NORTHEAST OHIO REGIONAL SEWER DISTRICT

2017 Tinkers Creek Environmental Monitoring
Biological, Water Quality and Habitat Survey Results

Prepared by:
Water Quality and Industrial Surveillance
Division

Introduction

The lower Cuyahoga River has been designated as one of 42 Great Lakes Areas of Concern (AOC) by the International Joint Commission. Past monitoring indicated impairment of aquatic biota in the river and was the basis for the establishment of Total Maximum Daily Loads (TMDLs) for the Lower Cuyahoga River. The causes of impairment to the river were classified as organic enrichment, toxicity, low dissolved oxygen, nutrients, and flow alteration (Ohio EPA, 2003). Recent monitoring by the Northeast Ohio Regional Sewer District (NEORSD), however, has shown recovery of the biological community in some reaches of the river. Further monitoring throughout the watershed is necessary to determine what areas may be still impaired.

In 2017, NEORSD conducted environmental assessments including water chemistry sampling, habitat assessments, and fish and macroinvertebrate community surveys on Tinkers Creek, a tributary to the Cuyahoga River. The objective of this study was to conduct environmental monitoring on Tinkers Creek, and its tributary Wood Creek, in addition to four other tributaries to the Cuyahoga River as part of NEORSD's general watershed monitoring program. Portions of the tributary data collected will provide additional information to support the continued monitoring of the lower Cuyahoga AOC and the potential delisting of some beneficial use impairments.

Sampling was conducted by the NEORSD Environmental Assessment group of the Water Quality and Industrial Surveillance (WQIS) Division and occurred from June 15 through September 30, 2017 (through October 15 for fish sampling assessments), as required in the Ohio EPA *Biological Criteria for the Protection of Aquatic Life Volume III* (1987b). Sampling was conducted by NEORSD Level 3 Qualified Data Collectors (QDCs) certified by Ohio EPA in Fish Community and Benthic Macroinvertebrate Biology, and Chemical Water Quality and Stream Habitat Assessments as explained in the NEORSD study plan *2017 Cuyahoga River Tributaries Environmental Monitoring* approved by Ohio EPA on May 12, 2017.

Figure 1 is a study area map, noting the location of the sampling location evaluated during the 2017 study. Table 1 indicates the sampling location for the study sites on Tinkers Creek and Wood Creek with respect to river mile, latitude/longitude, description, and the types of surveys conducted. A digital photo catalog of the sampling locations is available upon request by contacting the NEORSD WQIS Division.
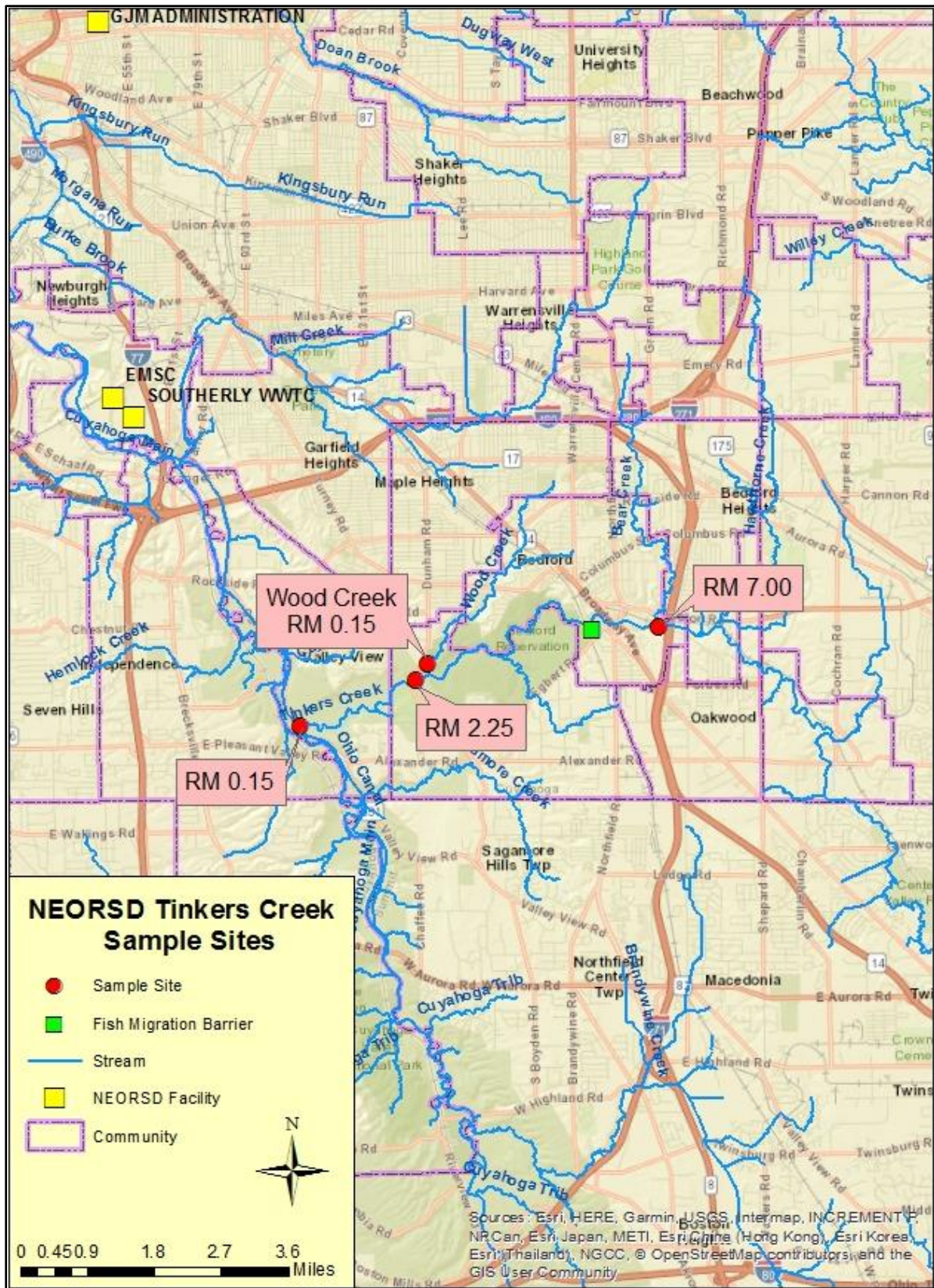
Figure 1. 2017 Tinkers Creek Monitoring Sites

Table 1. Tinkers Creek Evaluated Sites						
Site Location	Latitude	Longitude	River Mile	Description	HUC 8	Purpose
Tinkers Creek	41.38388	-81.51543	7.00	Upstream of Northfield Road Bridge. Metroparks Bedford Chagrin Parkway.	04110002 - Cuyahoga	General watershed monitoring.
Tinkers Creek	41.37404	-81.57854	2.25	Upstream of Dunham Road	04110002 - Cuyahoga	General watershed monitoring. Support Cuyahoga AOC.
Tinkers Creek	41.3654	-81.6083	0.15	Upstream of Canal Road	04110002 - Cuyahoga	General watershed monitoring. Support Cuyahoga AOC.
Wood Creek, Tinkers Creek Tributary	41.37726	-81.57523	0.15	Upstream of Button Road	04110002 - Cuyahoga	General watershed monitoring. Support Cuyahoga AOC.

Water Chemistry Sampling

Methods

Five separate water chemistry and bacteriological sampling events were conducted between July 26th and August 23, 2017. Techniques used for sampling and analyses were conducted according to methods found in *Surface Water Field Sampling Manual for water quality parameters and flows* (Ohio EPA, 2015b). Chemical water quality samples from each site were collected with a 4-liter disposable polyethylene cubitainer with a disposable polypropylene lid, three 473-mL plastic bottles and one 125-mL plastic bottle. The first 473-mL plastic bottle was field preserved with trace nitric acid, the second was field preserved with trace sulfuric acid, and the third bottle received no preservative. The sample collected in the 125-mL plastic bottle (dissolved reactive phosphorus) was filtered using a 0.45-µm PVDF syringe filter. All water quality samples were collected as grab samples. Bacteriological samples were collected in sterilized plastic bottles preserved with sodium thiosulfate. At the time of sampling, measurements for dissolved oxygen, pH, temperature, and conductivity were collected using either a YSI 600XL sonde or YSI EXO1 sonde. Duplicate samples and field blanks were each collected at randomly selected sites, at a frequency not less than 5% of the total samples collected. Relative percent difference (RPD) was used to determine the degree of discrepancy between the primary and duplicate sample (Formula 1).

$$\text{Formula 1:} \qquad \text{RPD} \ = \ \left(\frac{|x-y|}{((x+y)/2)} \right) \ * \ 100$$

x= is the concentration of the parameter in the primary sample

y= is the concentration of the parameter in the duplicate sample

The acceptable percent RPD is based on the ratio of the sample concentration and detection limit (Formula 2) (Ohio EPA, 2015b).

Formula 2: Acceptable % $RPD = [(0.9465x^{-0.344})*100] + 5$

x = sample/detection limit ratio

Those RPDs that are higher than acceptable may indicate potential problems with sample collection and, as a result, the data was not used for comparison to the water quality standards.

Mercury analysis for all the sampling events was completed using EPA Method 245.1. Because the detection limit for this method is above the criteria for the Human Health Nondrinking and Protection of Wildlife OMZA, it generally cannot be determined if Tinkers Creek was in attainment of those criteria. Instead, this type of mercury sampling

was used as a screening tool to determine whether contamination was present above those levels typically found in the stream.

Water chemistry analysis sheets for each site are available upon request from the NEORSD WQIS Division.

Results and Discussion

For the 2017 study, two duplicate samples and two field blanks were collected for quality assurance and quality control (QA/QC) purposes. The duplicate samples were collected at Tinkers Creek RM 0.15 on July 26, 2017, and Tinkers Creek RM 7.00 on August 16, 2017. While there were no rejections to report for the duplicate sample collected at Tinkers Creek RM 0.15, five parameters in the Tinkers Creek RM 7.00 duplicate sample, barium (Ba), potassium (K), manganese (Mn), molybdenum (Mo), and zinc (Zn); were rejected based on RPD values outside of the acceptable RPD range (Table 2). The date in which this sample was collected was not considered wet weather[1]. Therefore, the reason for the unacceptable difference between the samples remains unknown, but potentially could be due to lack of precision and consistency in sample collection and/or analytical procedures, environmental heterogeneity, and/or improper handling of samples.

Table 2. Duplicate Parameter Analysis					
Site	Date	Parameter	Acceptable RPD (%)	Actual RPD (%)	Qualifier
Tinkers Creek RM 7.00	8/16/2017	Ba	20.4	24.9	Rejected
		K	28.5	30.0	Rejected
		Mn	22.0	63.3	Rejected
		Mo	34.8	46.9	Rejected
		Zn	35.0	65.0	Rejected

Two field blank samples were collected in the 2017 sampling season, one at Wood Creek RM 0.15 on August 9, 2017; and another at Tinkers Creek RM 2.25 on August 23, 2017. For the field blanks, there were ten parameters that showed possible contamination. It is unclear how the field blank became contaminated and may be due to inappropriate sample collection, handling, and/or contaminated blank water. Table 3 lists water quality parameters that were listed as estimated based on Ohio EPA data validation protocol.

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[1] 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 are considered wet weather samples.

Table 3. Parameters Affected by Possible Blank Contamination
Cr
Sn
Zn

Paired parameters for all samples collected from each of the four sampling sites on Tinkers Creek and Wood Creek were evaluated for QA/QC purposes. The comparisons revealed no rejected data for the sampling sites, and one set of parameters with estimated data on several sampling dates (Table 4). Because there were no exceedances associated with these parameters, qualification of these results did not significantly change the overall water chemistry assessment of Tinkers Creek and Wood Creek.

Table 4. Paired Data Parameter Analysis						
Site	Date	Parameter	Data Pair	Acceptable RPD (%)	Actual RPD (%)	Qualifier
Tinkers Creek RM 7.00	7/26/2017	*TS*	*TDS*	16.1	1.0	Estimated
	8/23/2017*	*TS*	*TDS*	16.1	12.1	Estimated
Tinkers Creek RM 2.25	7/26/2017	*TS*	*TDS*	16.8	16.3	Estimated
	8/16/2017	*TS*	*TDS*	15.0	3.4	Estimated
Tinkers Creek RM 0.15	7/26/2017	*TS*	*TDS*	16.5	8.3	Estimated
Wood Creek RM 0.15	7/26/2017	*TS*	*TDS*	15.1	7.4	Estimated

* - Wet-Weather Event

Tinkers Creek is designated as a State Resource Water (SRW), Warmwater Habitat (WWH), Agricultural Water Supply (AWS), Industrial Water Supply (IWS), and Primary Contact Recreation (PCR). As a tributary to Tinkers Creek, Wood Creek is designated as WWH, AWS, IWS, and PCR. The primary contact recreational use criteria apply for *Escherichia coli* (*E. coli*). The water chemistry samples collected at each site were compared to the applicable Ohio Water Quality Standards for the designated uses to determine attainment (Ohio EPA, 2015a).

Water chemistry sampling at Tinkers Creek RMs 0.15, 2.25, and 7.00, as well as Wood Creek RM 0.15, in 2017 revealed mercury concentrations that were below the method detection limit for EPA Method 245.1. It is expected that the use of EPA Method 1631E, a low-level method, instead of EPA Method 245.1, would have resulted in exceedances of the criteria throughout the sampling period. Mercury may be introduced into Tinkers Creek and Wood Creek from urban runoff within the watershed.

The Primary Contact Recreation criteria for Tinkers Creek and Wood Creek include an *E. coli* criterion not to exceed a Statistical Threshold Value (STV) of 410 colony counts/100mL in more than ten percent of the samples taken during any 90-day period, and a 90-day geometric mean criterion of 126 colony counts/100mL (Ohio EPA, 2015a). Tinkers Creek and Wood Creek exceeded the primary contact recreation 90-day geometric mean at all sites. A wet-weather event occurred on August 23, 2017, and therefore, stormwater runoff may have contributed to these exceedances. *E. coli* exceedances may also have been impacted by possible failing home septic systems in the surrounding residential areas upstream of and adjacent to all of the sampling locations. The STV criterion was also exceeded for all the 90-day periods throughout the study for all the sampling sites on Tinkers Creek and Wood Creek (Table 5). Apart from the probable mercury exceedances and the exceedances for *E. coli*, the sampling locations on Tinkers Creek and Wood Creek met all other water quality criteria for the 2017 season.

Table 5. *E. coli* Exceedances				
Site	Sample Date	Sample Density (Most Probable Number /100ml)	90-Day Geometric Mean (Colony Counts /100ml)	Statistical Threshold Value (% Days >410 Colony Counts /100ml)
Tinkers Creek RM 7.00	7/26/2017	252	265.4	20.0
	8/2/2017	230	268.9	25.0
	8/9/2017	171	283.3	33.3
	8/16/2017	108	364.6	50.0
	8/23/2017*	1231	1231.0	100.0
Tinkers Creek RM 2.25	7/26/2017	131	141.4	20.0
	8/2/2017	76	144.2	25.0
	8/9/2017	90	178.5	33.3
	8/16/2017	54	251.4	50.0
	8/23/2017*	1170	1170.0	100.0
Tinkers Creek RM 0.15	7/26/2017	177	195.8	20.0
	8/2/2017	68	200.8	25.0
	8/9/2017	106	288.0	33.3
	8/16/2017	112	474.8	50.0
	8/23/2017*	2013	2013.0	100.0
Wood Creek RM 0.15	7/26/2017	237	145.3	20.0
	8/2/2017	54	128.6	25.0
	8/9/2017	72	171.7	33.3
	8/16/2017	74	265.1	50.0
	8/23/2017*	950	950.0	100.0

Shading = Exceedance of the criterion
* - Wet-Weather Event

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, 2015c). NEORSD did not assess DO swings or benthic chlorophyll *a* in 2017; however, nutrients were assessed.

Table 6 shows the mean calculated nutrient concentrations for the Tinkers Creek and Wood Creek sites assessed in 2017. The results of dissolved inorganic nitrogen and total phosphorous were compared to Table 2 listed in the SNAP document. According to this section of SNAP, Tinkers Creek RMs 0.15 exhibits "levels typical of enriched condition in phosphorus limited systems; moderate risk to beneficial use if allied responses (DO swings, benthic chlorophyll) are elevated,"; Tinkers Creek RM 2.25 and Wood Creek RM 0.15 exhibit levels "characteristic of tile-drained lands; otherwise atypical condition with moderate risk to beneficial use if allied responses (DO swings, benthic chlorophyll are elevated"; and Tinkers Creek RM 7.00 exhibits an "enriched condition; generally high risk to beneficial uses; often co-occurring with multiple stressors; increased risk with poor habitat" (Ohio EPA, 2015c). It should be noted for Tinkers Creek that the value for total phosphorus puts this site on the very low end of the high-risk narrative assessment. It is more likely that this site exhibits a moderate risk, similar to Tinkers Creek RM 0.15. These narrative descriptions and numeric level results indicate that nitrogen may be a significant concern as a primary source of impairment at the Wood Creek RM 0.15 site. Nitrogen loading to Wood Creek may be a result of an upstream effluent discharge from the Bedford Wastewater Treatment Plant. As well, stormwater runoff from the landscaped areas of Cleveland Metroparks surrounding Wood Creek RM 0.15 and Tinkers Creek RM 2.25, may contribute to both nitrogen and phosphorus loading.

Table 6. 2017 Tinkers Creek Nutrient Concentrations		
Site	Total Phosphorus Geometric Mean (mg/L)	Dissolved Inorganic Nitrogen Geometric Mean (mg/L)
Tinkers Creek RM 7.00	0.136	6.14
Tinkers Creek RM 2.25	0.096	6.86
Tinkers Creek RM 0.15	0.069	5.73
Wood Creek RM 0.15	0.113	16.91

Habitat Assessment

Methods

Instream habitat assessments were conducted once at the sampling sites on Tinkers Creek and Wood Creek in 2017 using the Qualitative Habitat Evaluation Index (QHEI). The QHEI was developed by the Ohio EPA to assess aquatic habitat conditions that may influence the presence or absence of fish species by evaluating the physical attributes of a stream. The index is based on six metrics: stream substrate, instream cover, channel morphology, riparian zone and bank condition, pool and riffle quality, and stream gradient. The QHEI has a maximum score of 100, and a score of 60 (55 for headwaters) or more suggests that sufficient habitat exists to support a fish community that attains the WWH criterion. 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.

Results and Discussion

The stream segment at Tinkers Creek RM 0.15 was assessed on July 26, 2017. A QHEI score of 72.75 was calculated with a narrative rating of *Good* (Table 7), thereby exceeding the target score of 60 for WWH. Cobble followed by gravel were the dominant substrates found within the stream reach (Table 8). The reach, while scoring overall able to support a healthy fish community, was lacking in instream cover for fish, with only a sparse representation of slow-moving shallows, large pools, boulders, and logs/woody debris. This reach also suffered from some severe erosion on the river right bank, which may have contributed to slight embeddedness within the substrate and overall low stability within the river right substrate. Other factors that provided a beneficial addition to the score were good overall channel morphology development, lack of channelization, and stable quality riffles within the reach.

The stream segment at Tinkers Creek RM 2.25 was assessed on July 26, 2017. A QHEI score of 56.00 was calculated with a narrative rating of *Fair* (Table 7), nearly attaining the WWH target of 60 and the potential to support a healthy fish community. Lack of adequate instream cover, marked by sparse amounts of overhanging vegetation, slow-moving shallows, boulders, and logs/woody debris; detracted from the overall score (Table 8). In addition, this reach suffered from low sinuosity, only fair channel development, and a very narrow riparian buffer; all of which are factors contributing to the lower overall score. Regarding the riffles found within the reach, the QDC noted that the riffles may have appeared of good quality, but in fact were composed of poor substrate and were unstable (possibly due to underlying bedrock causing a shift).

The stream segment at Tinkers Creek RM 7.00 was assessed on July 31, 2017. A QHEI score of 72.50 was calculated with a narrative rating of *Good* (Table 7), exceeding

the target score of 60, and demonstrating the potential to support a healthy fish population. Diverse instream fish cover was present at this reach, including small amounts of undercut banks, overhanging vegetation, rootwads, backwaters, and logs/woody debris; and more moderate presence of slow-moving shallows, rootmats, boulders, and aquatic macrophytes (Table 8). This diversity contributes to the potential ability of the reach to support a healthy fish population. Additional features benefitting the reach included lack of channelization, minimal erosion, and quality stable riffles present. Low sinuosity of the reach and moderate embeddedness of the substrate were two factors that minorly detracted from the overall score. An additional major detraction was the absence of any deep pools in the stream segment. Field assessments revealed that the deepest pool in the entire reach was 45 cm. This lack of deep pools would not provide additional refuge to fish during periods of lower flow.

The stream segment at Wood Creek RM 0.15 was assessed on July 31, 2017. A QHEI score of 69.00 was calculated with a narrative rating of *Good* (Table 7), exceeding the target score of 55 for WWH. The dominant substrates found during evaluation included bedrock followed closely by boulder. The reach was lacking instream fish cover availability, with only a moderate-to-sparse presence of undercut banks, rootmats, marginal quality boulders, and logs/woody debris (Table 8). Lack of deep pools greater than 70cm in this reach and an extremely high gradient to drainage ratio were among the major detractions from the overall QHEI score. Having minimal refuge areas along with an extremely high gradient may be a barrier to supporting a diverse fish community.

Table 7. 2017 Tinkers Creek and Wood Creek QHEI Results			
River Mile	Date	QHEI Score	Narrative Rating
Tinkers Creek RM 7.00	7/26/2017	72.50	*Good*
Tinkers Creek RM 2.25	7/26/2017	56.00	*Fair*
Tinkers Creek RM 0.15	7/26/2017	72.75	*Good*
Wood Creek RM 0.15	7/26/2017	69.00	*Good*

Table 8. Tinkers Creek and Wood Creek Qualitative Habitat Evaluation Index Scores and Physical Attributes																																
			WWH Attributes											MWH Attributes																		
														High Influence						Moderate Influence												
River Mile	QHEI Score	Habitat 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 Attribute**
Tinkers Creek RM 7.00	72.5	Good	x	x				x	x		x		**5**						**0**					x	x		x		x	x		**5**
Tinkers Creek RM 2.25	56	Fair	x	x					x		x		**4**				x		**1**					x	x		x		x	x		**5**
Tinkers Creek RM 0.15	72.75	Good	x	x		x		x			x	x	**6**				x		**1**						x		x		x			**3**
Wood Creek RM 0.15	69	Good	x	x	x	x	x	x	x	x	x	x	**10**				x		**1**													**0**

13

Fish Community Assessment

Methods

Two quantitative electrofishing passes were conducted at each sampling site on Tinkers Creek and Wood Creek for the 2017 sampling season. Sampling was conducted using longline electrofishing techniques and consisted of shocking all habitat types within a sampling zone while moving from downstream to upstream. The sampling zone was 0.20 kilometers for Tinkers Creek RMs 0.15, 2.25, and 7.00; and 0.15 kilometers for Wood Creek RM 0.15. The methods that were used followed Ohio EPA protocol methods as detailed in *Biological Criteria for the Protection of Aquatic Life, Volumes II* (1987a) and *III* (1987b). Fish collected during the surveys were identified, weighed, and examined for the presence of anomalies, including DELTs (deformities, eroded fins, lesions, and tumors). All fish were then released to the waters from which they were collected, except for vouchers and those that could not be easily identified in the field.

The electrofishing results for each pass were compiled and utilized to evaluate fish community health through the application of the Ohio EPA Index of Biotic Integrity (IBI) and the Modified Index of Well-Being (MIwb). The IBI incorporates 12 community metrics representing structural and functional attributes. The structural attributes are based upon fish community aspects such as fish numbers and diversity. Functional attributes are based upon fish community aspects such as feeding strategies, environmental tolerances, and disease symptoms. These metrics are individually scored by comparing the data collected at the survey site with values expected at reference sites located in a similar geographical region. The maximum possible IBI score is 60 and the minimum possible score is 12. The summation of the 12 individual metrics scores provides a single-value IBI score, which corresponds to a narrative rating of *Exceptional, Good, Marginally Good, Fair, Poor,* or *Very Poor*. The 12 metrics utilized for headwater and wading sites are listed in Table 9.

Table 9. Index of Biotic Integrity (IBI) Metrics	
Headwater	**Wading**
Total Number of Native Species	Total Number of Native Species
Number of Darters & Sculpins	Number of Darters & Sculpins
Number of Headwater Species	Number of Sunfish Species
Number of Minnow Species	Number of Sucker Species
Number of Sensitive Species	Number of Intolerant Species
Percent Tolerant Species	Percent Tolerant Species
Percent Pioneering Species	Percent Top Carnivores
Percent Omnivores	Percent Omnivores
Percent Insectivores	Percent Insectivores
Number of Simple Lithophils	Percent Simple Lithophils
Percent DELT Anomalies	Percent DELT Anomalies
Number of Individuals	Number of Individuals

The second fish index utilized by Ohio EPA is the Modified Index of Well-being (MIwb). The MIwb, Formula 3 listed below, incorporates four fish community measures: numbers of individuals, biomass, and the Shannon Diversity Index (H) (Formula 4) based on numbers and weight of fish. The MIwb is a result of a mathematical calculation based upon the formula.

Formula 3: $$MIwb = 0.5\,lnN + 0.5\,lnB + \overline{H}(No.) + \overline{H}(Wt.)$$

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

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

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

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

Formula 4: $$\overline{H} = -\sum\left[\left(\frac{n_i}{N}\right)log_e\left(\frac{n_i}{N}\right)\right]$$

$n_i =$ Relative numbers or weight of species

$N =$ Total number or weight of the sample

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

Results and Discussion

For the 2017 electrofishing events, Tinkers Creek RM 0.15 sampling reach averaged an IBI score of 42, narratively *Good*, and an MIwb score of 8.7, also narratively *Good* (Table 10), therefore attaining both the IBI and MIwb WWH criteria. The first electrofishing pass, completed on July 28, 2017, achieved an IBI score of 42, narratively *Good*, and an MIwb score of 8.2, also narratively *Good*. Of all the specimens collected, there were no DELTs reported. Additionally, four sunfish species were collected, including northern rockbass (*Ambioplites rupestris*), green sunfish (*Lepomis cyanellus*), northern bluegill sunfish (*Lepomis macrochirus*), and pumpkinseed sunfish (*Lepomis gibbosus*), which positively contributed to the overall score. Of the fish taxa collected in this sample, 71.6% of the individuals had equal to an intermediate pollution tolerance or better. Only one taxon, however, that was classified intolerant, stonecat madtom (*Noturus flavus*), was present, detracting from the overall score. Considering total sample composition, 22 of the 23 total taxa were native fish, and the dominant taxon was the sand shiner (*Notropis stramineus*), comprising 22.1% of the total sample.

Comparing the second electrofishing pass for Tinkers Creek RM 0.15, completed on September 14, 2017; the sample reach also achieved an IBI score of 42, narratively *Good*, and an MIwb score of 9.1, narratively *Very Good*, which was a slight improvement from the first pass. Differences included a slight loss in overall taxa, as only 20 taxa were collected during this sampling event. Nineteen of these total taxa were considered native, however, and contributed positively to the overall score. The decline in overall taxa for this sampling event may be attributed to sampling effort, weather, or seasonal population drifts. Another change and subsequent negative impact on the IBI score can be ascribed to absence of intolerant species during this event. Even so, the sample population was distributed similar to the previous electrofishing pass. Conversely, the proportion of tolerant taxa compared to the total taxa slightly improved, increasing the value for that metric. A few DELTs were found during field evaluation on fish collected in this sampling event, including a northern hog sucker (*Hypenlelium nigricans*) – Deformity, and common white sucker (*Catostomus commersonii*) – Deformity and Lesion. Once again, the sand shiner was the dominant species found at this reach, increasing to 26.4% of the total sample. Overall, the average IBI and MIwb scores for Tinkers Creek RM 0.15 reflect the sampling site's QHEI score of 72.75, narratively *Good*, confirming the reach's ability to support a diverse and healthy fish population.

The sample reach at Tinkers Creek RM 2.25 achieved an average IBI score of 43, narratively *Good*, and an averaged MIwb score of 8.4, narratively *Good*, therefore attaining both the IBI and MIwb WWH criteria for the 2017 sampling season (Table 10). The first electrofishing pass, completed on July 28, 2017, achieved an IBI score of 42, narratively *Good*, and an MIwb score of 7.9, narratively *Good*. No DELTs were reported among any of the specimens collected during this event. The IBI and MIwb scores were positively impacted by the presence of four sunfish species, including northern rockbass, green sunfish, northern bluegill sunfish, and pumpkinseed sunfish. As well, the proportion of tolerant specimens within the sample population resulted in a very low percentage (7.2%), another positive influence on the total score. Some metrics were negatively impacted, such as Number of Darter Species present. Only two species, greenside darter (*Etheostoma blenniodes*) and johnny darter (*Etheostoma caeruleum)*, were documented within the sample population. The dominant species of the sample population was central stoneroller minnow (*Campostoma anomalum*), accounting for 39.8% of the population sample. While the stoneroller minnow is intermediately tolerant to pollution, the second-most dominant species, the sand shiner, accounting for 22.8% of the sample population, was designated moderately intolerant to pollution. The sample, however, contained a large proportion of tolerant taxa, with 8 taxa classified as moderately tolerant to pollution or poorer. Only one taxon designated intolerant, the stonecat madtom, was present in the sample population.

The second electrofishing sample event for RM 2.25 was completed on September 8, 2017, achieving an IBI score of 44, narratively *Good*, and an MIwb score of 8.8, also narratively *Good*. Like Tinkers Creek RM 0.15, a slight loss of total taxa, including the loss of the only pollution intolerant species, occurred for the sample population for this

event at RM 2.25. A slight improvement in the proportion of simple lithophilic species (46.4%) was a positive influence on the overall IBI score. Unlike the previous sampling event, there were DELTs present on specimens collected, specifically a deformity in a specimen of the common shiner (*Notropis cornutus*), resulting in a reported DELT percentage of 0.134%. In 2017, Tinkers Creek RM 2.25 achieved a QHEI score of 56, narratively *Fair*. While this site just narrowly missed the target score of 60 and was marked by smaller amounts of fish cover and poorer substrate, the fish sample population collected still demonstrated the reach's potential to support a diverse fish community.

The electrofishing sampling reach at Tinkers Creek RM 7.00 averaged an IBI score of 33, narratively *Fair*, and an MIwb score of 6.8, narratively *Fair* for the 2017 sampling events (Table 10). This sampling reach is therefore in non-attainment of both the IBI and the MIwb criteria for 2017. The first electrofishing pass, completed on July 31, 2017, achieved an IBI score of 34, narratively *Marginally Good*, and an MIwb score of 7.1, narratively *Fair*. Several of the scoring metrics were negatively impacted from the specimens collected in this sample. Overall, only nine total taxa were present, all of which were native species, and no DELTs were reported. However, important species groups were absent, including darter species and intolerant species. Additionally, only two sucker species were present, including the common white sucker and the northern hog sucker, providing for another detraction to the overall IBI score. One of the highest scoring metrics in the sample population was the number of sunfish species present, as sunfish species dominated the taxa list. The four species present in the sample included northern rockbass, green sunfish, northern bluegill sunfish, and pumpkinseed sunfish. This sample population was also dominated by pollution tolerant taxa, as six of the nine total taxa were classified as moderately tolerant or poorer.

The second electrofishing pass for Tinkers Creek RM 7.00, completed on September 8, 2017, achieved an IBI score of 32, narratively *Fair*, and an MIwb score of 6.5, narratively *Fair*. Roughly the same number of total taxa were present during this sampling event, with only a slight increase to ten total taxa. None of the specimens collected were reported to have any DELTs. One reason for the slight decline in the overall score is due to a lower percentage of insectivores in the sample population (from 46.3% on July 31, 2017 to 19.9% on September 8, 2017). The overall number of specimens collected stayed consistent with the first electrofishing pass, yet there was an overwhelming shift in species dominance. In the first pass, all taxa present were distributed evenly, but in the second pass, the sample population was dominated by the 66 smallmouth bass (*Micropterus dolomieui*), accounting for 48.5% of the total population. While Tinkers Creek RM 7.00 achieved a QHEI score of 72.5 for the 2017 sampling season, it is evident that the sample populations collected in each event do not correlate with that high score. A lack of deep pools within the reach does not offer added refugia to fish in the event of low flow. As well, this stream segment has low sinuosity and its substrate is moderately embedded, minimizing available fish habitat. A waterfall is located downstream of the sampling location, under Broadway Avenue downstream of the Northfield Road overpass in Bedford, Ohio. The waterfall may

serve as a fish migration barrier, barring species from moving upstream to occupy Tinkers Creek at RM 7.00 (Figure 1). Tinkers Creek RM 7.00 is also located downstream of an Interstate 480/271 overpass and could be adversely impacted from stormwater runoff from the highway, and possible nutrient loading from the nearby Cleveland Metroparks property.
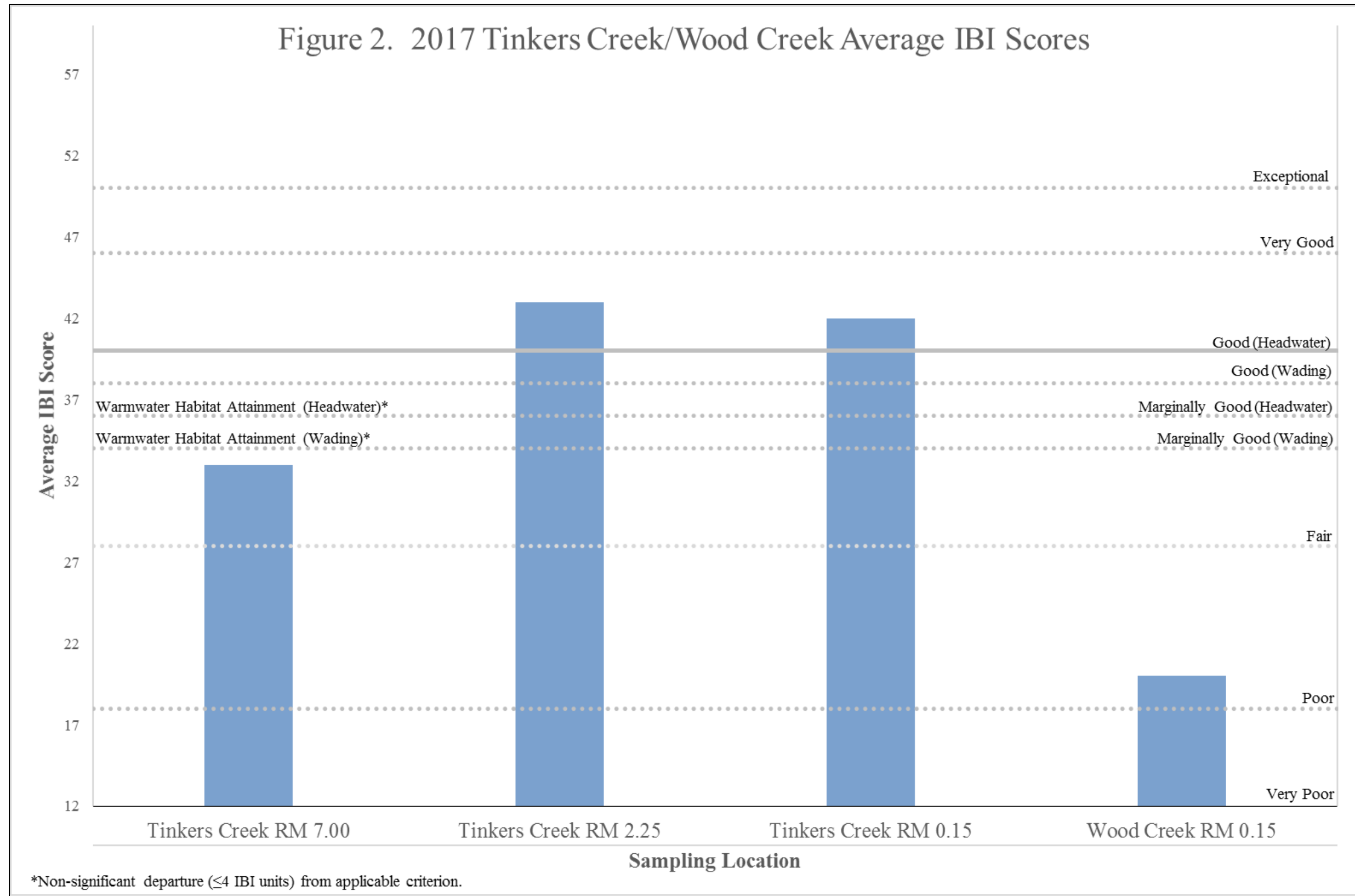
The electrofishing sampling reach at Wood Creek averaged an IBI score of 20, narratively *Poor* for the 2017 sampling events (Table 10). This sampling reach is therefore in non-attainment of the IBI criterion for 2017. During the first electrofishing pass, completed July 31, 2017, the reach achieved an IBI score of 20, narratively *Poor*. While no DELTs were recorded in any of the specimens, only two taxa were collected during this event, including blacknose dace (*Rhinicthys atratulus*) and the creek chub (*Semotilus atromaculatus*). Only 104 total specimens were collected; two blacknose dace and 102 creek chubs. Both taxa are designated as highly tolerant to pollution, and having an absence of intolerant species as well as most other significant species groups, contributed to the low score achieved during this event.

For the second electrofishing pass, completed September 14, 2017, the sampling reach at Wood Creek RM 0.15, also achieved an IBI score of 20, narratively *Poor*. In this sampling event, there was a taxa loss, with only 66 specimens of the creek chub being collected. Positively, there were no DELTs reported on any of the collected specimens. Like the previous pass, the reach was also absent of important species groups, contributing to the low score. Wood Creek RM 0.15 is likely impacted from the upstream Bedford Wastewater Treatment Plant, and possible stormwater runoff from landscaped areas within the bordering Cleveland Metroparks. While Wood Creek RM 0.15 achieved a QHEI score of 69 (narratively *Good*), exceeding the target score that can support a healthy fish population, lack of in-stream fish cover combined with a dominant bedrock substrate and a high-gradient, are likely to have been barriers for this reach to sustain a healthy and diverse fish population.

Table 10. 2017 Tinkers Creek and Wood Creek IBI Results								
	1st Pass			**2nd Pass**			**Average**	
River Mile	Date	IBI (*Narrative Rating*)	MIwb (*Narrative Rating*)	Date	IBI (*Narrative Rating*)	MIwb (*Narrative Rating*)	IBI (*Narrative Rating*)	MIwb (*Narrative Rating*)
Tinkers Creek RM 7.00	7/31/2017	34 (*Marginally Good*)	7.1 (*Fair*)	9/8/2017	32 (*Fair*)	6.5 (*Fair*)	33 (*Fair*)	6.8 (*Fair*)
Tinkers Creek RM 2.25	7/28/2017	42 (Good)	7.9 (Good)	9/8/2017	44 (Good)	8.8 (Good)	43 (Good)	8.4 (Good)
Tinkers Creek RM 0.15	7/28/2017	42 (Good)	8.2 (Good)	9/14/2017	42 (Good)	9.1 (Good)	42 (Good)	8.7 (Good)
Wood Creek RM 0.15	7/31/2017	20 (*Poor*)	N/A	9/14/2017	20 (*Poor*)	N/A	20 (*Poor*)	N/A

Bold = meets WWH criterion [IBI ≥40 (Headwater Site), IBI≥38 (Wading Site); MIwb≥7.9 (Wading Site)]
Italics = non-significant departure from WWH criterion [IBI ≥36 (Headwater Site), IBI ≥36 (Wading Site); MIwb ≥7.4 (Wading Site)]

Figure 2. 2017 Tinkers Creek/Wood Creek Average IBI Scores

*Non-significant departure (≤4 IBI units) from applicable criterion.

Macroinvertebrate Community Assessment

Methods

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

The macroinvertebrate samples were sent to Third Rock Consulting of Lexington, Kentucky, for identification and enumeration. Specimens were identified to the lowest practical taxonomic level as defined by the Ohio EPA (1987b). Lists of the species collected during the quantitative and qualitative sampling are available upon request from the NEORSD WQIS Division.

The overall aquatic macroinvertebrate community in the stream was evaluated using Ohio EPA's Invertebrate Community Index (ICI) (Ohio EPA 1987b, DeShon 1995). The ICI consists of ten community metrics (Table 11), each with four scoring categories. Metrics 1-9 are based on the quantitative sample, while Metric 10 is based on the qualitative EPT taxa. The total of the individual metric scores result in the overall score. This scoring evaluates the community against Ohio EPA's reference sites for each specific eco-region.

Table 11. 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

The HD samplers were successfully recovered from all sampling sites on Tinkers Creek and Wood Creek during the 2017 season. Combined with qualitative macroinvertebrate sampling on the day of HD retrieval, this allowed for a calculated ICI score to assess each of the sampling sites.

Tinkers Creek RM 0.15 received an ICI score of 40 with a narrative rating of *Good* for 2017 (Table 11 and Figure 3), therefore exceeding the WWH criterion of 34. Of the 45 total taxa collected in both the HD and qualitative sampling, nine representative species from the EPT (Ephemeroptera (Mayflies), Plecoptera (Stoneflies), and Trichoptera (Caddisflies)) were present, including four Ephemeropterans: *Baetis flavistriga*, *Baetis intercalaris*, *Maccaffertium terminatum*, and *Tricorythodes sp.*; and five Trichopterans: *Cheumatopsyche sp.*, *Ceratopsyche morosa*, *Ceratopsyche sparna*, *Hydropsyche depravata group*, and *Hydroptila sp.* As well, the individuals collected from these species accounted for 56.2% of all the organisms collected on the HD sampler. Dominance of EPT taxa in this stream reach is an indication of good water quality, which is reflected in the ICI score. A minimal presence of tolerant (as defined) organisms was another factor that provided a positive contribution to the overall score. Additionally, of those taxa designated pollution tolerance values according to the Ohio EPA Macroinvertebrate Taxa List (Ohio EPA, 2018), 81.8% of the taxa were classified as facultative tolerance or better, providing an indication that pollution sensitive organisms can thrive within this reach. The presence of stable and quality riffles, providing an oxygen-rich environment, along with quality substrate dominated by cobble and gravel may have also attributed to the dominance of these sensitive macroinvertebrates.

Tinkers Creek RM 2.25 received an ICI score of 26, narratively *Fair*, for the 2017 sampling season (Table 11 and Figure 3), consequently not meeting the WWH criterion. Contrary to Tinkers Creek RM 0.15, this sampling reach was negatively affected by a lack of overall EPT specimen abundance, only accounting for 6.1% of the total specimens collected on the HD sampler. One positive aspect of the sample population, however, was the presence of four different Trichopteran taxa, including *Cheumatopsyche sp.*, *Ceratopsyche morosa*, *Ceratopsyche sparna*, and *Hydroptila sp.* These taxa, it should be noted, were not found in abundant quantities, however. RM 2.25 was dominated by non-Tanytarsini Midge Dipterans (True Flies) and other non-insect taxa (69.11% of total organisms), most of which were other members of the family Chironomidae (Non-Biting Midge), detracting from the overall ICI score. As well, the composition of the sample population consisted of 18.90% tolerant (as defined) organisms, resulting in another major reduction in the ICI score. As previously mentioned, the habitat quality at the RM 2.25 reach was only designated *Fair* when assessed for QHEI. The unstable riffles composed of poor substrate that were found in the sampling reach may be considered inefficient at supporting more sensitive and healthy macroinvertebrate populations. As well, upstream stormwater nutrient-enriched runoff from the surrounding park area may have been a contribution to the abundance of more tolerant organisms, which resulted in the low ICI score.

The macroinvertebrate community at Tinkers Creek RM 7.00 received an ICI score of 42, narratively *Very Good*, for 2017 (Table 11 and Figure 3), exceeding the WWH criterion. A total of 40 taxa were collected at the sampling site, from the HD sampler and qualitative dipnet sampling. Only 2.89% of the 2455 organisms collected from the HD

sampler were considered tolerant (as defined), an indication that more sensitive organisms would thrive in the reach. Of the 38 taxa collected that were designated pollution tolerance values according to the Ohio EPA Macroinvertebrate Taxa List, 84.21% of the taxa were designated as facultative pollution tolerance or better. One of the major reductions to the ICI score was the number of Ephemeroptera taxa present in the sample population. Only four taxa were present, including *Baetis flavistriga*, *Baetis intercalaris*, *Maccaffertium terminatum*, and *Tricorythodes sp*. For a stream of this size and drainage area, it is ideal to have a population assemblage with 8 or more taxa. While there was not much diversity in taxa, population abundance of Ephemeroptera and Trichoptera accounted for 48.51% of all organisms collected. This high proportion within the sample is another indication of the ability of the stream to sustain a healthy macroinvertebrate population.

The macroinvertebrate community at Wood Creek RM 0.15 received an ICI score of 32, narratively *Marginally Good*, for 2017 (Table 11 and Figure 3), meeting the WWH criterion (within non-significant departure). Between the HD and qualitative dipnet sampling, 40 different taxa were collected at this location. Dominating the sample population were Dipterans, accounting for 20 of the 40 total taxa collected, which positively affected the ICI score. However, as these taxa were proportionally abundant (73.11% of all organisms collected), the ICI score suffered from this low-scoring metric. Seven Trichopteran taxa, an indicator of good water quality, were present in the sample population, including the following: *Chimarra aterrima*, Polycentropodidae, *Cheumatopsyche sp.*, *Ceratopsyche morosa*, *Ceratopsyche sparna*, *Hydropsyche depravata group*, and *Hydroptila sp.* The presence of these 7 taxa, as well as their population proportion (14.87% of all organisms collected), both had a positive influence on the overall ICI score. Conversely, the presence and population proportion for another good water quality indicator, Ephemeroptera, were severely low within this sample population. Only one taxa, *Baetis flavistriga*, was represented in the sample, which accounted for only 3.03% of the total population. Wood Creek RM 0.15 is a high gradient stream segment, and that, along with lack of suitable substrates, may have been prohibitive to achieving a more robust and higher quality macroinvertebrate community.

Table 11. Invertebrate Community Index (ICI) Scores	
River Mile	ICI Score (*Narrative Rating*)
Tinkers Creek RM 7.00	**42** (*Very Good*)
Tinkers Creek RM 2.25	26 (*Fair*)
Tinkers Creek RM 0.15	**40** (*Good*)
Wood Creek RM 0.15	**32*** (*Marginally Good*)
Bold – Attainment of WWH criterion * - Non-significant departure (≤4 ICI units) from applicable criterion	

Figure 3. 2017 Tinkers Creek/Wood Creek ICI Scores

*Non-significant departure (≤4 ICI units) from applicable criterion.
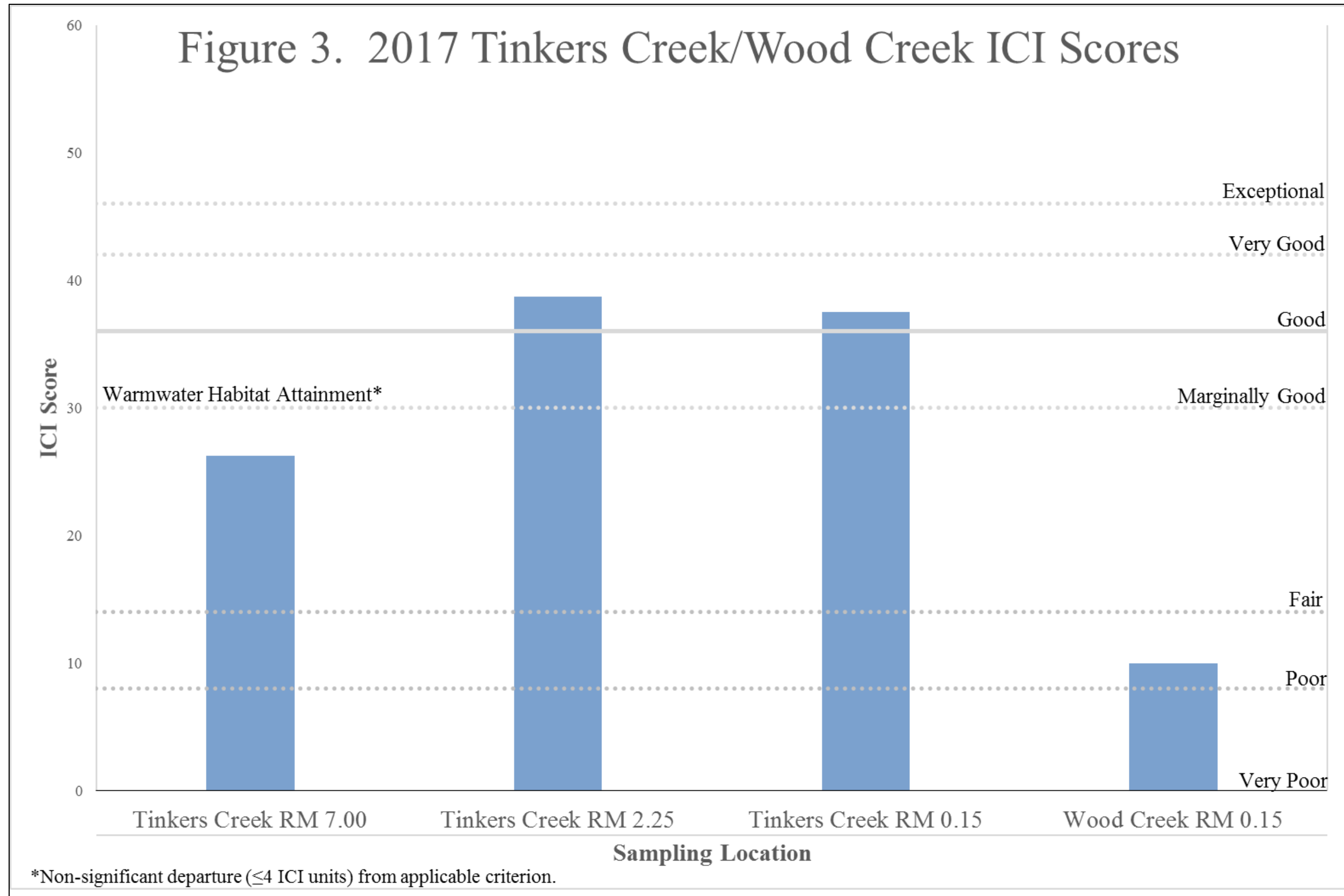
Conclusions

The results of the water chemistry sampling, habitat assessments, and fish and benthic macroinvertebrate community surveys conducted by NEORSD in 2017 indicate that the Tinkers Creek/Wood Creek watershed may have been impacted by a variety of environmental stressors and various aquatic habitat limitations. Three of the four sampling locations that were evaluated achieved at least partial Aquatic Life Use Attainment status, with Tinkers Creek RM 0.15 achieving full biological attainment. The site on Wood Creek was in non-attainment (Table 12).

Bacteriological sampling within the Tinkers Creek and Wood Creek sampling sites showed elevated densities of *E. coli*, which is regarded as an indicator of poor water quality conditions. These water quality exceedances may be attributed to stormwater runoff or failing home septic systems in the surrounding residential areas. As well, nutrient-enriched conditions were evident at two of the sampling locations, Tinkers Creek RM 2.25, and Wood Creek RM 0.15. Resulting from these water quality conditions, the fish and/or macroinvertebrate communities at each sampling site may have been disturbed through overall loss of taxa, individuals, or population shifts toward more pollution-tolerant species.

Undesirable habitat conditions within some of the sampling locations presented another challenge and may have prohibited the support of more diverse and higher-quality fish and/or macroinvertebrate communities. Sparseness or complete lack of in-stream cover for fish and unstable substrate or poor riffles for macroinvertebrates were likely to have been the largest contributing factors.

Bacteriological and nutrient issues may be able to be improved to achieve attainment of water quality status, therefore improving the overall quality of the in-stream biological community. The matters surrounding quality of habitat, however, and the associated impacts to the fish and macroinvertebrate communities, may not be easily remediated. Permanent anthropogenic changes to the area surrounding the Tinkers Creek and Wood Creek watershed may prevent restoration of some habitat, including issues with erosion, instream cover, and channel sinuosity. Ultimately, water quality will need to improve within the watershed before any noticeable changes are present in the biological communities.

Table 12. 2017 Tinkers Creek/Wood Creek Survey Results						
River Mile	Aquatic Life Use Attainment Status	Average IBI Score (*Narrative Rating*)	Average MIwb Score (*Narrative Rating*)	ICI Score (*Narrative Rating*)	QHEI Score (*Narrative Rating*)	Water Quality Exceedances
Tinkers Creek RM 7.00	PARTIAL	*33 (Fair)*	*6.8 (Fair)*	*42 (Very Good)*	*72.5 (Good)*	*E. coli*
Tinkers Creek RM 2.25	PARTIAL	*43 (Good)*	*8.4 (Good)*	*26 (Fair)*	*56 (Fair)*	*E. coli*
Tinkers Creek RM 0.15	FULL	*42 (Good)*	*8.7 (Good)*	*40 (Good)*	*72.75 (Good)*	*E. coli*
Wood Creek RM 0.15	NON	*20 (Poor)*	*N/A*	*32 (Marginally Good)*	*69 (Good)*	*E. coli*
WWH biocriterion attainment: IBI score of 40 (Headwater), 38 (Wading); MIwb score of 7.9 (Wading); ICI score of 34 Non-significant departure: ≤4 IBI units; ≤0.5 MIwb units; ≤4 ICI units						

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