MI/EGLE/WRD-21/001

MICHIGAN DEPARTMENT OF ENVIRONMENT, GREAT LAKES, AND ENERGY
WATER RESOURCES DIVISION
JANUARY 2021

STAFF REPORT

Biological surveys of selected stations in the White River and Duck Creek watersheds, Oceana, Newaygo, and Muskegon Counties, Michigan; July-September 2017

Introduction

Biological and physical habitat conditions of 11 selected water bodies in the White River and Duck Creek watersheds in Oceana, Newaygo, and Muskegon Counties were assessed by staff of the Michigan Department of Environment, Great Lakes, and Energy (EGLE), Surface Water Assessment Section (SWAS), in July-September 2017. *E. coli* monitoring was also conducted at nine sites throughout the White River watershed, and those results are summarized in a separate report (Rippke, 2018).

The primary objectives of the biological assessments were to:

1) Assess the current condition of individual water bodies and determine if Michigan Water Quality Standards (WQS) are being met.
2) Identify nonpoint sources of water quality impairment.
3) Evaluate statewide biological community status and temporal trends.

Watershed Information

History and Geography

The study area for this survey included 560 square miles, covering fifteen 12-digit Hydrologic Unit Codes (HUC) in the White River watershed, plus Duck Creek (Figure 1). The human population of the study area in 2010 was about 38,000 people, living in an estimated 17,800 housing units (U.S. Census Bureau, 2010 and 2012). Major urban centers include Whitehall and Montague (near White Lake at the confluence with Lake Michigan) and several small towns including New Era, Rothbury, and Hesperia. For the most part, urbanization is concentrated along the Lake Michigan and White Lake shorelines. Septic systems are the sewage treatment method for about 13,600 housing units in study area. White Lake is a 2,570-acre coastal drowned river mouth lake and was formerly a federally designated Area of Concern. Priorities of the Area of Concern include contaminated sediment remediation, eutrophication control, wildlife habitat restoration, and former industrial site contamination removal. Facilities that once contaminated the area include Oxy Chem / Hooker Chemical, Koch Chemical, DuPont, a historic tannery site (with contamination dating back to 1866), and Occidental. Dredging to remove the contaminated sediment has been completed and the beneficial use impairments have been removed.

Water velocity, stream morphology, and flow are influenced by the gradient, or slope, of the stream. Flow conditions of the river at survey sites are a key factor in determining aquatic macroinvertebrate and fish community composition. The gradient, described as meters of elevation change over 1 kilometer (km) of stream length, was calculated within each National Hydrography Dataset reach that contained a survey site (Table 1), using U.S. Geological Survey (USGS) Digital Elevation Models.

The White River was used as a "log float" beginning in the mid-1800s when a man named Heald (namesake of Heald Creek) first floated logs downstream to White Lake, where the first water-powered sawmill was built in 1838 (Splka.org/WhiteRiver.html). The last major log drive in the area was in 1903 and the land was left denuded of hemlock and white pine, as well as any large diameter hardwoods (Splka.org/WhiteRiver.html). Both the act of logging and ensuing wildfires were responsible for excessive erosion of the sandy soils into the river.

Modifications were made to the White River's structure in order to float harvested logs downstream. These modifications included the regulation of flow by dams, straightening and narrowing of channels by various piers and wing dams, and homogenization of bed substrate by removal of obstructions (Nilsson et al., 2005).

Flow of the White River is impeded by a dam in Hesperia, Michigan. The presence of a dam in this location is believed to date back to 1860, supplying electrical power beginning in 1911 (WestMichiganAngler.com/Rivers/White-River/). The current dam no longer generates electricity and was built in 1977. The impoundment from the dam has a significant warming effect on the river water and impedes fish passage. The impoundment is considered an asset to the community because its excellent warmwater fishery attracts tourism. Another dam is in White Cloud, and was built in 1872, creating a 50-acre lake.

The White River is the southernmost major coldwater river system in the lower peninsula and roughly 80 percent of the total stream mileage carries a coldwater designation. Coldwater streams have water temperatures appropriate to supporting breeding populations of coldwater-adapted fish, such as trout, and are afforded special protections under Michigan's dissolved oxygen and temperature WQS. Twenty inland lakes, as well as several impoundments, drain to the White River. The lake drainage has a warming effect on the temperature of the water downstream and results in several tributaries being designated to protect warmwater fisheries. Sea lamprey (an exotic, invasive species of fish that parasitizes native fish) is common in the White River system, as the larval phase burrows into the soft sediments that are so common here. The U.S. Fish and Wildlife Service routinely performs lampricide treatments where sea lamprey larva are detected in surveys, mainly in the main stem White River, the North Branch White River, and the lower portions of tributaries downstream of Hesperia, Michigan.

Portions of the White River (about 70 miles of the main stem and 93 miles of tributaries) are designated as a "Natural River" by the State of Michigan. The Michigan Department of Natural Resources developed a Natural River Plan for the White River (Michigan.gov/Documents/White River Plan). The purpose of the natural river designation is to protect the natural flow regime, aesthetics, biological communities, and recreational opportunities afforded by the White River, while protecting residents from flood damage that may occur as a result of the free-flowing nature of the river. Around 23 percent of the watershed is within the Manistee National Forest.

The study area is located in the Southern Lake Michigan Lake Plain, Manistee, and Newaygo Outwash subsections of the Regional Landscape Ecosystem (Albert, 1995). The Manistee and Southern Lake Michigan Lake Plain subsections have a climate that is moderated by Lake Michigan, resulting in a long growing season and protection from late spring frosts, making the area ideal for commercial fruit production. There is no exposed bedrock in the study area. The topography is diverse, including sand dunes, sand lake plains, moraines, and outwash. The dominant soil texture in the study area is excessively drained sandy soils. Some areas were too sandy to support agriculture and are now abandoned to field succession. The steep eroding banks of the White River are an artifact of the river's natural deep trenching into the sandy substrate, although in some areas this was exacerbated by historic logging activities. The Newaygo Outwash Plain was dominated by large white pine trees in the presettlement era, which were excessively logged and moved downstream via the White River. Following the deforestation, white pine regeneration was poor, and uplands are currently dominated by white oak and black oak. White pines are present in the understory but are subject to severe browsing by white-tailed deer. Closer to Lake Michigan, in the Manistee and Southern Lake Michigan Lake Plain, hemlock and aspen are more common.

Land Cover

Land cover, or the types of vegetation or anthropogenic uses covering the land, has a bearing on stream hydrology, sediment transport (erosion), and water temperature. For example, agricultural land covers generally lose more topsoil by sheet and gully erosion than a forested land would, while developed land with its impervious surfaces would generally increase runoff and decrease infiltration during precipitation or snow melt events. The 2011-era land cover for the study area is approximately 7.5 percent developed land, 14 percent cultivated, 4 percent pasture/hay, 73 percent natural land cover types (50 percent upland forest/grassland, 13 percent wetland, and about 10 percent other) with less than 2 percent water and bare land (Table 2) (National Oceanic and Atmospheric Administration [NOAA], 2011). From land cover data, a swath of agricultural activity occurs in Brayton Drain (41 percent cultivated land cover), Pierson Drain (41 percent cultivated land cover) and western portions of Black (Delong) Creek. Recognizing that the riparian zone has the greatest impact on aquatic ecosystems, 2011-era land cover was also analyzed within a 30-meter buffer of each stream, within each subwatershed. This revealed drastic differences in riparian zone condition among the subwatersheds in the study area (Table 2). Only 27 percent of the immediate riparian zone was occupied by natural land cover types in the Pierson Drain subwatershed, while the Five Mile subwatershed had 95 percent of the immediate riparian zone occupied by natural land cover types. Pierson Drain has also lost 82 percent of its presettlement wetland area. The remainder of the subwatersheds have lost between 1.5 to 22 percent of presettlement wetland area (Fizzell, 2015).

Historical Sampling Efforts and Information

Most recently, the White River watershed was surveyed at 17 sites by EGLE staff in 2012. Overall, the macroinvertebrate communities in the White River were acceptable or excellent, ranging in score from -1 (acceptable) to +8 (excellent) on a scale of -9 to +9. Habitat ratings ranged from 93 (marginal) to 159 (excellent) on a scale of 0 to 200. In addition to biological surveys, analyses of 2006-era land cover, human population, and river reach gradient were completed (Rippke, 2013).

Methods

The macroinvertebrate community and physical habitat were qualitatively assessed at ten stations (Table 1) using SWAS Procedure 51 (Creal et al., 1996; MDEQ, 1990) for wadeable streams. One additional station was visited, and it was determined that the procedure was not appropriate due to lack of flow. If a station is at a road crossing, it is sampled upstream unless otherwise noted. The macroinvertebrate communities were assessed and scored with metrics that rate water bodies from excellent (+5 to +9) to poor (-5 to -9). Scores from +4 to -4 are rated acceptable. Negative scores in the acceptable range are considered tending towards a poor rating, while positive scores in the acceptable range are tending towards an excellent rating. Habitat evaluations are based on ten metrics, with a maximum total score of 200. A station with a habitat score greater than 154 is characterized as having excellent habitat, 105-154 is good, 56-104 is marginal, and less than 56 is poor. Where available, macroinvertebrate community scores are used to determine attainment of the Other Indigenous Aquatic Life and Wildlife (OIALW) designated use. Habitat scores and individual metrics are used to help better understand the biological community scores.

Site Selection

Two site-selection methods were used to assess the White River and Duck Creek watersheds in 2013: (1) stratified random; and (2) targeted. Randomly selected sites were assigned to support the SWAS Status (1 site) and Trend (2 sites) Program. Status sites will be used to estimate the statewide support status for the OIALW designated use component of Rule 100 (R 323.1100(e)) of the Part 4 Rules, WQS, promulgated under Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. Trend sites in the White River watershed will be used to facilitate a measurement of statewide biological community temporal trends (MDEQ, 2015). Targeted sites (8 sites) are chosen through the “Targeted Monitoring Request” process, which involves stakeholders from across Michigan submitting monitoring requests. All survey types are considered when assessing support of the OIALW designated use at the local stream reach level.

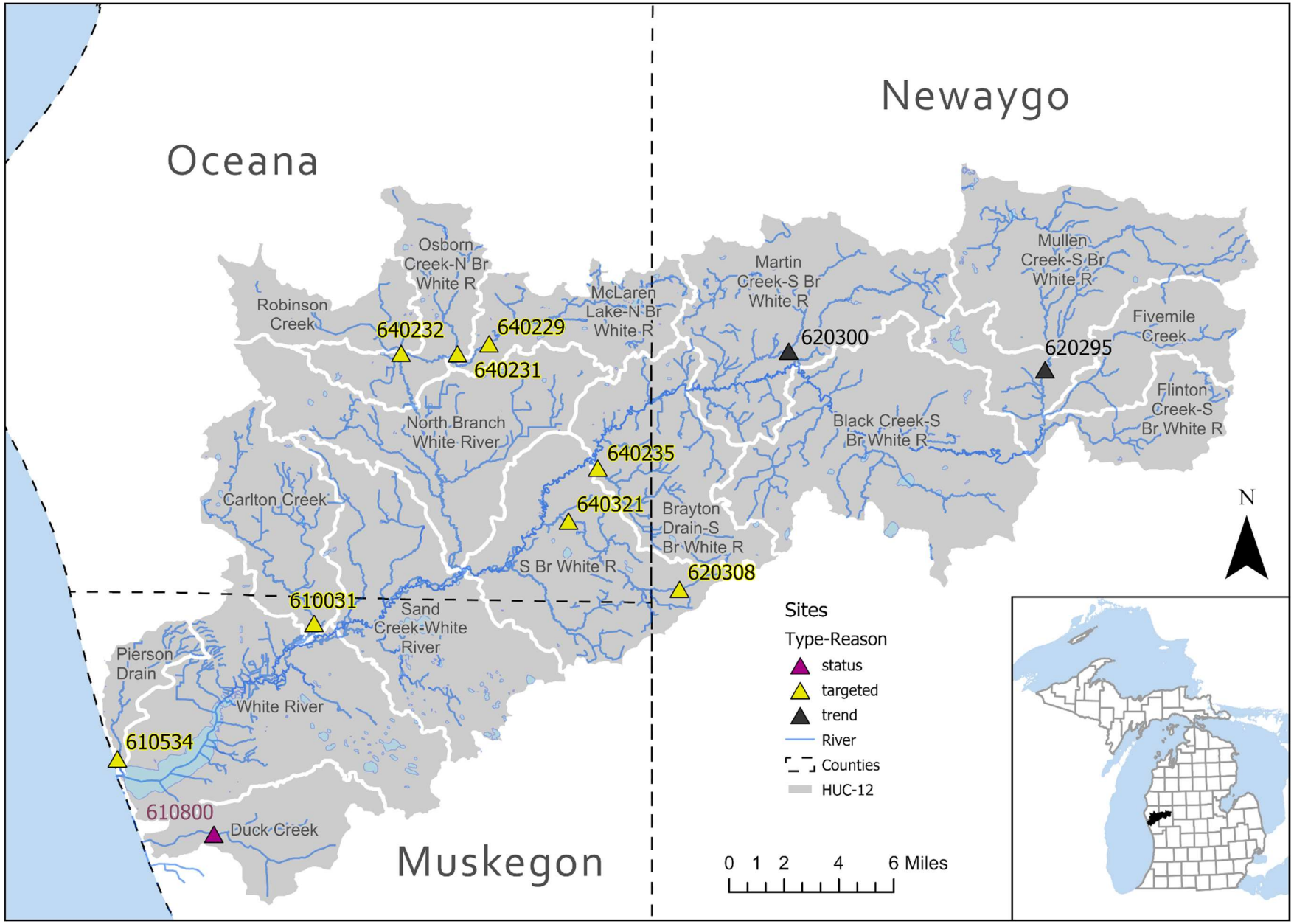

Figure 1. Map of survey sites, by type (reason for sampling), in the White River and Duck Creek area.

Table 1. Survey site locations, stream slopes (meters per kilometer), and results of biological surveys.

Site / WQX	Water Body	Road Crossing	County	HUC-12	Longitude	Latitude	Site Type	Stream Slope (m/km)	Habitat (Score and Rating)	Macro-invertebrates (Score and Rating)
620295	S Br White River	Monroe St	Newaygo	40601010703	-85.7536	43.5909	trend*	3.1	171 (Excellent)	+7 (Excellent)
620300	Martin Creek	Warner Ave	Newaygo	40601010705	-85.9399	43.601	trend*	7.2	162 (Excellent)	+6 (Excellent)
620308	Cushman Creek (Poll Drain)	Dickinson Ave	Newaygo	40601010707	-86.0192	43.4752	targeted	3.4	92 (Marginal)	-1 (Accept.)
640321	Cushman Creek	S 184th Ave	Oceana	40601010707	-86.0998	43.5112	targeted	5.0	152 (Good)	+3 (Accept.)
640229	N Br White River	S 160th Ave	Oceana	40601010801	-86.1577	43.60482	targeted	5.3	175 (Excellent)	+8 (Excellent)
640231	Swinton Creek	E Johnson Rd	Oceana	40601010803	-86.18067	43.59955	targeted	3.4	117 (Good)	+2 (Accept.)
640232	Robinson Creek	E Johnson Rd	Oceana	40601010802	-86.2216	43.5997	targeted	0.5	161 (Excellent)	+3 (Accept.)
640235	Brayton Creek	E Arthur Rd	Oceana	40601010706	-86.0786	43.5392	targeted	2.4	134 (Good)	+5 (Excellent)
610031	Carlton Creek	Fruitvale Rd	Muskegon	40601010902	-86.2842	43.4565	targeted	3.1	171 (Excellent)	+8 (Excellent)
610800	Duck Creek	Orshal Rd	Muskegon	40601011008	-86.35630	43.3453	status*	2.6	136 (Good)	+2 (Accept.)
610534	Pierson Drain	Old Channel Trl	Muskegon	40601010903	-86.42636	43.3848	site visit	1.4	NA	NA

Table 2. Land cover and population information by subwatershed (U.S. Census Bureau, 2012).

HUC 12 Code	Subwatershed Name	Area (sq. mi)	Developed Land (%)	Agricultural (%)	Wetland (%)	Forest (%)	Lost Wetland (% of pre-settlement)	Population (count)	Housing Units (count)	Population Density (persons/ sq. mi.)
40601010701	Mullen Creek-South Branch White River	46.5	4.0	9.0	19.3	59.6	5.8	964	667	21
40601010702	Five Mile Creek	18.7	3.8	18.4	11.6	56.4	2.4	435	221	23
40601010703	Flinton Creek-South Branch White River	29.4	6.6	11.5	13.7	56.4	3.5	1,750	1,040	60
40601010704	Black Creek-South Branch White River	61.5	5.7	20.1	16.0	48.7	7.8	3,932	1,749	64
40601010705	Martin Creek-South Branch White River	49.5	3.6	13.4	17.4	56.1	5.0	1,115	627	23
40601010706	Brayton Drain-South Branch White River	34.0	9.3	52.5	7.8	20.3	12.5	3,175	1,387	93
40601010707	South Branch White River	43.6	4.2	24.8	9.5	52.6	7.0	1,470	572	34
40601010801	McLaren Lake-North Branch White River	23.1	5.2	13.5	13.6	54.7	4.4	900	604	39
40601010802	Robinson Creek	17.2	6.1	37.9	14.5	29.0	15.8	570	246	33
40601010803	Osborn Creek-North Branch White River	22.7	8.1	27.0	9.7	37.4	2.1	927	439	41
40601010804	North Branch White River	45.7	5.3	17.0	16.3	47.5	10.1	1,406	670	31
40601010901	Sand Creek-White River	48.3	4.6	2.7	11.8	69.1	1.5	1,939	945	40
40601010902	Carlton Creek	27.9	8.5	21.6	11.0	44.8	18.5	2,561	1,114	92
40601010903	Pierson Drain	8.8	14.8	55.1	1.3	18.9	82.1	734	382	83
40601010904	White River	61.0	19.6	6.0	7.5	47.1	11.1	12,884	5,883	211
40601011008	Duck Creek	21.8	13.7	2.5	9.7	55.6	22.5	3,150	1,257	145
Sum	Entire Study Area	560	7.5	17.6	12.7	49.8	8.5	37,911	17,803	68

Summary of Findings by Monitoring Objective

Objective 1: Assess the current status and condition of individual waters of the state and determine whether Michigan WQS are being met.

In 2017, aquatic macroinvertebrate community and habitat assessments were conducted at a total of ten stations and all sites scored in the acceptable to excellent range. Macroinvertebrate community scores ranged from -1 (acceptable) to +8 (excellent) (Table **1** and Table **4**). Habitat score ranged from 92 (marginal) to 175 (excellent) (Table **1** and

Table 3). Pierson Drain at Old Channel Trail (610534) was not suitable for assessing macroinvertebrate communities and habitat due to lack of flow and isolated pools. However, at the time of the site visit, the bridge was washed out, demonstrating high erosion potential and flashiness. The lowest scoring site was Cushman Creek at Dickinson Avenue (620308) for both habitat and macroinvertebrate community. Cushman Creek in this headwaters area, also known as Poll Drain, has been straightened in the distant past and deep soft muck was noted along the banks. The low ratings in both habitat and macroinvertebrate community are likely a result of that channelization. Slimes were also noted in the perifluvial zone on the north bank; though no obvious source was present, groundwater inputs were hypothesized due to the presence of watercress. A faulty septic system contaminating groundwater entering the creek is a potential cause that should be investigated. Further downstream, Cushman Creek at 184th Road (640321) was targeted for monitoring because it had previously scored low acceptable in 2012 surveys (Rippke, 2013). In the 2017 survey, the macroinvertebrate score was +3 (acceptable). The difference appears to be due to normal variation since there were no significant land use changes or other obvious issues.

Objective 2: Identify nonpoint sources of water quality impairment

Overall, road stream crossings with older culverts continue to be an issue requiring attention. During this survey, it was noted that the culvert in the South Branch White River at Monroe Road (620295) was perched (also noted in the 2012 surveys). Perched culverts may be a barrier to fish passage. Erosion and sediment deposition, as well as scums on the surface of the water, were noted in Brayton Drain upstream of Arthur Road (640235; Figure 2). Brayton Drain is 52% agricultural land cover (Table 2). In an *E. coli* study of tributaries to the White River, Brayton Drain also had very elevated levels during dry weather and exceeded the partial body contact recreation WQS on all five dates monitored (Rippke, 2018). In 2020, EGLE conducted a bacterial source tracking study of multiple tributaries to Brayton Drain to locate sources (results will be published at the completion of the study).

Figure 2. Erosion, sediment deposition, and surface scums were noted in Brayton Drain, which has a relatively high amount of agriculture in the subwatershed.

Objective 3: Evaluate statewide biological community status, and statewide temporal trends.

Beginning in 2016, the Water Resources Division decreased the sampling effort used to develop statistical assessment evaluations of macroinvertebrate communities in rivers and streams at the watershed scale in favor of obtaining statewide estimates only. In 2017, one randomly selected site (Duck Creek at Orshal Road) was sampled to support statewide attainment status calculation for the OIALW designated use.

Two stations (Table 1) are trend stations and will be sampled every five years. Statewide trend information cannot be summarized until 2021, when enough data have been collected. On a per site basis, Martin Creek at Warner Road (620300) scored excellent in 2017 and 2012 (+6 and +7, respectively) and acceptable in 2007 (+2) (Rippke, 2008 and 2013). The South Branch White River at Monroe Road (620295) had an excellent macroinvertebrate rating in 2017 (+7), and an acceptable rating in 2012 and 2007 (+3 and +4, respectively) (Rippke, 2008 and 2013).

Conclusions and Future Monitoring Recommendations

Macroinvertebrate communities scored acceptable to excellent at all sites, while habitat rated from marginal to excellent. *E. coli* issues were documented throughout the watershed and those results are in a separate report. Cushman Creek at 184th Road was part of the 2017 *E. coli* study, and the site exceeded the daily maximum total body contact WQS on 3 of the 5 events (Rippke, 2018). Because of the slimes noted above, Cushman Creek (Poll Drain) at Dickinson Avenue (620308) should be investigated for failing septic system issues, with *E. coli* monitoring in that specific location as a first step.

Field Work By:

Molly Rippke, Matthew Wesener, and Dawn Roush, Aquatic Biologists
Surface Water Assessment Section
Water Resources Division

Report By:

Molly Rippke, Aquatic Biology Specialist
Ryan Baldwin, Aquatic Biologist
Surface Water Assessment Section
Water Resources Division

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Table 3. Habitat evaluation for selected stations in the White River and Duck Creek watersheds.

	620295 South Branch White River Monroe Road 7/7/2017	620300 Martin Creek Warner Avenue 7/7/2017	620308 Cushman Creek (Poll Drain) Dickinson Road 9/19/2017	640321 Cushman Creek 184th Avenue 9/5/2017
HABITAT METRIC	**RIFFLE/RUN**	**GLIDE/POOL**	**GLIDE/POOL**	**RIFFLE/RUN**
Substrate and Instream Cover				
Epifaunal Substrate/ Available Cover (20)	11	10	5	15
Embeddedness (20)*	16			12
Velocity/Depth Regime (20)*	15			14
Pool Substrate Characterization (20)**		10	8	
Pool Variability (20)**		18	3	
Channel Morphology				
Sediment Deposition (20)	16	10	6	12
Flow Status – Maint. Flow Volume (10)	10	10	9	9
Flow Status - Flashiness (10)	9	9	8	9
Channel Alteration (20)	18	19	11	20
Frequency of Riffles/Bends (20)*	18			18
Channel Sinuosity (20)**		18	5	
Riparian and Bank Structure				
Bank Stability (L) (10)	10	10	7	4
Bank Stability (R) (10)	10	10	9	7
Vegetative Protection (L) (10)	9	9	6	4
Vegetative Protection (R) (10)	9	9	8	8
Riparian Vegetative Zone Width (L) (10)	10	10	4	10
Riparian Vegetative Zone Width (R) (10)	10	10	3	10
TOTAL SCORE (200):	171	162	92	152
HABITAT RATING:	**EXCELLENT**	**EXCELLENT**	**MARGINAL**	**GOOD**
Weather:	Sunny	Sunny	Partly Cloudy	Sunny
Air Temperature: ºF	75	78	85	85
Water Temperature: ºF	65	67	64	61
Average Stream Width: Feet	32	23.1	8	14
Average Stream Depth: Feet	1	1.6	0.3	0.7
Surface Velocity: Feet/Second	3.6	1.3	0.6	1.3
Estimated Flow: Cubic Feet/Second	123.9	49.0	1.2	12.7
Stream Modifications:	None	None	Dredged	None
Nuisance Plants (Y/N):	N	N	N	N
STORET No.:	620295	620300	620308	640321
County Code:	62	62	62	64
TRS:	14N12W21	14N14W13	13N14W32	13N15W22
Latitude (dd):	43.5909	43.601	43.4752	43.5112
Longitude (dd):	-85.7536	-85.9399	-86.0192	-86.0997
Ecoregion:	SMNITP	SMNITP	SMNITP	SMNITP
Stream Type:	Coldwater	Coldwater	Coldwater	Coldwater
USGS Basin Code:	4060101	4060101	4060101	4060101

*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).

	640229 North Branch White River 160th 9/20/2017	640231 Swinton Creek Johnson Rd 9/20/2017	640232 Robinson Creek Johnson Rd 9/25/2017	640235 Brayton Creek Arthur Rd 9/19/2017
HABITAT METRIC	**GLIDE/POOL**	**GLIDE/POOL**	**GLIDE/POOL**	**RIFFLE/RUN**
Substrate and Instream Cover				
Epifaunal Substrate/ Available Cover (20)	13	6	11	11
Embeddedness (20)*				10
Velocity/Depth Regime (20)*				15
Pool Substrate Characterization (20)**	18	6	15	
Pool Variability (20)**	18	10	15	
Channel Morphology				
Sediment Deposition (20)	13	10	14	10
Flow Status – Maint. Flow Volume (10)	10	9	10	9
Flow Status - Flashiness (10)	9	8	9	7
Channel Alteration (20)	18	17	16	20
Frequency of Riffles/Bends (20)*				16
Channel Sinuosity (20)**	20	16	13	
Riparian and Bank Structure				
Bank Stability (L) (10)	9	6	9	5
Bank Stability (R) (10)	9	6	9	7
Vegetative Protection (L) (10)	9	8	10	8
Vegetative Protection (R) (10)	9	8	10	8
Riparian Vegetative Zone Width (L) (10)	10	2	10	4
Riparian Vegetative Zone Width (R) (10)	10	5	10	4
TOTAL SCORE (200):	175	117	161	134
HABITAT RATING:	**EXCELLENT**	**GOOD**	**EXCELLENT**	**GOOD**
Weather:	Cloudy	Sunny	Partly Cloudy	Partly Cloudy
Air Temperature: ºF	66	75	65	72
Water Temperature: ºF	60	58	57	64
Average Stream Width: Feet	16	19.7	16	21
Average Stream Depth: Feet	1.1	0.6	1.4	0 .5
Surface Velocity: Feet/Second	0.9	1.4	1.2	1.3
Estimated Flow: Cubic Feet/Second	14.4	15.6	27.5	14.0
Stream Modifications:	None	None	None	None
Nuisance Plants (Y/N):	N	N	N	N
STORET No.:	640229	640231	640232	640235
County Code:	64	64	64	64
TRS:	14N15W18	14N16W14	14N16W16	13N15W11
Latitude (dd):	43.60482	43.59955	43.59971	43.53909
Longitude (dd):	-86.15769	-86.18067	-86.22163	-86.07841
Ecoregion:	SMNITP	SMNITP	SMNITP	SMNITP
Stream Type:	Coldwater	Coldwater	Coldwater	Coldwater
USGS Basin Code:	4060101	4060101	4060101	4060101

*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).

	610031 Carlton Creek Fruitvale Rd. 9/19/2017	610800 Duck Creek Orshal Road 9/19/2017		
HABITAT METRIC	**GLIDE/POOL**	**GLIDE/POOL**		
Substrate and Instream Cover				
Epifaunal Substrate/ Available Cover (20)	15	11		
Embeddedness (20)*				
Velocity/Depth Regime (20)*				
Pool Substrate Characterization (20)**	16	10		
Pool Variability (20)**	10	10		
Channel Morphology				
Sediment Deposition (20)	13	8		
Flow Status – Maint. Flow Volume (10)	10	8		
Flow Status - Flashiness (10)	10	7		
Channel Alteration (20)	19	16		
Frequency of Riffles/Bends (20)*				
Channel Sinuosity (20)**	18	10		
Riparian and Bank Structure				
Bank Stability (L) (10)	10	9		
Bank Stability (R) (10)	10	9		
Vegetative Protection (L) (10)	10	9		
Vegetative Protection (R) (10)	10	9		
Riparian Vegetative Zone Width (L) (10)	10	10		
Riparian Vegetative Zone Width (R) (10)	10	10		
TOTAL SCORE (200):	171	136		
HABITAT RATING:	**EXCELLENT**	**GOOD**		
Weather:	Sunny	Cloudy		
Air Temperature: ºF	70	70		
Water Temperature: ºF	60	60		
Average Stream Width: Feet	28	22		
Average Stream Depth: Feet	1	0.6		
Surface Velocity: Feet/Second	1.3	1.1		
Estimated Flow: Cubic Feet/Second	38.1	15.4		
Stream Modifications:	None	None		
Nuisance Plants (Y/N):	N	N		
STORET No.:	610031	610800		
County Code:	61	61		
TRS:	12N17W01	11N17W16		
Latitude (dd):	43.4565	43.34537		
Longitude (dd):	-86.2842	-86.3563		
Ecoregion:	SMNITP	SMNITP		
Stream Type:	Coldwater	Coldwater		
USGS Basin Code:	4060101	4060101		

*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 4. Qualitative macroinvertebrate community sampling results at selected stations in White River and Duck Lake watersheds.

TAXA	South Branch White River Monroe Road 7/7/2017 620295	Martin Creek Warner Avenue 7/7/2017 620300	Cushman Creek (Poll Drain) Dickinson Road 9/19/2017 620308	Cushman Creek 184th Avenue 9/5/2017 640321
PLATYHELMINTHES (flatworms)				
Turbellaria	1		4	
ANNELIDA (segmented worms)				
Hirudinea (leeches)			5	
Oligochaeta (worms)	19	1	2	2
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	12	5	124	140
Decapoda (crayfish)		1		2
Arachnoidea				
Hydracarina	8		2	1
Insecta				
Ephemeroptera (mayflies)				
Baetiscidae		1		
Baetidae	23	9		10
Caenidae	1	3		
Ephemerellidae	8	1		23
Ephemeridae		1		
Heptageniidae	1		1	11
Isonychiidae		1		
Tricorythidae	21	8		
Odonata				
Anisoptera (dragonflies)				
Aeshnidae	3	6		1
Gomphidae				1
Zygoptera (damselflies)				
Calopterygidae	4	4	3	9
Plecoptera (stoneflies)				
Perlidae		2		4
Hemiptera (true bugs)				
Corixidae			1	
Gerridae	1			
Notonectidae			3	

TAXA	South Branch White River Monroe Road 7/7/2017 620295	Martin Creek Warner Avenue 7/7/2017 620300	Cushman Creek (Poll Drain) Dickinson Road 9/19/2017 620308	Cushman Creek 184th Avenue 9/5/2017 640321
Veliidae			2	
Megaloptera				
Corydalidae (dobson flies)		1		
Sialidae (alder flies)			15	2
Trichoptera (caddisflies)				
Brachycentridae	37	129		41
Glossosomatidae	15	1		5
Hydropsychidae	36	56	9	27
Lepidostomatidae	6			
Leptoceridae		1		5
Limnephilidae	2	1		
Phryganeidae		1	1	1
Polycentropodidae				2
Uenoidae	1			
Coleoptera (beetles)				
Dytiscidae (total)		1	1	
Haliplidae (adults)			2	
Hydrophilidae (total)		1		
Dryopidae		1		
Elmidae	2	5		12
Diptera (flies)				
Athericidae	1	5		9
Ceratopogonidae		1	1	
Chironomidae	40	26	62	5
Ptychopteridae			1	
Simuliidae	39	2		9
Tabanidae	1	3	1	
Tipulidae		1	1	1
MOLLUSCA				
Gastropoda (snails)				
Ancylidae (limpets)	1	2		
Physidae	1	2	1	
Pelecypoda (bivalves)				
Pisidiidae	1	1		

TAXA	South Branch White River Monroe Road 7/7/2017 620295	Martin Creek Warner Avenue 7/7/2017 620300	Cushman Creek (Poll Drain) Dickinson Road 9/19/2017 620308	Cushman Creek 184th Avenue 9/5/2017 640321
Unionidae (mussels)			1	
TOTAL INDIVIDUALS	285	284	243	323

	South Branch White River Monroe Road 7/7/2017 620295		Martin Creek Warner Avenue 7/7/2017 620300		Cushman Creek Dickinson Road 9/19/2017 620308		Cushman Creek 184th Avenue 9/5/2017 640321	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	26	1	33	1	22	0	23	0
NUMBER OF MAYFLY TAXA	5	1	7	1	1	0	3	0
NUMBER OF CADDISFLY TAXA	6	1	6	1	2	0	6	1
NUMBER OF STONEFLY TAXA	0	-1	1	1	0	-1	1	1
PERCENT MAYFLY COMP.	18.95	1	8.45	0	0.41	-1	13.62	0
PERCENT CADDISFLY COMP.	34.04	1	66.55	1	4.12	0	25.08	0
PERCENT DOMINANT TAXON	14.04	1	45.42	-1	51.03	-1	43.34	-1
PERCENT ISOPOD, SNAIL, LEECH	0.70	1	1.41	1	2.47	1	0.00	1
PERCENT SURF. AIR BREATHERS	0.35	1	0.70	1	4.12	1	0.00	1
TOTAL SCORE		7		6		-1		3
MACROINVERTEBRATE RATING	Excellent		Excellent		Acceptable		Acceptable	

Taxa	North Branch White River 160th 9/20/2017 640229	Swinton Creek Johnson Rd 9/20/2017 640231	Robinson Creek Johnson Rd 9/25/2017 640232	Brayton Creek Arthur Rd 9/19/2017 640235
PLATYHELMINTHES (flatworms)				
Turbellaria				1
ANNELIDA (segmented worms)				
Hirudinea (leeches)				1
Oligochaeta (worms)	1	45	2	8
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	61	115	142	90
Decapoda (crayfish)	3			1
Arachnoidea				
Hydracarina			5	
Insecta				
Ephemeroptera (mayflies)				
Baetiscidae	1			
Baetidae	43	16	34	14
Ephemerellidae		2	14	3
Ephemeridae		1		
Heptageniidae	13		1	48
Leptophlebiidae	2		1	
Polymitarcyidae	1			
Odonata				
Anisoptera (dragonflies)				
Aeshnidae		1	4	5
Cordulegastridae			1	
Gomphidae		4		1
Zygoptera (damselflies)				
Calopterygidae	47	4	11	1
Plecoptera (stoneflies)				
Perlidae	1		1	6
Perlodidae		1		
Pteronarcyidae				2
Hemiptera (true bugs)				
Belostomatidae	6		1	
Corixidae			1	
Gerridae	1	1	1	1

Taxa	North Branch White River 160th 9/20/2017 640229	Swinton Creek Johnson Rd 9/20/2017 640231	Robinson Creek Johnson Rd 9/25/2017 640232	Brayton Creek Arthur Rd 9/19/2017 640235
Nepidae	1			
Notonectidae	1		1	
Saldidae	1			4
Veliidae		1		
Megaloptera				
Corydalidae (dobson flies)	1			1
Sialidae (alder flies)		1	1	1
Trichoptera (caddisflies)				
Brachycentridae	9	7	33	
Glossosomatidae				11
Helicopsychidae			20	
Hydropsychidae	50	13		29
Leptoceridae	8	1		
Limnephilidae	2	1	3	
Philopotamidae				1
Polycentropodidae	3			
Coleoptera (beetles)				
Dytiscidae (total)	1			
Gyrinidae (adults)	1			
Hydrophilidae (total)			1	1
Dryopidae	1			
Elmidae	2	2		7
Diptera (flies)				
Athericidae	2			1
Ceratopogonidae	1			
Chironomidae	18	51	12	9
Ptychopteridae				1
Simuliidae	35	4	6	7
Tabanidae			1	
Tipulidae	3	8	1	3
MOLLUSCA				
Pelecypoda (bivalves)				
Pisidiidae		11		
TOTAL INDIVIDUALS	320	290	298	258

METRIC	North Branch White River 160th 9/20/2017 640229		Swinton Creek Johnson Rd 9/20/2017 640231		Robinson Creek Johnson Rd 9/25/2017 640232		Brayton Creek Arthur Rd 9/19/2017 640235	
	Value	Score	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	30	1	21	0	24	0	27	1
NUMBER OF MAYFLY TAXA	5	1	3	0	4	1	3	0
NUMBER OF CADDISFLY TAXA	5	1	4	0	3	0	3	0
NUMBER OF STONEFLY TAXA	1	1	1	1	1	1	2	1
PERCENT MAYFLY COMP.	18.75	1	6.55	0	16.78	0	25.19	1
PERCENT CADDISFLY COMP.	22.50	0	7.59	0	18.79	0	15.89	0
PERCENT DOMINANT TAXON	19.06	1	39.66	-1	47.65	-1	34.88	0
PERCENT ISOPOD, SNAIL, LEECH	0.00	1	0.00	1	0.00	1	0.39	1
PERCENT SURF. AIR BREATHERS	3.75	1	0.69	1	1.68	1	2.71	1
TOTAL SCORE		8		2		3		5
MACROINVERTEBRATE RATING	Excellent		Acceptable		Acceptable		Excellent	

Taxa	Carlton Creek Fruitvale Rd. 9/19/2017 610031	Duck Creek Orshal Road 9/19/2017 610800
ANNELIDA (segmented worms)		
Oligochaeta (worms)	3	3
ARTHROPODA		
Crustacea		
Amphipoda (scuds)	60	7
Decapoda (crayfish)	1	
Isopoda (sowbugs)	10	3
Arachnoidea		
Hydracarina	2	3
Insecta		
Ephemeroptera (mayflies)		
Baetidae	53	11
Ephemerellidae	5	5
Heptageniidae	3	13
Odonata		
Anisoptera (dragonflies)		
Aeshnidae	2	4
Zygoptera (damselflies)		
Calopterygidae	13	7
Plecoptera (stoneflies)		
Perlidae	1	
Perlodidae		1
Hemiptera (true bugs)		
Belostomatidae	1	1
Corixidae	2	
Veliidae		1
Megaloptera		
Corydalidae (dobson flies)	1	1
Sialidae (alder flies)	2	
Trichoptera (caddisflies)		
Brachycentridae	3	85
Hydropsychidae	78	69
Leptoceridae	1	
Limnephilidae	3	3
Molannidae	1	
Philopotamidae		2
Coleoptera (beetles)		
Hydrophilidae (total)		1
Elmidae	1	
Diptera (flies)		
Ceratopogonidae	1	1
Chironomidae	19	29
Simuliidae	13	15
Tipulidae		3
MOLLUSCA		
Gastropoda (snails)		
Physidae	4	1
Pelecypoda (bivalves)		
Pisidiidae	2	3

Taxa	Carlton Creek Fruitvale Rd. 9/19/2017 610031	Duck Creek Orshal Road 9/19/2017 610800
TOTAL INDIVIDUALS	285	272

	Carlton Creek Fruitvale Rd. 9/19/2017 610031		Duck Creek Orshal Road 9/19/2017 610800	
METRIC	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	26	1	24	0
NUMBER OF MAYFLY TAXA	3	0	3	0
NUMBER OF CADDISFLY TAXA	5	1	4	0
NUMBER OF STONEFLY TAXA	1	1	1	1
PERCENT MAYFLY COMP.	21.40	1	10.66	0
PERCENT CADDISFLY COMP.	30.18	1	58.46	1
PERCENT DOMINANT TAXON	27.37	0	31.25	0
PERCENT ISOPOD, SNAIL, LEECH	4.91	0	1.47	1
PERCENT SURF. AIR BREATHERS	1.05	1	1.10	1
TOTAL SCORE		8		2
MACROINVERTEBRATE RATING	Excellent		Acceptable	