

Appendix H3: Macroinvertebrate Report 2012

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER RESOURCES DIVISION
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STAFF REPORT

A BIOLOGICAL SURVEY OF SITES ON THE KALAMAZOO RIVER AND TALMADGE CREEK
NEAR THE ENBRIDGE OIL SPILL IN MARSHALL
CALHOUN COUNTY, MICHIGAN
SEPTEMBER 2012

INTRODUCTION

On July 26, 2010, a 30-inch diameter pipeline ruptured and discharged heavy crude oil into Talmadge Creek, a tributary to the Kalamazoo River, which drains into Lake Michigan. The amount of oil discharged is estimated at 819,000 to 1,000,000 gallons. The oil flowed down 2.2 miles of Talmadge Creek, a small designated warmwater stream, before entering the Kalamazoo River downstream of Marshall, Michigan. The Kalamazoo River is also a designated warmwater stream that is bordered by wetland, forest, residential properties, farm land, and commercial properties for the approximate 35-mile stretch of impacted river in Calhoun and Kalamazoo Counties between Marshall and Morrow Lake.

In September 2010, staff of the Surface Water Assessment Section (SWAS), Water Resources Division (WRD), Michigan Department of Environmental Quality (MDEQ), with assistance from Entrix (currently Cardno ENTRIX), conducted qualitative macroinvertebrate community and stream habitat surveys on the Kalamazoo River and Talmadge Creek. The survey documented that macroinvertebrate abundance and diversity were drastically reduced in both water bodies because of the oil spill and associated cleanup activities (Walterhouse, 2011). SWAS and Entrix staff also assisted staff of the Michigan Department of Natural Resources (MDNR), Fisheries Division, with fish collection efforts and quantitative stream habitat assessments. The MDNR, Fisheries Division, reported reduced fish abundance and diversity along with impacts to stream habitat in Talmadge Creek (Wesley and Walterhouse, 2010a). Fish community diversity and catch also declined at two of the three sites on the Kalamazoo River, which were impacted by the oil spill and cleanup activities.

In August 2011, SWAS staff again conducted qualitative macroinvertebrate community and stream habitat surveys on the Kalamazoo River and Talmadge Creek. The objective of these surveys was to monitor the short- and long-term effects of the oil spill and associated cleanup activities on macroinvertebrate communities and aquatic habitat. Macroinvertebrate abundance and diversity reported in 2011 (Walterhouse, 2012) in Talmadge Creek were found to have improved from results collected in 2010 (Walterhouse, 2011) in the sections of stream where cleanup activities were conducted, but were still found to be impacted when compared to upstream sites. No oil sheen or odor was noted during the 2011 surveys in Talmadge Creek as both odor and sheen had been observed in 2010. Kalamazoo macroinvertebrate abundance and diversity also improved when compared to 2010 data, but abundance was still impacted when compared to historic data. Oil sheen along with petroleum odor was noted at some Kalamazoo River site locations when sampling near depositional areas. Shallow riffle habitat at Stations K2 and K3 (Figure 1), which were described as having been severely disturbed by cleanup activities during the 2010 survey, were noted in 2011 as recovering with noticeable new colonization of periphyton and macroinvertebrates. Sediment deposition, particularly downstream of Battle Creek, was noted as appearing to have increased by both depth and

aerial coverage during the 2011 surveys. Complete results are available in the 2011 MDEQ report (Walterhouse, 2011).

In September 2012, SWAS staff conducted additional qualitative macroinvertebrate community and stream habitat surveys on the Kalamazoo River and Talmadge Creek. The objective of these surveys was to continue to monitor the short- and long-term effects of the oil spill and associated cleanup activities on macroinvertebrate communities and aquatic habitat. Future surveys will be conducted to monitor the long-term effects of the oil spill and associated cleanup activities on the fish and macroinvertebrate communities and aquatic habitat (Wesley and Walterhouse, 2010b).

SWAS staff also assisted the MDNR, Fisheries Division, with fish collection and quantitative stream habitat assessments. The MDNR, Fisheries Division, is preparing a separate report which details the fish and quantitative stream habitat sampling efforts.

METHODS

The sites selected for this survey were specifically chosen because of historic (i.e., baseline) surveys that were conducted prior to the oil spill (Wesley and Walterhouse, 2010a) and the fact that they were used in previous years for monitoring the long-term effects of the oil spill and associated cleanup activities. An additional site (Station T2, Figure 1) on Talmadge Creek was added in 2011 just upstream of the oil spill because stream flow at the historic control site further upstream (Station T1, Figure 2) at 17 Mile Road was minimal. Station T1 could not be sampled due to low water in 2012. Station T2 (Figure 4) is similar in width and flow to the impacted reach at Station T3. The surveys described in this report were conducted according to the SWAS Procedure 51 (MDEQ, 1990; Creal et al., 1996). The macroinvertebrate communities were scored with metrics that rate water bodies from excellent (+5 to +9) to poor (-5 to -9). Macroinvertebrate ratings from +4 to -4 are considered acceptable. Negative ratings that are acceptable indicate water bodies that are tending toward poor, while positive ratings that are acceptable indicate slight impairment (Creal et al., 1996). Stream habitat was qualitatively evaluated at each station using a scoring system that ranged from 0 (poor) to 200 (excellent).

Sampling locations are shown in Figure 1.

SUMMARY AND OBSERVATIONS

Qualitative macroinvertebrate scores and ratings alone do not adequately measure the impact of the oil spill and associated cleanup activities.

Cleanup and channel restoration activities in Talmadge Creek continued after the August 2011 survey was completed due to discoveries of undetected oil spill deposits, which required removal. Macroinvertebrate abundance and diversity in Talmadge Creek, downstream of the oil spill where cleanup operations have altered the in-stream and riparian habitat (Station T3, Figure 1), are much improved in 2012 compared to 2010 data and are similar to 2011 data (Table 1 and 2). The stream channel has been nearly entirely exposed to sunlight for the past two years (Figure 4), which appears to have increased productivity at least in terms of taxa diversity (Table 2 and 4). Station T3 appears to still show signs of impact from the oil spill, consistent with 2011 sampling results, in that the macroinvertebrate species composition at Station T3 is much different from Station T2 (upstream of the oil spill and cleanup activities, Figure 4) and is dominated by species known to reach high densities during the early stages of recolonization (Mackay, 1992). The total number of taxa (Table 2) was slightly higher at

Station T3 and the overall macroinvertebrate Procedure 51 scores at Stations T2 and T3 were both in the “acceptable” category (Table 1).

Kalamazoo River sites reported scores similar to 2011 results (Table 1) with Sites K2, K3, and K4 all showing slight increases in overall scores. The score at Site K1 decreased from +6 in 2011 to +3 in 2012. This decrease can mainly be attributed to the fact that no stoneflies were collected in 2012 during the survey.

Oil sheen or odor was not noted during sampling at any of the Talmadge Creek or Kalamazoo River sites in 2012, but a slight oil sheen was noted in the sampling bucket while processing at the most downstream site (K4). Limited observations of areas of Talmadge Creek and the Kalamazoo River where stream bank erosion issues developed during response and cleanup activities appeared to continue to be stabilized with various stream bank stabilization techniques.

Table 1. Qualitative Macroinvertebrate scores from Procedure 51 surveys conducted over multiple years at Kalamazoo River (K) and Talmadge Creek (T) sites (Figure 1).

Station	Years							
	1994	1999	2004	2008	2009	2010	2011	2012
T1	--	2	--	--	--	-1	0	-- ²
T2	--	--	--	--	--	1	1	0
T3	--	-3	--	--	--	-4	4	3
K1	--	4	6	--	--	5	6	3
K2	--	--	--	--	--	6	6	8
K3	--	--	6	2,4,3,2 ¹	--	3	5	6
K4	4	--	2	--	6	2	1	4

(+5 to +9) Excellent (+4 to -4) Acceptable (-5 to -9) Poor
 Surveys conducted prior to 2008 used a Procedure 51 protocol, which only required a macroinvertebrate sample size of 100 compared to the requirement of 300 after the revision.
¹ Location was scored multiple times in 2008 as part of a quality assurance/quality control (QA/QC) process.
² Location was not sampled due to low water levels.

Table 2. Total number of taxa recorded from Procedure 51 surveys conducted over multiple years at Kalamazoo River and Talmadge Creek sites (Figure 1).

Station	Years							
	1994	1999	2004	2008	2009	2010	2011	2012
T1	--	17	--	--	--	14	14	-- ²
T2	--	--	--	--	--	27	26	28
T3	--	19	--	--	--	7	24	30
K1	--	20	40	--	--	34	35	40
K2	--	--	--	--	--	38	42	38
K3	--	--	44	48,56,48,44 ¹	--	31	36	42
K4	22	--	29	--	33	20	27	28

¹ Location was scored multiple times in 2008 as part of a QA/QC process.
² Location was not sampled due to low water levels.
 Surveys conducted prior to 2008 used a Procedure 51 protocol, which only required a macroinvertebrate sample size of 100 compared to the requirement of 300 after the revision.

SAMPLING RESULTS

Talmadge Creek - Macroinvertebrates

The 2012 macroinvertebrate community sampling results for stations (T2, T3, Figure 1) on Talmadge Creek are presented in Table 3. Macroinvertebrate metrics, scores, and ratings for these sites are located in Table 4. Station T1, which had been sampled in past years, was not sampled in 2012 due to lack of flow and low water levels (Figure 2). Station T2 (Figure 4) was sampled to serve as a control station for comparison to Station T3, which is in the impacted portion of Talmadge Creek. The results from these two stations in 2012 are very similar to documented results from 2011 (Walterhouse, 2012). Station T3 received a higher score (3) than the control site (0) and had a slightly greater diversity of invertebrates. Station T3 was highly disturbed by cleanup activities since 2010 and is in a continuing state of recovery. The macroinvertebrate community present at Station T3 is different in species composition when compared to the upstream control at Station T2 and is dominated by species commonly associated with areas that have been disturbed and in the early stages of recolonization (Mackay, 1992). The removal of trees, shrubs, herbaceous plants, and grasses during the response activity has allowed for direct sunlight to reach the stream by opening the vegetated canopy (Figure 3). This increase in direct sunlight has allowed for the proliferation of filamentous algal growth on the stream substrate, which is not present in such quantity at the upstream control station (T2). Blackflies (Simuliidae), midges (Chironomidae), and mayflies (Baetidae), which are some of the first species to appear in highly disturbed areas (Mackay, 1992), were prevalent at Station T3 while being absent or at much lesser concentrations at Station T2.

The comparable results from 2011 and 2012 are not unexpected as the stream channel was once again disturbed by additional cleanup activities after the 2011 surveys took place, which likely set back recovery. Additional years of assessment will be needed to fully document short- and long-term impacts associated with the oil spill and response activities.

Kalamazoo River - Macroinvertebrates

The 2012 macroinvertebrate results for the Kalamazoo River sites (K1, K2, K3, and K4) are presented in Table 5. Macroinvertebrate metrics, scores, and ratings are presented in Table 6. The stations are situated in an upstream to downstream sequence as depicted in Figure 1. The control station on the Kalamazoo River was upstream of the oil spill in Marshall at Kalamazoo Street (Station K1). Three sites on the Kalamazoo River were surveyed in the reach impacted by the oil spill and the associated cleanup activities. Station K2 was located on the Kalamazoo River in the vicinity of the Squaw Lake Drain confluence at about Mile Post 2.75. Station K3 was downstream of the Ceresco Dam at 11 Mile Road approximately at Mile Post 7.25. Station K4 on the Kalamazoo River was located downstream of the city of Battle Creek at Custer Drive at about Mile Post 21.25.

The upstream control site (K1) had an overall macroinvertebrate score of +3 and rating of acceptable. This score is down from the 2011 survey results of (+6/excellent). The reduction in score between the 2011 and 2012 (Table 1) results is largely attributed to the fact that no stoneflies (Plecoptera) were noted in 2012 at this location where two individuals were recorded in 2011. Besides the absence of stoneflies, the overall species composition at Station K1 in 2012 was very similar to 2011 results, with more taxa actually being recorded in 2012 (Table 2).

Station K2 received a score of +8 and a rating of "excellent," which is a slight increase from the 2010 and 2011 rating of excellent (+6). Species composition and diversity was similar to 2011

with 42 taxa recorded in 2011 and 38 identified in 2012. The increase in score can be attributed to a slight decrease in percent dominant taxa and slight increase in percent caddisfly composition.

Downstream at Station K3, the score was +6 with a rating of “excellent.” This station harbored the most diversity of the 2012 Kalamazoo River locations with 42 taxa recorded. The score is a slight increase from +5 in 2011 (Table 1).

Station K4, the most downstream location, produced a score of +4 and a rating of acceptable. As it did in 2010 and 2011, this site produced the least diversity with 28 species documented. This reduction in number of taxa can likely be attributed to the lack of diversity of in-stream substrates, which were abundant at upstream locations. This score is an increase from the score of +1 recorded in 2011. The species composition was similar to that recorded in 2011 (Table 1); a slight change in the percentage composition of some species was the cause of this increase in score.

Macroinvertebrate Abundance

Procedure 51 is a qualitative collection method that involves sampling all available in-stream habitats to produce a composite macroinvertebrate sample that is typically sub-sampled until 300 organisms have been identified and counted. After 300 organisms have been counted, the remainder of the composite sample is examined for large and/or rare organisms that were not identified in the initial sub-samples. These organisms are added as one individual to the total taxa list. Typically, only a small volume of the composite sample is needed to yield the 300 organisms required by Procedure 51. This is especially true in streams such as the Kalamazoo River that have a diversity of in-stream habitat types, especially in riffle habitats like those present at Stations K2 and K3. The majority of the sample is typically examined for large and/or rare taxa. Counting the entire composite sample is seldom necessary, except in streams that are either habitat-limited or have serious violations of Michigan’s Water Quality Standards. Macroinvertebrate abundance in the composite samples at the upstream control sites on Talmadge Creek (Stations T1 and T2) and the Kalamazoo River (Station K1) was normal in 2010 and 2011. The abundance of macroinvertebrates in the composite samples collected at all of the impacted sites on Talmadge Creek (Station T3) and Kalamazoo River (Stations K2, K3, and K4) in 2010 was so low that the entire composite sample was counted at all of the sites and the goal of enumerating 300 organisms was not achieved at Station T3 on Talmadge Creek and Station K4 on the Kalamazoo River.

In 2011, the abundance of macroinvertebrates was greater than in 2010 at all of the impacted sites on Talmadge Creek and the Kalamazoo River. It was still necessary to count the entire macroinvertebrate composite sample at the impacted site (Station T3) on Talmadge Creek and two stations (K2 and K4) of the three impacted sites on the Kalamazoo River. The abundance of macroinvertebrates at Station K4 was extremely limited.

In 2012, the abundance of macroinvertebrates was improved relative to results found in 2011 at the impacted sites on Talmadge Creek and the Kalamazoo River in that none of the sites required the complete enumeration of the entire contents of the composite sample. Abundance at Station K4 was still limited in comparison to the upstream sites.

Talmadge Creek - Stream Habitat

Qualitative stream habitat assessment results for 2012 in Talmadge Creek are presented in

Table 7. Stations T2 and T3 both were rated “good,” with Station T2 scoring 138 and Station T3 scoring 125 out of a possible 200. These scores are nearly identical to 2010 results, as little has changed. Again, because of lack of flow and minimal water, Station T1 was not evaluated as it had been in past years.

Riffle habitat at Station T2 was lacking and sand was the predominant substrate, but some gravel and cobble were present along with an abundance of in-stream cover. The riparian corridor was a wide, undisturbed scrub/shrub wetland.

In 2010, the in-stream habitat, stream banks, and adjacent riparian corridor at Station T3 were highly disturbed due to the cleanup activities and were rated as marginal. In 2011, after the August 2011 survey, additional cleanup operations were conducted on Talmadge Creek that involved dredging the stream banks and channel. The overall 2012 habitat score was slightly higher than in 2011, but still on the lower end of “good.” The stream banks and riparian zone were stabilized with vegetative cover and various structures. The stream channel remains narrower than in 2010. Riffle habitat was present, but in-stream cover was still extremely limited. The substrate was primarily sand and small gravel with a limited amount of cobble still present. The disturbance from cleanup activities has effectively created a clean channel that is silt free.

Kalamazoo River - Stream Habitat

The qualitative stream habitat scores for 2012 are presented in Table 8. Results are very similar to the 2011 evaluation. All sites were scored as glide/pool habitat except for Station K3, which had significant riffle/run habitat and was scored as such.

At the upstream control site, Station K1 (17 Mile Road) in-stream habitat was abundant and included moderate amounts of large woody debris, aquatic vegetation, and root wads. The stream substrate was diverse with a nearly equal mixture of cobble, gravel, sand, and silt along with scattered boulders. The only significant detraction from the overall habitat score was the limited width of the riparian zone. This site scored “good” as it did in 2011.

Station K2 (Squaw Lake Drain Confluence) scored on the lower end of “excellent” in comparison to its upper end of “good” rating in 2011. The total score at Station K2 only differed by 7 points with the site receiving 148 in 2011, and 155 in 2012, out of a total of 200 points. In-stream cover was slightly higher and sediment deposition was rated as slightly lower in 2012. The dominant substrates were cobble and gravel with lesser amounts of sand, silt, and boulders. Submergent aquatic vegetation is still only beginning to become established and was present in about 15 percent of the reach.

Station K3 (11 Mile Road) received the exact same score as in 2011, and was rated on the upper end of “good.” Cobble and gravel were the dominant substrates along with scattered boulders and lesser amounts of sand and silt along the stream margins. Others forms of in-stream cover that were still moderately abundant included large woody debris, aquatic vegetation, and root wads. Cleanup operations had nearly eliminated all overhanging vegetation, but regrowth along the river edge is evident. Substantial depositional areas are still observed at this site.

Station K4 (Upstream of Custer Road), is substantially larger in average width and depth than the other sites surveyed (Figure 5). This station was rated “good;” the same as in 2011. The in-stream habitat suitable for colonization is limited at this site, but the wide, forested floodplain helps to increase its habitat score. Sand and silt make up approximately 85 percent of the

substrate at this site, with only small, scattered patches of gravel present. Large woody debris resulting from dead trees and wind storms make up the majority of in-stream habitat. Aquatic vegetation, overhanging vegetation, and undercut banks are also present in limited quantities at this location.

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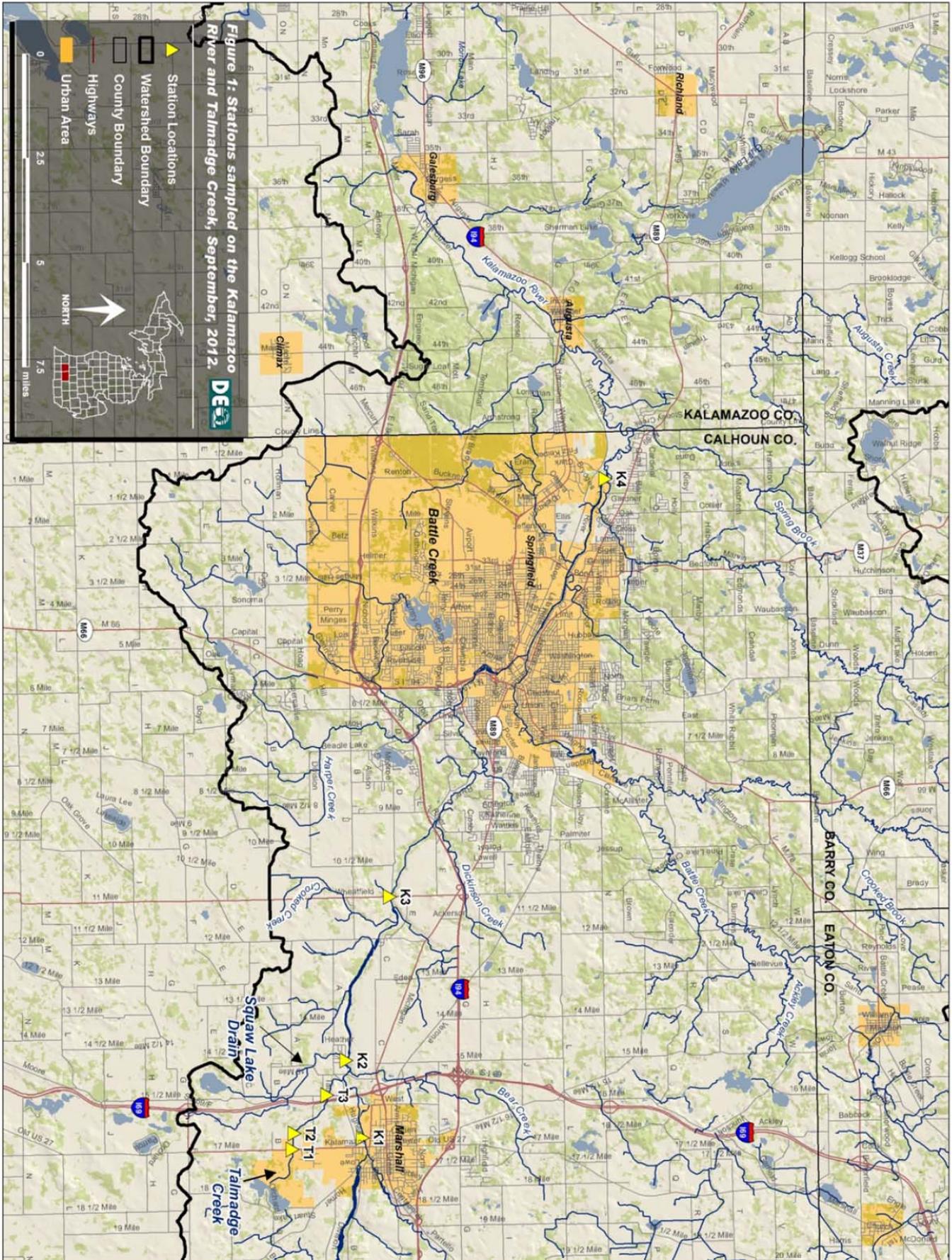


Figure 1. Stations sampled on the Kalamazoo River and Talmadge Creek, September 2012.

Table 3. Qualitative macroinvertebrate sampling results for Talmadge Creek sites, September 2012.

TAXA	Talmadge Creek Downstream of 17 Mile Rd. Station T2 9/11/2012	Talmadge Creek 15 ½ Mile Rd. Station T3 9/11/2012
ANNELIDA (segmented worms)		
Hirudinea (leeches)	1	
Oligochaeta (worms)	1	4
ARTHROPODA		
Crustacea		
Amphipoda (scuds)	203	18
Arachnoidea		
Hydracarina	5	2
Insecta		
Ephemeroptera (mayflies)		
Baetidae	1	13
Caenidae		3
Ephemerellidae		2
Heptageniidae		15
Isonychiidae		20
Odonata		
Anisoptera (dragonflies)		
Aeshnidae	1	
Gomphidae	1	1
Libellulidae	1	
Zygoptera (damselflies)		
Calopterygidae	17	1
Coenagrionidae	1	1
Hemiptera (true bugs)		
Belostomatidae		1
Corixidae	3	3
Gerridae	1	
Mesoveliidae		1
Nepidae		1
Saldidae	5	
Trichoptera (caddisflies)		
Hydropsychidae	2	76
Hydroptilidae		1
Leptoceridae	1	10
Limnephilidae	1	2
Molannidae	1	1
Coleoptera (beetles)		
Dytiscidae (total)	1	
Halplidae (adults)	1	1
Elmidae	1	
Gyrinidae (larvae)		1
Halplidae (larvae)		1
Diptera (flies)		
Ceratopogonidae	1	1
Chironomidae	42	149
Culicidae		2

Table 3. Qualitative macroinvertebrate sampling results for Talmadge Creek sites, September 2012.

	Talmadge Creek Downstream of 17 Mile Rd. Station T2 9/11/2012	Talmadge Creek 15 ½ Mile Rd. Station T3 9/11/2012
Simuliidae		13
Tabanidae	1	
Tipulidae	3	
MOLLUSCA		
Gastropoda (snails)		
Ancylidae (limpets)	2	1
Hydrobiidae		1
Physidae	1	6
Planorbidae	4	2
Pelecypoda (bivalves)		
Sphaeriidae (clams)	18	
TOTAL INDIVIDUALS	321	354

Table 4. Macroinvertebrate metric evaluation at Talmadge Creek sites, September 2012.

	Talmadge Creek Downstream of 17 Mile Rd. Station T2 9/11/2012		Talmadge Creek 15 ½ Mile Rd. Station T3 9/11/2012	
METRIC	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	28	1	30	1
NUMBER OF MAYFLY TAXA	1	0	5	1
NUMBER OF CADDISFLY TAXA	4	1	5	1
NUMBER OF STONEFLY TAXA	0	-1	0	-1
% MAYFLY COMP.	0.31	-1	14.97	0
% CADDISFLY COMP.	1.56	-1	25.42	0
% DOMINANT TAXON	63.24	-1	42.09	-1
% ISOPOD, SNAIL, LEECH	2.49	1	2.82	1
% SURFACE AIR BREATHERS	3.43	1	2.54	1
TOTAL SCORE	0		3	
Community Rating	Acceptable		Acceptable	

Table 5. Qualitative macroinvertebrate sampling results for Kalamazoo River sites, September 2012.

TAXA	Kalamazoo River at Kalamazoo St. (17 Mile Rd.) Station K1 9/11/2012	Kalamazoo River Squaw Lake Drain Confluence Station K2 9/12/2012	Kalamazoo River 11-Mile Rd. Station K3 9/12/2012	Kalamazoo River Custer Drive Station K4 9/12/2012
PLATYHELMINTHES (flatworms)				
Turbellaria	2		1	
ANNELIDA (segmented worms)				
Hirudinea (leeches)	1		1	
Oligochaeta (worms)	1	9	5	
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	109	22	6	5
Decapoda (crayfish)	1	1	1	1
Isopoda (sowbugs)	5		1	3
Arachnoidea				
Hydracarina		1		2
Insecta				
Ephemeroptera (mayflies)				
Baetidae	24	23	63	37
Caenidae	1	4		4
Ephemerellidae	13	5	11	
Heptageniidae	11	8	3	2
Isonychiidae		3	7	
Leptophlebiidae				1
Tricorythidae	3	19	3	8
Odonata				
Anisoptera (dragonflies)				
Aeshnidae		1	1	1
Gomphidae	1			1
Zygoptera (damselflies)				
Calopterygidae	6	3	3	
Coenagrionidae	18	3	1	32
Plecoptera (stoneflies)				
Pteronarcyidae		2	1	
Hemiptera (true bugs)				
Corixidae	4			1
Gerridae	1		1	6
Mesoveliidae		1		1
Nepidae	1			
Pleidae	1			7
Megaloptera				
Corydalidae (dobson flies)		1		
Sialidae (alder flies)	1		1	
Trichoptera (caddisflies)				
Brachycentridae	40	3	1	1
Glossosomatidae			1	
Helicopsychidae	3	26	2	
Hydropsychidae	34	54	80	85
Hydroptilidae	3	1	2	6

Table 5. Qualitative macroinvertebrate sampling results for Kalamazoo River sites, September 2012.

	Kalamazoo River at Kalamazoo St. (17 Mile Rd.) Station K1 9/11/2012	Kalamazoo River Squaw Lake Drain Confluence Station K2 9/12/2012	Kalamazoo River 11-Mile Rd. Station K3 9/12/2012	Kalamazoo River Custer Drive Station K4 9/12/2012
Leptoceridae	7	8	1	1
Limnephilidae	4		1	
Philopotamidae	3	1		
Polycentropodidae	1			2
Uenoidae		2	27	2
Lepidoptera (moths)				
Pyrilidae		1	1	1
Coleoptera (beetles)				
Gyrinidae (adults)	1			
Elmidae	8	3	6	19
Haliplidae (larvae)	1			
Psephenidae (larvae)		3		
Diptera (flies)				
Ceratopogonidae			1	
Chironomidae	15	44	34	77
Culicidae		1	2	
Simuliidae	16	12	19	4
Tabanidae	1		1	
Tipulidae		1		
MOLLUSCA				
Gastropoda (snails)				
Ancylidae (limpets)	8	1	1	8
Hydrobiidae		4	4	
Lymnaeidae	3	10	36	
Physidae	4	2	5	
Planorbidae	1	1	3	4
Pleuroceridae	1	7	13	
Viviparidae			1	
Pelecypoda (bivalves)				
Corbiculidae	1	13	3	
Sphaeriidae (clams)	6	8	8	
Unionidae (mussels)			1	
TOTAL INDIVIDUALS	365	312	364	322

Table 6. Macroinvertebrate metric evaluation at Kalamazoo River sites, September 2012.

METRIC	Kalamazoo River at Kalamazoo St. (17 Mile Rd.) Station K1 9/11/2012		Kalamazoo River Squaw Lake Drain Confluence Station K2 9/12/2012		Kalamazoo River 11-Mile Rd. Station K3 9/12/2012		Kalamazoo River Custer Drive Station K4 9/12/2012	
	Value	Score	Value	Score	Value	Score	Value	Score
	TOTAL NUMBER OF TAXA	40	1	38	1	42	1	28
NUMBER OF MAYFLY TAXA	5	1	6	1	5	1	5	1
NUMBER OF CADDISFLY TAXA	8	1	7	1	8	1	6	1
NUMBER OF STONEFLY TAXA	0	-1	1	1	1	1	0	-1
% MAYFLY COMP.	14.25	0	19.87	1	23.90	1	16.15	0
% CADDISFLY COMP.	26.03	0	30.45	1	31.59	1	30.12	1
% DOMINANT TAXON	29.86	0	17.31	1	21.98	0	26.40	0
% ISOPOD, SNAIL, LEECH	6.30	0	8.01	0	17.86	-1	4.66	0
% SURFACE AIR BREATHERS	2.19	1	0.64	1	0.82	1	4.66	1
TOTAL SCORE	3		8		6		4	
Community Rating	Acceptable		Excellent		Excellent		Acceptable	

Table 7. Habitat evaluation for Talmadge Creek sites, September 2012.

HABITAT METRIC	Talmadge Creek Downstream of 17 Mile Rd. Station T2 9/11/2012 RIFFLE/RUN		Talmadge Creek 15 ½ Mile Rd. Station T3 9/11/2012 RIFFLE/RUN	
	Substrate and Instream Cover			
Epifaunal Substrate/ Available Cover (20)		11		8
Embeddedness (20)*		11		14
Velocity/Depth Regime (20)*		11		11
Pool Substrate Characterization (20)**				
Pool Variability (20)**				
Channel Morphology				
Sediment Deposition (20)		11		13
Flow Status - Maintained Flow Volume (10)		8		8
Flow Status - Flashiness (10)		9		8
Channel Alteration (20)		13		5
Frequency of Riffles/Bends (20)*		8		16
Channel Sinuosity (20)**				
Riparian and Bank Structure				
Bank Stability (L) (10)		9		8
Bank Stability (R) (10)		9		8
Vegetative Protection (L) (10)		9		6
Vegetative Protection (R) (10)		9		6
Riparian Veg. Zone Width (L) (10)		10		7
Riparian Veg. Zone Width (R) (10)		10		7
TOTAL SCORE (200):		138		125
HABITAT RATING:		GOOD		GOOD
		(SLIGHTLY IMPAIRED)		(SLIGHTLY IMPAIRED)
Date:		9/11/2012		9/11/2012
Weather:		Sunny		Sunny
Air Temperature:		65 °F		70 °F
Water Temperature:		58°F		65°F

Table 7. Habitat evaluation for Talmadge Creek sites, September 2012.

	Talmadge Creek Downstream of 17 Mile Rd. Station T2 9/11/2012	Talmadge Creek 15 1/2 Mile Rd. Station T3 9/11/2012
Average Stream Width:	5 ft.	8 ft.
Average Stream Depth:	0.2 ft.	0.25 ft.
Surface Velocity:	0.2 ft./sec	0.5 ft./sec
Estimated Flow:	0.2 cfs	1 cfs
Stream Modifications:	None	Dredged
Nuisance Plants (Y/N):	N	N
Report Number:	MI/DEQ/WRD-13/011	MI/DEQ/WRD-13/011
STORET No.:	130405	130335
Stream Name:	Talmadge Creek	Talmadge Creek
Road Crossing/Location:	D/S of 17 Mile Road	15 1/2 Mile Road
County Code:	13	13
TRS:	03S06W02	02S06W34
Latitude (dd):	42.2402	42.251717
Longitude (dd):	-84.97066	-84.9885712
Ecoregion:	SMNITP	SMNITP
Stream Type:	Warmwater	Warmwater
USGS Basin Code:	4050003	4050003

* Applies only to Riffle/Run stream Surveys

** Applies only to Glide/Pool stream Surveys

Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Rating describes the general riverine environment at the site(s).

Table 8. Habitat evaluation for Kalamazoo River sites, September 2012.

HABITAT METRIC	Kalamazoo River at Kalamazoo St. (17 Mile Rd.) Station K1	Kalamazoo River Squaw Lake Drain Confluence Station K2	Kalamazoo River 11-Mile Rd. Station K3	Kalamazoo River Custer Drive Station K4
	GLIDE/POOL	GLIDE/POOL	RIFFLE/RUN	GLIDE/POOL
Substrate and Instream Cover				
Epifaunal Substrate/ Available Cover (20)	18	15	15	10
Embeddedness (20)*			16	
Velocity/Depth Regime (20)*			13	
Pool Substrate Characterization (20)**	18	16		13
Pool Variability (20)**	16	15		8
Channel Morphology				
Sediment Deposition (20)	16	18	13	11
Flow Status - Maintained Flow Volume (10)	9	8	8	7
Flow Status - Flashiness (10)	7	7	8	4
Channel Alteration (20)	18	18	16	15
Frequency of Riffles/Bends (20)*			11	
Channel Sinuosity (20)**	13	13		8
Riparian and Bank Structure				
Bank Stability (L) (10)	9	8	8	9
Bank Stability (R) (10)	9	8	8	9
Vegetative Protection (L) (10)	1	9	4	9
Vegetative Protection (R) (10)	8	6	9	9
Riparian Veg. Zone Width (L) (10)	1	10	4	10
Riparian Veg. Zone Width (R) (10)	5	4	10	10

Table 8. Habitat evaluation for Kalamazoo River sites, September 2012.

	Kalamazoo River at Kalamazoo St. (17 Mile Rd.) Station K1	Kalamazoo River Squaw Lake Drain Confluence Station K2	Kalamazoo River 11-Mile Rd. Station K3	Kalamazoo River Custer Drive Station K4
TOTAL SCORE (200):	148	155	143	132
HABITAT RATING:	GOOD (SLIGHTLY IMPAIRED)	EXCELLENT (NON-IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)
Date:	9/11/2012	9/12/2012	9/12/2012	9/12/2012
Weather:	Sunny	Sunny	Sunny	Sunny
Air Temperature:	75°F	70°F	75°F	79°F
Water Temperature:	68°F	65°F	68°F	74°F
Average Stream Width:	120 ft.	210 ft.	160 ft.	360 ft.
Average Stream Depth:	2.5 ft.	1.3 ft.	1.2 ft.	1.5 ft.
Surface Velocity:	0.6 ft./sec	1 ft./sec	1.1 ft./sec	0.7 ft./sec
Estimated Flow:	180 cfs	273 cfs	211.2 cfs	378 cfs
Stream Modifications:	None	None	None	None
Nuisance Plants (Y/N):	N	N	N	N
Report Number:	MI/DEQ/WRD-13/011	MI/DEQ/WRD-13/011	MI/DEQ/WRD-13/011	MI/DEQ/WRD-13/011
STORET No.:	130211	130406	130048	130052
Stream Name:	Kalamazoo River	Kalamazoo River	Kalamazoo River	Kalamazoo River
Road Crossing/Location:	u/s Marshall WWTP - d/s Kalamazoo St.	Squaw Lake Drain confluence	11-Mile Road	Custer Drive
County Code:	13	13	13	13
TRS:	02S06W26	02S06W33	02S07W25	01S08W29
Latitude (dd):	42.26391	42.25852	42.27429	42.35074
Longitude (dd):	-84.96836	-85.00469	-85.08097	-85.27561
Ecoregion:	SMNITP	SMNITP	SMNITP	SMNITP
Stream Type:	Warmwater	Warmwater	Warmwater	Warmwater
USGS Basin Code:	4050003	4050003	4050003	4050003

* Applies only to Riffle/Run stream Surveys

** Applies only to Glide/Pool stream Surveys

Note: Individual metrics may better describe conditions directly affecting the biological community while the Habitat Rating describes the general riverine environment at the site(s).



Figure 2. Site T1 upstream reference site. This site is more of a wetland site than the more downstream locations (T2 and T3). T1 was unable to be sampled in 2012 due to low water levels. Photo taken by William Taft, 2011.

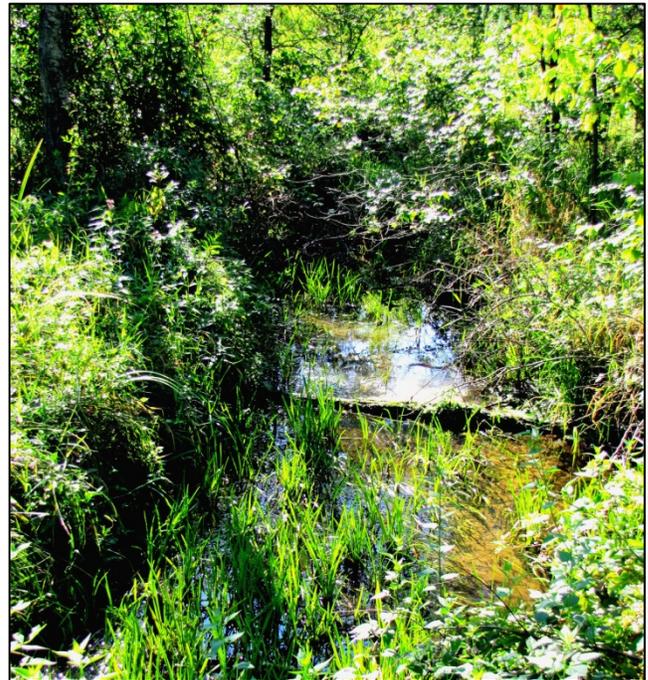


Figure 4. Site T2 upstream reference location. This site was sampled as a reference location in 2010, 2011, and 2012. T2 is heavily vegetated and comparable in flow to T3 (impacted site). Photo by William Taft, 2011.



Figure 3. Site T3 on Talmadge Creek. Image shows open canopy and artificial structure along stream bank. Photo by William Taft, 2011.

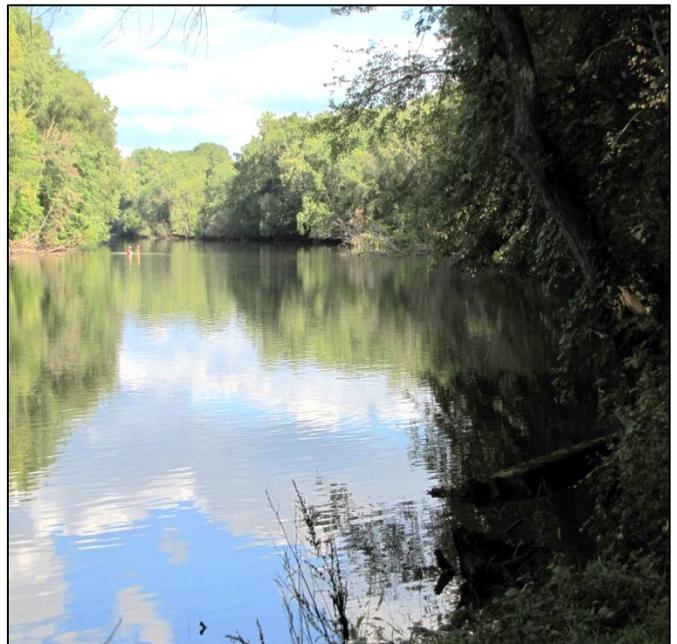


Figure 5. Site K4, Upstream of Custer Drive on the Kalamazoo River. This site is much wider and slower than any of the upstream Kalamazoo River or Talmadge Creek Sites. Photo by William Taft, 2011.