Biotic Integrity (IBI) scores for each site.

A list of the species, numbers, pollution tolerances and incidence of DELT anomalies for fish collected during the electrofishing passes at each site is available upon request.

Electrofishing Results

Table 3 shows the IBI scores that were calculated for each site. None of the sites met the Warmwater Habitat (WWH) criterion for headwater sites (Figure 2).

RM 0.20 Granger Road and Schaaf Road

A score of 34 (*Fair*) was obtained at this site and was the highest of the five sites sampled on West Creek. Since this site is the most downstream site and closest to the Cuyahoga River, migratory species coming from the Cuyahoga River may have influenced the fish community scores. IBI metric scores of 5 were obtained for the high

number of minnow species (7), low proportion of pioneering species (13.7%) and low proportion of omnivores (10.5%) present.

RM 1.60 Downstream of Lancaster Drive

A score of 26 (*Poor*) was obtained at this site in the creek in 2008. The predominant fish collected were blacknose dace and central stoneroller minnow. These two species accounted for 89.9% of the total catch. IBI metric scores of 5 were obtained for low proportion of DELTs (0%), low proportion of pioneering species (9.3%) and low proportion of omnivores (0.93%) present.

RM 2.40 Brooklyn Heights Park upstream of I-480

A score of 30 (*Fair*) was obtained at this site in 2008. Eighty-eight percent of the total catch was predominantly blacknose dace and central stoneroller minnows. In 2008, IBI metric scores of 5 were obtained for low proportion of DELT's (0%), low proportion of pioneering species (8.3%) and low proportion of omnivores (3.2%) present. The bedrock substrate, poor channel development, and no functional riffle are limiting factors to a more diverse fish community.

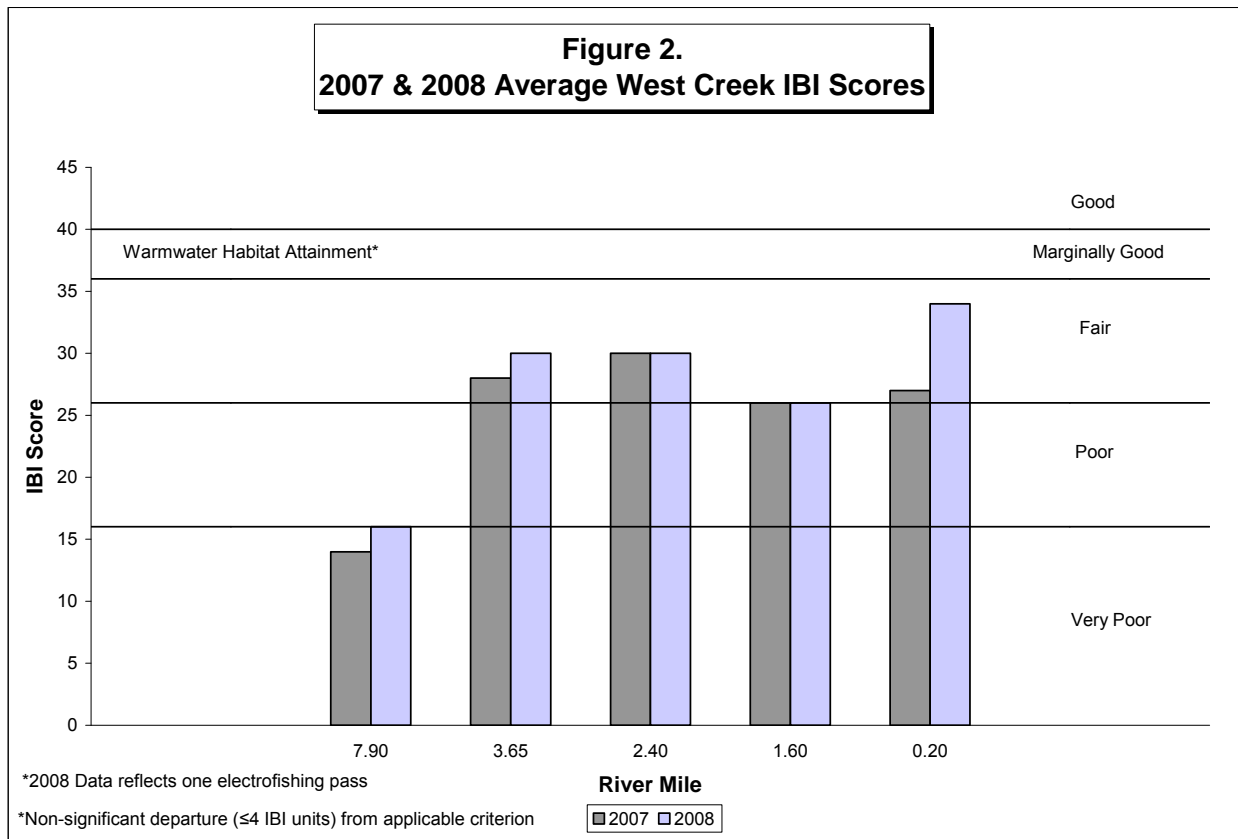
RM 3.65 Upstream of Broadview Road

A score of 30 (*Fair*) was obtained at this site in 2008. As with the previous two sites (RM 2.4 and RM 1.6), the predominant fish collected were blacknose dace and central stoneroller minnow. These fish accounted for 87.3% of the total catch. In 2008, IBI metric scores of 5 were obtained for low proportion of DELT's, low proportion of pioneering species and low proportion of omnivores present. As with RM 2.40, the bedrock substrate and no functional riffle were prominent are limiting factors affecting fish diversity.

RM 7.90 Pleasant Valley Road

Of the sites sampled, the most upstream one, located downstream of West Pleasant Valley Road at RM 7.90, did the poorest. In 2008, a score of 16 (*Poor*) was obtained. Thirty-nine Northern fathead minnows and one yellow bullhead comprised the total catch for this site. Although the QHEI score at this site was *Fair* in 2008, this section of the creek had a slow current velocity and was predominately a pool and glide habitat. This may have influenced the fish community at this location. Once the remediation work of re-establishing the old wetland, and debris removal takes place just downstream of the sampling zone, an improvement in the fish community should be evident.

Year	Site	RM	2007			2008
			Pass 1	Pass 2	Average	Pass 1
	DS West Pleasant Valley Road	7.90	12	16	14	16
	US Broadview Road	3.65	26	30	28	30
	Brooklyn Heights Park	2.40	30	30	30	30
	DS Lancaster Drive	1.60	26	26	26	26
	DS Schaaf Road	0.20	20	34	27	34



Fish and Habitat Discussion

The QHEI narrative rating at RM 0.20 went from *Fair* in 2007 to *Good* in 2008 and the reason the score was slightly higher in 2008 is that there was more instream cover consisting of overhanging vegetation and logs and woody debris present. This is the closest site to the Cuyahoga River. Pollution intolerant species collected from this area may have entered from the Cuyahoga River which could influence the fish community

scores. QHEI scores were obtained in the *Good* and *Fair* range in 2006 and 2007, (56.00 and 51.50) respectively. Fish Index scores were relatively the same in 2008 as in 2007 with the IBI score the same as the second pass (34).

QHEI scores at RM 1.00 scored lower in 2008 compared to 2007 based on a habitat assessment of shallow poorly developed pools and slightly less instream cover present. QHEI scores were obtained in the *Good* range in 2006 and 2007, (61.00 and 63.25) respectively.

QHEI scores at RM 1.60 were in the *Fair* and *Good* range in 2006 and 2007, (48.25 and 60.50) respectively. In 2008 a score of 73, *Excellent* was obtained. In 2007, the stream habitat lacked undercut banks, overhanging vegetation, rootwads, aquatic macrophytes and woody debris. The improvement in the score was the result better in-stream cover in 2008. The high quality habitat and the low fish index scores could be explained by the concrete flume which is acting as a fish migration barrier to the site.

For RM 7.90, in 2007, for both passes, a total of 24 fish were collected. IBI scores of 12 and 16 were obtained on each of the passes, which were the result of extremely low numbers of fish that were collected. In 2008, 39 fathead minnows and one yellow bullhead comprised the total catch at this site with an IBI score of 16 (Very Poor). A *Fair* (53.5) QHEI score was obtained in 2008.

Macroinvertebrate Sampling

Macroinvertebrate Sampling Methods

Macroinvertebrates were sampled for a six-week period in 2008 using a modified multiplate Hester-Dendy (HD) sampler. Five replicates of these artificial substrate samplers were affixed to a cinder block and deployed at each location. The HD sampler was used to conduct a quantitative assessment and a qualitative assessment was conducted, in accordance with Ohio EPA protocols. The qualitative assessment was completed during retrieval of the HD, at which time all available habitats were actively sampled with a dip net. A Marsh-McBirney FloMate Model 2000 Portable Flow Meter, which measures velocity in feet per second (fps), was used during deployment and retrieval of the HD to measure stream (flow or velocity).

The overall aquatic macroinvertebrate community was evaluated using Ohio EPA's Invertebrate Community Index (ICI). The ICI consists of ten community metrics based on drainage, each with four different scoring categories. Metrics 1-9 are based on the quantitative sample, while Metric 10 is based on the number of Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) in the qualitative sample.

Metric 10 is also referred to as the EPT taxa. The total of the ten individual metric categories determine the ICI score. The higher the ICI score, the less of a deviation from relatively unimpacted reference sites utilized by the Ohio EPA for each eco-region.

Quantitative and qualitative macroinvertebrate samples were shipped to EA Engineering, Science and Technology, Incorporated, for identification and enumeration. Specimens were identified to the lowest practical taxonomic level, as defined by Ohio EPA (1987), when life stage and condition allowed. The taxa lists and enumerations are available upon request.

In order for a direct comparison of the ICI results, some deployment recommendations should be adhered to. During deployment, if the flow for an HD is under 0.3 fps, the data should be used with caution. This is because the stream flow over the HD has been determined to have one of the greatest influences on the macroinvertebrate community represented, second to only water quality (DeShon 1995). The ICI metrics are also not calibrated to drainage areas less than 10 square miles. Therefore, when calculating the ICIs with drainage areas less than 10 square miles, 10 square miles were used.

Macroinvertebrate Sampling Results and Discussion

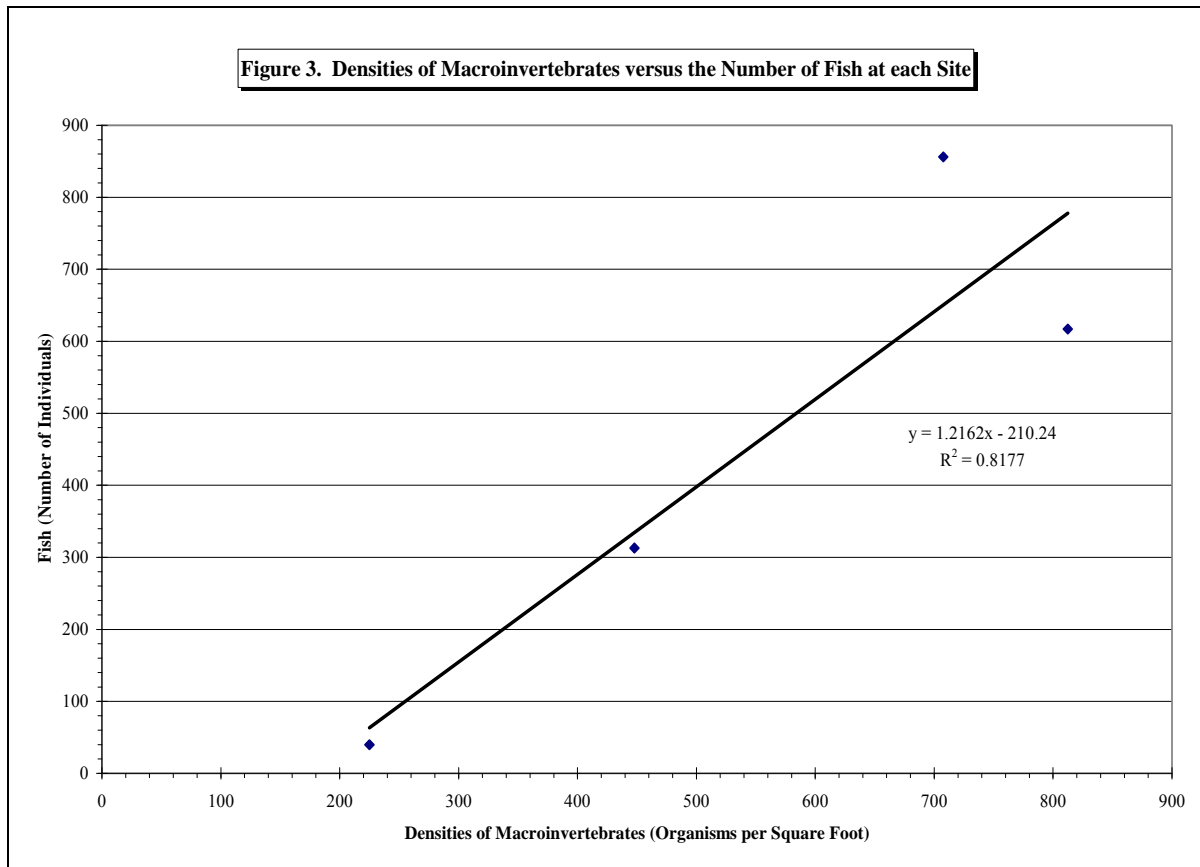
In 2008, all of the sites were in attainment for the WWH ICI criterion, except for RM 7.90. In Table 4, the 2008 sampling results are summarized. The identification and enumeration of the collections can be made available upon request.

Table 4. 2008 West Creek Assessment				
River Mile	Retrieval Date	ICI Score*	Predominant Organism(s) in Qualitative Sampling	Comments
7.90	07/29/08	24	Baetids	Current less than 0.3 fps, Drainage less than 10 square miles
3.65	07/29/08	36	Baetids, Caddisflies	Drainage less than 10 square miles
2.40	08/26/08	32	Net-spinning Caddisflies, Baetids	Drainage less than 10 square miles
1.60	07/29/08	30	Midges, Baetids	Current less than 0.3 fps, Drainage less than 10 square miles
0.20	07/28/08	32	Baetids	
* WWH for the ICI Criterion is ≥ 34 units: Non-significant departure from attainment is ≤ 4 units				

The community composition is essential in determining the quality of the stream. Even though most of the communities were in attainment, about 60 percent of the community's compositions from the sites were either pollution tolerant species or other organisms that are not included in the positive scoring metrics. Macroinvertebrate community composition will improve, as pollution tolerant species or other organisms compositions decrease over time.

West Creek was sampled qualitatively in 2006 and both quantitatively and qualitatively in 2007. However, in 2007, due to under preservation of some of the samples, only two of the sites received ICI scores. The ICI scores for RMs 3.65 and 7.90 in 2007 were 40 and 22, respectively. The 2007 ICI scores for these sites were consistent with the 2008 scores. The qualitative sampling in 2006 occurred in October, and those results will not be included for comparison because macroinvertebrate sampling ends on the last day of September.

Figure 3 compares the densities of macroinvertebrates to the number of fish collected at sites that are located upstream of permanent in-stream structures impeding fish migration within the creek and from the Cuyahoga River. RM 0.20 is the only sample site that does not have any permanent in-stream structures affecting fish migration, therefore, the data from this site was not included in Figure 3. A linear relationship was exhibited. As the density of macroinvertebrates increased at each site, so did the number of fish. With the completion of the restoration projects and removal or alteration of permanent in-stream structures affecting fish migration within the creek and from the Cuyahoga River, a more diverse fish community is expected to be established in the future.



Conclusions

Table 5 shows the attainment status of West Creek for the 2008 study period. The IBI criterion was not met at any of the sites. All sites except one, RM 7.90, met the ICI criterion. The water chemistry samples also showed no excursions of the applicable water quality standards.

Table 5. West Creek 2008 Attainment Status for Biological Criterion				
River Mile	Attainment Status	IBI	ICI	Relative Location
7.90	Non-Attainment	16	24	Downstream of West Pleasant Valley Road
3.65	Partial Attainment	30	36	Upstream Broadview Road
2.40	Partial Attainment	30	32	Brooklyn Heights Park
1.60	Partial Attainment	26	30	Downstream of Lancaster Drive
0.20	Partial Attainment	34	32	Downstream of Schaaf Road
Warmwater Habitat Criterion		≥40	≥34	
Nonsignificant Departure from Criterion		≤4	≤4	

The overall macroinvertebrate community appears to be relatively healthy in West Creek, except for at RM 7.90. The community limitations at RM 7.90 are most likely due to undesirable habitat conditions coupled with the low drainage area.

The fish communities in West Creek ranged from poor to fair at the five electrofishing sites. The lack of a diverse fish community at most of the sites appears to be a result from either specific habitat limitations or permanent in-stream structures impeding fish migration. Restoration projects on West Creek that are scheduled to begin in 2009 will attempt to establish better habitat and remove permanent in-stream structures impeding fish migration within the creek and from the Cuyahoga River. Future monitoring, once restoration is complete, will determine project effectiveness and any changes in the biological communities.

Reference List

- Ohio EPA. 1987. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Division of Water Quality Monitoring and Assessment. Columbus, Ohio. Last updated: August 2008.
- DeShon, J.E. 1995. Development and Application of the Invertebrate Community Index (ICI). In: Davis and Simon, editors. Biological assessment and criteria, tools for water resource planning and decision making. Boca Raton, FL: Lewis Publishers; 1995. p 217-43.
- Ohio EPA. 1997. NEORSO Ohio EPA NPDES Permit No. 3PA00002*ED. Ohio Environmental Protection Agency. Columbus, Ohio. February 24, 1997.
- Ohio EPA. 2003. *Total Maximum Daily Loads for the Lower Cuyahoga River*. Ohio Environmental Protection Agency, Division of Surface Water. Columbus, Ohio. September 2003.
- West Creek Preservation Committee. July 2005 revised December 2008. Website accessed at: <http://www.westcreek.org/Final%20WSAP%2012-15-08.pdf> Last Accessed on June 11, 2009. Parma, Ohio.
- Ohio EPA. 2006. *Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices*. Ohio Environmental Protection Agency, Division of Surface Water, Division of Environmental Services. Columbus, Ohio.
- Ohio Department of Health. 2007. website: <http://www.odh.ohio.gov/ASSETS/22E1223A9A9A4E5AB044E91B0A7AF61C/InfraFS.pdf> Last Accessed on June 11, 2009. Columbus, Ohio.