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MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY
WATER BUREAU
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STAFF REPORT

BIOLOGICAL AND WATER CHEMISTRY SURVEYS OF SELECTED STATIONS IN THE RABBIT RIVER WATERSHED ALLEGAN COUNTY, MICHIGAN AUGUST, SEPTEMBER, AND OCTOBER 2008

Introduction

Biological, chemical, and physical habitat conditions of the Rabbit River watershed in Allegan County were assessed by Surface Water Assessment Section (SWAS) staff in August 2008. The primary objectives of the assessments were:

1. To support the development of water quality-based effluent limits (WQBELs) for National Pollutant Discharge Elimination System (NPDES) permits.
2. Identify nonpoint sources (NPS) of water quality impairment.
3. Assess the current status and condition of individual water bodies and determine if Michigan Water Quality Standards (WQS) are being met.
4. Satisfy monitoring requests submitted by internal and external customers.
5. Evaluate biological integrity temporal trends.

The macroinvertebrate community and physical habitat was qualitatively assessed at each of 15 stations (Table 1, Figure 1), using the SWAS Procedure 51 (MDEQ, 1990; Creal et al., 1996) for wadeable streams. 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 10 metrics, with a possible maximum total score of 200. A station habitat score of >154 is characterized as having excellent habitat, 105-154 is good, 56-104 is marginal, and <56 is poor. Water samples were also collected and preserved according to Michigan Department of Environmental Quality (MDEQ) protocol (MDNR, 1994).

Two site selection methods were used to assess the Rabbit watershed in 2008: stratified random and targeted. A probabilistic monitoring approach, using stratified random site selection, was used to select several stations within the Thornapple River and Rabbit River watersheds (MDEQ, 2006 draft). The information collected from these sites will be used to address statewide and regional questions about water quality. The Thornapple River watershed biosurvey was conducted separately from the Rabbit River watershed biosurvey and is addressed in a separate report. Additional stations within the Rabbit River watershed were selected for targeted monitoring to fulfill specific monitoring requests, assess known or potential areas of concern, collect information and assess attainment of designated uses from areas where historic information was lacking, or to provide information for NPDES activities.

Table 1. Summary of the aquatic habitat and macroinvertebrate community evaluations for selected stations in the Rabbit River watershed, Allegan County, Michigan. August 2008.

Site #	STORET #	Water Body	Site Location	TRS	Township	Latitude	Longitude	Habitat Evaluation		Macroinvertebrate Community	
								Rating	Score	Rating	Score
1	30679	Hooker and Harvey Drain	137th Avenue (Tyler Road)	04N11W35	Leighton	42.68869	-85.57050	Marginal	60	Acceptable	-3
2	30570	Green Lake Creek	142nd Avenue	04N11WS17	Leighton	42.7250	-85.6440	Good	109	Acceptable	0
3	30678	Green Lake Creek	11th Street	04N11WS19	Leighton	42.7130	-85.6540	Marginal	66	Acceptable	-1
4	30675	Red Run	142nd Avenue	04N12WS11	Dorr	42.7250	-85.6880	Marginal	104	Poor	-5
5	30674	Red Run	20th Street	04N12WS16	Dorr	42.7330	-85.7420	Marginal	70	Acceptable	-2
6	30602	Black Creek	34th Street	04N13WS05	Salem	42.7600	-85.8800	Marginal	93	Acceptable	-4
7	30672	Black Creek	139th Avenue	04N14WS25	Overisel	42.7030	-85.9000	Marginal	82	Acceptable	-1
8	30577	Miller Creek	16th Street	03N12WS26	Hopkins	42.6170	-85.7020	Good	112	Excellent	5
9	30683	Bear Creek	Hopkins Village Park	03N12W20	Hopkins	42.62935	-85.76173	Marginal	70	Acceptable	0
10	30680	Rabbit River	12th Street	04N12W36	Hopkins	42.68190	-85.66245	Marginal	85	Acceptable	-2
11	30677	Rabbit River	132nd Avenue	03N12WS17	Hopkins	42.6530	-85.7500	Good	116	Acceptable	3
12	30654	Rabbit River	26th Street	04N13WS36	Salem	42.6930	-85.8000	Good	117	Acceptable	4
13	30676	Rabbit River	downstream of 30th Street	04N13WS27	Salem	42.7035	-85.8419	Marginal	82	Acceptable	0
14	30673	Rabbit River	36th Street	04N13WS30	Salem	42.7010	-85.8990	Good	131	Acceptable	-1
15	30682	Rabbit River	End of Walnut Street	03N14WS06	Heath	42.6741	-86.0052	Good	125	Acceptable	1

Habitat Scoring
Poor < 56 Good 105-154 Marginal 56-104 Excellent >154

Macroinvertebrate Scoring
Poor < -4 Acceptable -4 to +4 Excellent > +4

Watershed Information

The Rabbit River watershed is approximately 293 square miles with 443 miles of stream, of which 229 miles are perennial streams (USDA/NRCS, 2001). Most of the watershed is in Allegan County, with small areas in Kent, Ottawa, and Barry Counties. The headwaters of the Rabbit River begin east of the city of Warren. Major tributaries to the Rabbit River include, Green Lake Creek located north of Wayland, Pierce Drain and Miller Creek located southeast of the village of Hopkins, and the Little Rabbit River, Red Run Drain, and Black Creek, which are tributaries that flow from the north. The Rabbit Rivers flows west and slightly south until its confluence with the Kalamazoo River north of the city of Fennville. Land use is dominated by agriculture (cultivated row crops, pasture, and hay; 64%), followed by forest, scrub/shrub, and grasslands (18%), wetlands and open water (9%), and developed area (9%) (USDA/NRCS, 2001).

The watershed is located in the Allegan District Ecosystem (Albert et al., 1986). The Allegan district consists of a sand lake plain on the western edge and sandy end-moraine ridges on the eastern edge. All stations are located in the Southern Michigan and Northern Indiana Till Plains Ecoregion (SMNITP; Omernik and Gallant, 1988). Designated coldwater streams in the watershed include: the entire main stem of the Rabbit River, all tributaries to the Rabbit River upstream of the Green Lake Creek confluence; Silver Creek, Miller Creek, unnamed tributaries upstream of Miller Creek, and the West Branch of Pigeon Creek in Monterey Township, and all tributaries upstream of Miller Lake in Watson Township.

The most recent assessment of the Rabbit River watershed was conducted in 2003 (Walterhouse, 2004). Stations sampled in 2003 had habitat ratings ranging from poor to good, and macroinvertebrate ratings ranging from poor to excellent.

2008 Macroinvertebrate and Habitat Biosurvey Sampling Results

Hooker and Harvey Drain

Hooker and Harvey Drain was sampled at 137th Street (Tyler Road) (Station 1). The glide/pool habitat scored marginal (60; moderately impaired; Table 2a). The substrate was dominated by sand, followed by a small amount of silt. Pools were generally absent due to the large deposits of sand. Bank scour evidence suggested that the channel flow was somewhat flashy. The riparian area consisted of a 20-foot buffer of herbaceous vegetation with some mature trees, followed by agriculture fields. A local resident indicated that the drain was dredged approximately 7 years prior to this visit and that he planned to request permission to dredge it again in the near future. The macroinvertebrate community scored at the lower end of acceptable (-3; Tables 2b and 2c).

Green Lake Creek

Green Lake Creek was sampled at 142nd Avenue (Station 2) and at 11th Street (Station 3). The riffle/run habitat at Station 2 scored at the lower end of good (109; slightly impaired; Table 2a). The substrate consisted of sand and gravel riffles embedded approximately 50% with sand. The right stream bank was reinforced with concrete rip rap as the stream flowed closer to 142nd Avenue. Bank scour evidence suggested that the channel flow was somewhat flashy. The riparian area consisted

Figure A: Green Lake Creek upstream of 11th Street.

of a 40-foot buffer of herbaceous vegetation with some mature trees, followed by agriculture fields. The macroinvertebrate community scored acceptable (0, Tables 2b and 2c).

The glide/pool habitat at Station 3 in Green Lake Creek scored marginal (66; moderately impaired; Table 2a). The habitat was markedly different from Station 2 located just one mile upstream. There was a large amount of shifting sand that was more than 12 inches deep in places. This large amount of sand was not observed at Station 2 suggesting there may be additional sources of sediment between Stations 2 and 3. Bank scour evidence suggested that the channel flow was somewhat flashy. The riparian area at Station 3 was greatly impacted by residential yards (Figure A) that were mowed to the edge of the stream resulting in a large amount of bank erosion and bank sloughing. The macroinvertebrate community scored acceptable (-1, Tables 2b and 2c).

Red Run Drain

The macroinvertebrate community and habitat in Red Run Drain was sampled at 142nd Street (Station 4) and at 20th Street (Station 5). The glide/pool habitat at Station 4 was rated at the high end of marginal (104; moderately impaired; Table 3a). The flow at Station 4 was very slow making wetland-like conditions. There was a large amount of emergent vegetation and periphyton present. Sand and silt dominated the substrate and a large sandbar was evidence of sediment deposition. The riparian area was lacking large trees and the road and a yard reduced the riparian zone width. The water was unexpectedly turbid at this station with a greenish hue. Water samples were collected (Table 7) and results are discussed in the water chemistry section of this report. Upstream observations of Red Run Drain at 14th Street indicated clear water conditions. The source of this turbidity is unknown and was reported to the MDEQ, Kalamazoo District Office. The macroinvertebrate community scored poor (-5; Tables 3b and 3c). Possible causes of impairment include sedimentation, extremes in flow conditions, historic dredging of the drain and the subsequent inability of the stream to recover, an unconfirmed possible discharge of milk house waste to the stream upstream of Station 4, storm water runoff, tile drainage, and other NPS often associated with agricultural practices. In 2003, two other stations located upstream and downstream of Station 4 on Red Run Drain scored poor (Walterhouse, 2004). Flow and habitat deficiencies were cited as reasons for nonattainment.

The riffle/run habitat at Station 5 was rated at the high end of marginal (104; moderately impaired; Table 3a). Substrate was dominated with sand. There was one small riffle area with deeply embedded gravel located approximately 150 feet upstream of the road crossing. Just upstream of the area that was sampled, cattle were allowed direct access to Red Run Drain. The cattle were in the stream and had extensively trampled the banks in a 50-foot section of stream. MDEQ, Kalamazoo District Office, NPS staff were present at the time of sampling and forwarded the information on to the Michigan Department of Agriculture. Bank scour evidence suggested that the channel flow was somewhat flashy. The macroinvertebrate community scored acceptable (-2, Tables 3b and 3c).

Additional water chemistry data was collected in late September throughout the Red Run Drain watershed as a follow-up to the observation of the unnatural turbidity and odor found at Station 4 in August. Results of this sampling can be found in the water chemistry section of this report and Table 7.

Black Creek

Black Creek was sampled at 34th Street (Station 6) and 139th Avenue (Station 7). The glide/pool habitat at Station 6 was rated marginal (93; moderately impaired; Table 3a). Silt and sand was

the dominant substrate at this station with root wads and aquatic vegetation making up most of the epifaunal substrate available to macroinvertebrates for colonization. The stream channel at this station was very straight and deeply incised due to historic dredging and channelization activities. The riparian area consisted of mostly grasses on one side and a narrow area of younger trees and shrubs on the other side. The macroinvertebrate community scored at the low end of acceptable (-4; Tables 3b and 3c).

The glide/pool habitat at Station 7 was rated marginal (82; moderately impaired; Table 3a). Approximately 100 yards upstream of the road crossing, a very large amount of shifting sand deposition was observed. The sand deposition resulted in an average water depth of less than 6 inches and a uniform stream bottom. The stream channel at this station was very straight due to historic dredging and channelization activities. The riparian area was intact but was missing large trees. Bank scour evidence and one large woody debris dam suggested that the channel flow was flashy. The macroinvertebrate community scored acceptable (-1; Tables 3b and 3c).

Miller Creek

Miller Creek was sampled at 16th Street (Station 8). Miller Creek is a tributary to Pierce Drain. The riffle/run habitat at this station was rated good (112; slightly impaired; Table 4a). Substrate at this station was a mix of sand, gravel, silt, and cobble. Bank scour evidence and exposed roots suggested that the channel flow was somewhat flashy. The riparian area was impacted by a yard mowed to the stream edge on one side and on the other side by a pasture. There was a 10-foot wide riparian buffer between the stream and the pasture; however, there was a strong manure odor present in the water and in the stream sediments. No direct discharges from the pasture were observed in the stream segment that was surveyed. The macroinvertebrate community scored at the low end of excellent (5; Tables 4b and 4c). This was the highest macroinvertebrate community score for the Rabbit River watershed in 2008.

Bear Creek

Bear Creek was sampled at a park in the village of Hopkins (Station 9). The park is just downstream of an agriculture feed supply company that is located directly adjacent to the creek. The glide/pool habitat at Station 9 was rated marginal (70; moderately impaired; Table 4a). Several areas along the stream bank had recently been reinforced with riprap to prevent erosion. The stream channel was very straight and uniform with very little pool variability and was incised approximately 8 feet (Figure B). The riparian area was impacted on both sides by the park. A five-foot wide grassy area was left as a riparian buffer. Bank scour evidence and areas of erosion suggested that the channel flow was somewhat flashy. The macroinvertebrate community scored acceptable (0; Tables 4b and 4c).

Figure B: Bear Creek at Hopkins Village Park upstream of Godfrey Road.

Rabbit River

The Rabbit River was sampled at 6 stations throughout the watershed (Stations 10, 11, 12, 13, 14, and 15). Station 10 (the most upstream station) was sampled at 12th Street. The glide/pool habitat at Station 10 was rated marginal (85; moderately impaired; Table 4a). The substrate at this station consisted of a large amount of shifting sand that was more than 12 inches deep in places. A few large deep pools were present; however, it was apparent that the pools are filling

in with the shifting sand. Bank scour evidence and areas of erosion suggested that the channel flow is flashy. The riparian area on one side of the stream was fairly intact; however, US-131 was not far from the other side of the stream and impacted the riparian zone width. The macroinvertebrate community scored acceptable (-2; Tables 4b and 4c).

Station 11 was sampled at 132nd Avenue where it dead ends from the east. The glide/pool habitat at Station 11 was rated good (116; slightly impaired; Table 4a). The substrate at this station was once again dominated by a large amount of shifting sand and silt. The epifaunal substrate consisted of a mix of woody debris, rootwads, and leaf pack. There was a large amount of erosion with raw stream banks as high as 4 feet as evidence that the stream is flashy at times. Recent best management practices were evident, in the form of anchored woody debris that was taken from the main channel and placed parallel along the stream banks. The anchored trees added protection to the eroding banks, but left little woody debris in the middle of the channel. The riparian area at this station was very intact with a large wooded floodplain that naturally lacked herbaceous vegetation. The macroinvertebrate community scored acceptable (3; Tables 4b and 4c).

Station 12 was sampled at 26th Street. The glide/pool habitat was rated good (117; slightly impaired; Table 5a). The substrate was dominated by sand and woody debris, and leaf packs were available as epifaunal substrate. A fine layer of silt covered most of the woody debris. The riparian area was intact. A large amount of bank scour indicated that the river is flashy at this station. The macroinvertebrate community scored at the high end of acceptable (4; Tables 5b and 5c).

Station 13 was sampled downstream of 30th Street. The glide/pool habitat at Station 13 was rated marginal (82; moderately impaired; Table 5a). The river was very wide and slow with pools more than 6-feet deep (Figure C). Sand once again dominated the substrate; however, clay deposits were present and there was a layer of silt on top of the sand. Cobble, gravel, and leaf packs were absent and there was very little woody debris. A portion of the riparian area was impacted by a yard and row crops that had a 10-foot buffer. On the south side of the river, the banks were more than 50-feet high in places and were eroding. The habitat at this station was very different and much less suitable for macroinvertebrate colonization than that at Station 12, which was located just two miles upstream. Station 13 had more sedimentation, less woody debris available for epifaunal substrate, less pool diversity, and a reduced amount of riparian vegetative protection when compared to Station 12. Station 13 was also much wider, slower, deeper, and had more silt and clay. The macroinvertebrate community scored acceptable (0; Tables 5b and 5c).

Figure C: Rabbit River downstream of 30th Street.

Station 14 was sampled at 36th Street. The glide/pool habitat was rated good (131; slightly impaired; Table 5a). Shifting sand was the dominant substrate. Rootwads and woody debris provided epifaunal substrate. Bank scour evidence suggested the stream is flashy at times, but tree roots help to stabilize the stream banks. The riparian area consisted of a wooded floodplain that was very intact and naturally lacked herbaceous vegetation in the understory. The macroinvertebrate community scored acceptable (-1; Tables 5b and 5c).

Station 15 (the most downstream Rabbit River station) was sampled at the end of Walnut Street, just downstream of highway M-40. The glide/pool habitat was rated good (125; slightly impaired; Table 5a). The river is impounded by a small dam upstream of M-40, approximately 0.2 miles upstream of this station. The substrate at this station was a mixture of sand and silt with a few areas of gravel. Woody debris was present but was pushed towards the stream banks. There were several areas of erosion along the stream banks, but the riparian area was fairly intact. The macroinvertebrate community scored acceptable (1; Tables 5b and 5c).

Water Sample Results

Water samples were taken from Red Run Drain on August 26 at 142nd Avenue (Station 4) and throughout the Red Run Drain watershed September 22, 24, and 30, and October 13. Locations of water sampling stations are listed in Table 6 and results are noted in Table 7. Water samples indicated that total phosphorus levels in Red Run Drain were as much as 8 times higher than the 0.06 milligrams per liter (mg/L) that is the average for reference streams in the SMNITP Ecoregion (Lundgren, 1994) and 15 times higher than the 0.03 mg/L that is considered reference conditions by the United States Environmental Protection Agency (USEPA) for the ecoregion (USEPA, 2000). Total phosphorus values were highest at 142nd Avenue (0.45 mg/L). Stations located upstream of 142nd Avenue had total phosphorus values averaging 0.2 mg/L. Stations located further downstream from 142nd Avenue had total phosphorus values averaging 0.1 mg/L. Total Kjeldahl nitrogen levels in Red Run Drain were as much as 5 times higher than reference conditions (0.58 mg N/L; USEPA, 2000) and concentrations followed a similar pattern to total phosphorus from upstream to downstream. This suggests that there may be 1 or more sources of nutrients to the stream upstream of 142nd Avenue.

Carbonaceous Biochemical Oxygen Demand (CBOD) and ammonia values at 142nd Avenue were also several times higher than average background values for those parameters in Michigan. The average background values are noted as 2 mg/L for CBOD and 0.1 mg/L for ammonia (GLEAS, 1997).

E. coli samples were also taken to document *E. coli* levels throughout the watershed. Red Run Drain was listed in the 2008 Integrated Report (LeSage and Smith, 2008) as having insufficient information regarding *E. coli* levels in the water body. Previous USEPA results indicated possible *E. coli* WQS violations. *E. coli* results from September 2008 indicated that the daily maximum WQS for total body contact recreation (300 *E. coli*/100 milliliters [ml]) was being exceeded from 18th Street upstream to 14th Street, north of 144th Avenue, and the WQS for partial body contact recreation (1,000 *E. coli*/100ml) was being exceeded from 142nd Avenue upstream to 14th Street north of 144th Avenue (Table 7).

Dissolved oxygen levels were also measured throughout Red Run Drain; however, results will be presented in a separate report.

Summary of Results of Monitoring Objectives

1. Support WQBEL development for NPDES permits.

   The facilities in Table 2 have NPDES permits in this watershed. There was no targeted monitoring planned in direct relation to any of the permits.

Table 2: NPDES Permits in the Rabbit River Watershed.

Facility Designated Name	Permit #	Receiving Water	Township	Latitude	Longitude
Hamilton Com Schools	MIG580317	Lohman Drain	Hamilton	42.6833	-86.0167
Poll Farm Inc-CAFO	MIG010148	Unnamed Drain	Hamilton	42.666	-85.9771
Wolverine Power Supply-Vandyke	MI0004162	Little Rabbit River via Green County Drain Extension	Dorr	42.7333	-85.8361
Walnutdale Farms Dorr Twp-CAFO	MIG010063	Red Run Drain	Wayland	42.7322	-85.6822
Custom Asphalt Producer-Moline	MIS111312	Red Run Drain	Dorr	42.7521	-85.6755
Hopkins WWSL	MIG580301	Herlan Drain	Hopkins	42.6233	-85.7617
Hopkins Elevator	MIS111180	Bear Creek	Hopkins	42.6203	-85.7628
Sebright Products-12th St	MIS510258	Miller Creek via ditches	Shelbyville	42.625	-85.6625
C Stoddard & Sons	MIS520019	Mineral Springs Drain	Wayland	42.67	-85.6631
Crystal Flash LP-Wayland	MIG081034	Rabbit River via unnamed drain	Wayland	42.6744	-85.6578
Bay Valley Foods LLC	MIG250414	Rabbit River	Wayland	42.6792	-85.65
Bay Valley Foods LLC	MIS510213	Rabbit River	Wayland	42.6792	-85.65
Rabbit River Estates MHC	MIG580342	Rabbit River	Wayland	42.6686	-85.6197
Moline WWTP	MI0055107	Green Lake Creek	Moline	42.7333	-85.6417
Green Lake WWSL	MIG580393	Tollenaar Drain	Caledonia	42.7339	-85.5825

2. Identify NPS of water quality impairment.

The following NPS issues were identified from the 2008 sampling and were reported to MDEQ, Kalamazoo District Office, NPS staff. Locations are noted in Figure 1 and Tables 1 and 6.

Miller Creek upstream of 16th Street (Station 8), Hopkins Township
The sediment and water at this station smelled like manure. No bacterial slimes or nuisance vegetation were observed. No discharges to the stream were observed in the 300-foot segment of stream surveyed upstream of 16th Street. There may be possible runoff from the adjacent cow pasture and farmyard. The cattle pasture was fenced off from the stream but comes very close to stream edge. The macroinvertebrate community at this station indicated the other indigenous aquatic life and wildlife designated use is being met.

Unnamed Tributary to Miller Creek downstream of 12th Street (Station NPS-1), Hopkins Township
Unrestricted livestock access to stream. Livestock were not observed at the time we observed this site, but the grass was closely cropped and trampling of stream banks was evident.

Rabbit River downstream of 26th Street at 138th Avenue (immediately downstream of Station 12), Salem Township
Silt fences had been put up for recent road construction, but were beginning to fail and sediment was entering the stream channel from the road.

Winks Brook at 138th Avenue (east of 24th Street) (Station NPS-2), Salem Township
Winks Brook is a small intermittent tributary to the Rabbit River. Observations of this site indicated that a possible culvert replacement had occurred and no silt fences or other sedimentation control Best Management Practices were implemented. A large amount of sediment from the road and construction was in the dry stream bed (Figure D).

Figure D: Winks Brook at 138th Avenue

Black Creek upstream of 140th Avenue (Station NPS-3), Salem/Overisel Township Line
Cattle have direct access to the stream and banks are being trampled causing severe erosion. A biosurvey report from 2003 sampling (Walterhouse, 2004) also indicates that cattle had access to the stream at that time as well.

Rabbit River upstream of 36th Street (Station 14), Salem Township
A local resident reported that during rain events oil slicks, tires, and other trash can be seen at this road crossing. The resident reported that land lying to the northeast side of the river is the source of the trash. Plastic oil containers and a tire were observed in the floodplain of the river on the northeast side.

Red Run Drain, Dorr Township
In 1991, the Walnutdale Farms Concentrated Animal Feeding Operation located near Red Run Drain upstream of 142nd Avenue and 14th Street, was reported to be a source of silage leachate and animal waste entering Red Run Drain. By 2003, the USEPA was involved and seeking restitution. NPS staff indicates Walnutdale Farms is making significant efforts to prevent environmental issues through facility upgrades and day-to-day maintenance efforts. In 2003, macroinvertebrate surveys were conducted upstream (upstream of 14th Street and 144th Avenue) and downstream of Walnutdale Farms (upstream of 16th Street) and both surveys indicated poor macroinvertebrate communities. Flow and habitat alterations due to drain maintenance activities were cited as the causes of impairment. The drain is currently designated as a Category 4b water body on the 2008 Section 303(d) nonattainment list (LeSage and Smith, 2008). The Michigan Section 303(d) nonattainment list is the list of waters that do not support their designated uses or attain WQS and require the development of total maximum daily loads (TMDLs). A Category 4b water body is one that has available data and/or information that indicate at least one designated use is not being supported or is threatened, but a TMDL is not needed because other approved pollution control mechanisms are in place and are reasonably expected to result in attainment of the designated use within a practical time frame. In the case of Red Run Drain, the mechanisms include the upgrades and maintenance improvements that have been made at Walnutdale Farms.

As noted in the section, "Macroinvertebrate and Habitat Biosurvey Sampling Results," in 2008 the macroinvertebrate community in Red Run Drain upstream of 142nd Street and upstream of 20th Street scored poor and acceptable, respectively. The following subparagraphs summarize additional observations and results of water chemistry sampling at several road crossings throughout the Red Run Drain watershed.

- Red Run Drain upstream of 14th Street, north of 144th Avenue (Station NPS-4)
  A clay pipe was present in the northwest streambank. There was no discharge when the pipe was first observed, but then clear water started to trickle and then discharge rapidly for about 30 seconds before trickling and stopping. Discharge did not occur again during the 5-10 minutes the pipe was observed. No slimes were present and the discharge was clear with no odors. Water samples were collected in September 2008 from this location (Table 7) and as noted above in the Water Chemistry section, nutrient levels were higher than what is expected in reference streams in this ecoregion. *E. coli* concentrations exceeded daily maximum WQS for total body contact recreation.

- Red Run Drain downstream of 144th Avenue (Station A) and upstream of 14th Street, south of 144th Avenue (Station B)
  Water samples were collected in September and October 2008 from these locations (Table 7) and as noted above in the Water Chemistry section, nutrient levels were higher than what was found in reference streams in this ecoregion. At station B, *E. coli* concentrations exceeded daily maximum WQS for total and partial body contact

recreation. The *E. coli* concentrations at Station B were much more elevated than concentrations found less than a mile upstream at station NPS-4.

- Red Run Drain upstream of 142nd Avenue (Station 4)
  This area was very wetland-like with slow moving water. The water looked very turbid and greenish in color and the station had an unusual odor. Red Run Drain was observed 0.5 and 1 mile upstream where it crosses 14th Street and no unusual turbidity was observed. Kalamazoo District Office, NPS staff noted that there have been unconfirmed reports of milk waste being discharged to the stream, and this could be a possible source of the turbidity. This station was revisited in late September and although the unusual turbidity and color was not observed, the unusual odor still persisted.

  As noted above in the Water Chemistry section, water samples were collected in late September and early October (Table 7) and indicated that nutrient, CBOD, and ammonia levels were much higher than what would be expected. *E. coli* concentrations exceeded daily maximum WQS for total and partial body contact recreation. In addition, *E. coli* concentrations were much more elevated than those found upstream.

- Red Run Drain at 16th Street (Station NPS-5)
  Livestock appear to have possible direct access to the Red Run Drain upstream of this road crossing. No cattle could be seen in the stream and a 10-foot wide buffer of longer grass was present between the pasture and the stream; however, no fencing was present and cattle were observed in the distance. The 2003 biosurveys indicated that cattle had access to the stream at that time (Walterhouse, 2004). Water samples were collected downstream of this road crossing in September and early October (Table 7). Results indicated that nutrient concentrations were higher than expected, but were somewhat decreased from the levels found further upstream.

- Red Run Drain upstream of 18th Street (Station C)
  Water samples collected at this station indicated that nutrient concentrations were higher than expected, but were somewhat decreased from the levels found further upstream. *E. coli* concentrations were decreased from those found upstream, but exceeded the daily maximum WQS for total body contact recreation.

- Red Run Drain upstream of 20th Street (Station 5)
  As noted above, cattle had direct access to the stream causing trampling of banks and severe erosion. Kalamazoo District Office, NPS staff observed the station and reported the issue to the Michigan Department of Agriculture. Water samples were collected from this station in September (Table 7). Results indicated that nutrient concentrations were higher than expected, but were similar to those found upstream at 18th Street. *E. coli* concentrations were decreased from those found upstream and just met WQS.

Bear Creek in Hopkins Village Park (Station 9), Village of Hopkins

Kalamazoo District Office, NPS staff requested assistance in investigating possible nutrient loading from an agriculture feed supply operation that is in close proximity to Bear Creek. The operation is located directly adjacent to the stream in the village of Hopkins. Observations were made near the operation and the macroinvertebrate community was sampled at the Hopkins Village Park, located just downstream of the operation. The macroinvertebrate community at this station indicated the other indigenous aquatic life and wildlife designated use is being met. No nuisance vegetation or bacterial slimes were observed. Although obvious nutrient sources were not observed, the operation and associated parking lots and driveways lie directly adjacent to the stream with no riparian buffer.

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

   Aquatic macroinvertebrate community and habitat assessments were conducted at a total of 15 stations (Table 2, Figure 1). Twelve of these stations are considered status stations, which were chosen with a randomized design. Three of these stations were targeted stations.

   The other indigenous wildlife and aquatic life designated use was being met at all but one of the 15 stations. The other indigenous aquatic life and wildlife designated use was not being met in Red Run Drain upstream of 142nd Avenue. Red Run Drain is listed as a Category 4B water body on the 2008 Section 303(d) nonattainment list for WQS exceedances for dissolved oxygen and macroinvertebrate impairments. The macroinvertebrate community scored poor (-5) and acceptable (-2) in Red Run Drain at 142nd Avenue and 20th Street, respectively, in 2008 (Tables 3b and 3c).

   Red Run Drain was listed in the 2008 Integrated Report as having insufficient information regarding *E. coli* levels in the water body. Previous USEPA results indicated possible *E. coli* WQS violations. *E. coli* results from September 2008 indicated that the daily maximum WQS for total body contact recreation (300 *E. coli*/100ml) was being exceeded from 20th Street upstream to 14th Street north of 144th Avenue, and the daily maximum WQS for partial body contact recreation (1000 *E. coli*/100ml) was being exceeded from 142nd Avenue upstream to 14th Street north of 144th Avenue (Table 7).

   The Hooker and Harvey Drain located northeast of Wayland is listed as a Category 4C water body on the 2008 Section 303(d) nonattainment list from 137th Avenue (Tyler Road) upstream to the headwaters. A Category 4C water body is one in which available data and/or information indicate that at least one designated use is not being supported or is threatened, but a TMDL is not needed because the impairment is not caused by a pollutant (e.g., impairment is due to lack of flow or stream channelization). In 1998, the drain was sampled at Tyler Road and although the macroinvertebrate community was rated acceptable, only 6 taxa were collected. The macroinvertebrate community data collected in 2008 indicates the other indigenous aquatic life and wildlife designated use is being met; however, it should be noted that this portion of the drain is maintained and a local resident who owns land adjacent to the drain indicated that he hopes to have it dredged in the near future.

   In 2008, 93% $\pm$ 8% (using a 95% confidence interval) of the Thornapple River and Rabbit River watersheds were estimated to be supporting the "other indigenous wildlife and aquatic life" designated use component of R.323.1100(1)(e) of the Michigan WQS. This estimate is based on 44 stratified random sites selected within the two watersheds. Details of these results will be available in a future report.

4. Satisfy monitoring requests submitted by internal and external customers.

   Staff from the Michigan Department of Natural Resources (MDNR) has requested any information in relation to the Hamilton Dam Impoundment on the Rabbit River near the M-40 crossing. The dam is failing, and although there are currently no plans to remove it, there is concern about the sediment behind the dam, if it should ever fail. The Hamilton Dam Impoundment is currently on the Section 303(d) nonattainment list due to a fish contaminant advisory for polychlorinated biphenyls in carp. Biosurvey Station 15 was located downstream of the dam as part of the 2008 randomly selected stations. As noted

previously, the glide/pool habitat was rated good (125; slightly impaired; Table 5a) and the macroinvertebrate community scored acceptable (1; Tables 5b and 5c).

Staff from the MDNR was also interested in any information concerning conditions in the Rabbit River upstream and downstream of the Monterey Lake/Sandy Pines outlet (Pigeon Creek). Biosurvey Stations 12 and 13 (Figure 1) were located on the Rabbit River downstream and upstream, respectively, of the confluence of Pigeon Creek. Macroinvertebrate communities scored acceptable at both stations; however, the macroinvertebrate community score at Station 12 (the upstream station) was one point away from an excellent score, while the downstream Station 13 was tending towards poor. The habitat at Station 12 was significantly different from Station 13. At Station 13 there was more sedimentation, less woody debris available for epifaunal substrate, less pool diversity and a reduced amount of riparian vegetative protection when compared to Station 12. Station 13 was much wider, slower, deeper, and had more silt and clay than Station 12. Pigeon Creek at 138th Avenue was observed to be a relatively small sandy bottom stream. Factors that may contribute to the change in habitat and lower macroinvertebrate community score at the downstream station include possible effects of cattle in a pasture along the river off 138th Avenue, the development of a new housing development along 138th Avenue, possible historic channelization in this portion of the watershed, and possible impacts of tributary inputs to the Rabbit River between stations.

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5. Evaluate biological integrity temporal trends.

   The SWAS Biological Status and Trend Monitoring Procedure (MDEQ, 2006 [draft]) was used to randomly select sites within the Rabbit River watershed. These sites were used to estimate the watershed attainment status for the “other indigenous aquatic life” designated use component of R 323.1100(e) of the Michigan WQS, and will be used as baseline data to facilitate a measurement of biointegrity temporal trends.

Field Work By: Tamara Lipsey, Aquatic Biologist
Kay Edly, Aquatic Biologist
Doyle Brunsen, Environmental Engineer
Surface Water Assessment Section
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Report By: Tamara Lipsey, Aquatic Biologist
Surface Water Assessment Section
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Figure 1. 2008 Survey stations, Rabbit River watershed. Allegan County, Michigan.

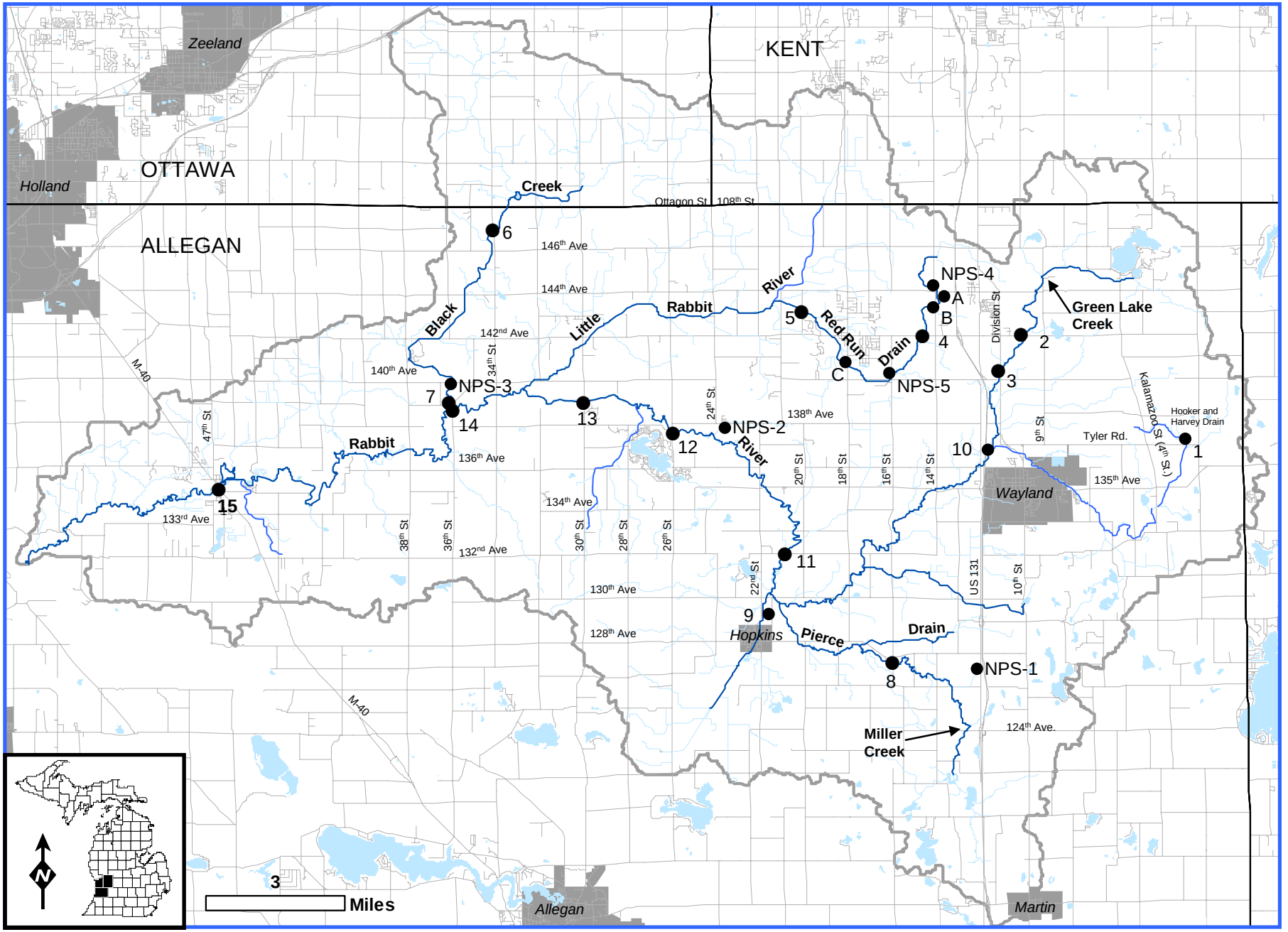

Table 2a. Habitat evaluation for selected streams in the Rabbit River watershed, Allegan County, Michigan. August 2008.

	STATION 1 Hooker & Harvey Drain 137th Avenue GLIDE/POOL	STATION 2 Green Lake Creek 142nd Avenue RIFFLE/RUN	STATION 3 Green Lake Creek 11th Street GLIDE/POOL
HABITAT METRIC			
Substrate and Instream Cover			
Epifaunal Substrate/ Avail Cover (20)	6	11	5
Embeddedness (20)*		10	
Velocity/Depth Regime (20)*		13	
Pool Substrate Characterization (20)**	6		6
Pool Variability (20)**	2		2
Channel Morphology			
Sediment Deposition (20)	1	8	1
Flow Status - Maint. Flow Volume (10)	8	8	8
Flow Status - Flashiness (10)	3	4	3
Channel Alteration (20)	9	11	13
Frequency of Riffles/Bends (20)*		11	
Channel Sinuosity (20)**	1		16
Riparian and Bank Structure			
Bank Stability (L) (10)	3	6	1
Bank Stability (R) (10)	3	6	1
Vegetative Protection (L) (10)	5	7	3
Vegetative Protection (R) (10)	5	6	3
Riparian Veg. Zone Width (L) (10)	4	4	2
Riparian Veg. Zone Width (R) (10)	4	4	2
TOTAL SCORE (200):	60	109	66
HABITAT RATING:	MARGINAL (MODERATELY IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)	MARGINAL (MODERATELY IMPAIRED)

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).

Date:	8/13/2008	8/14/2008	8/14/2008
Weather:	Partly Cloudy	Sunny	Sunny
Air Temperature:	70 Deg. F.	65 Deg. F.	72 Deg. F.
Water Temperature:	62 Deg. F.	64 Deg. F.	64 Deg. F.
Ave. Stream Width:	7 Feet	11 Feet	10 Feet
Ave. Stream Depth:	0.25 Feet	0.5 Feet	0.7 Feet
Surface Velocity:	1 Ft./Sec.	0.8 Ft./Sec.	1 Ft./Sec.
Estimated Flow:	1.75 CFS	4.4 CFS	7 CFS
Stream Modifications:	Dredged	Bank Stabilization	Canopy Removal, Bank Stabilization
Nuisance Plants (Y/N):	N	N	N
Report Number:			
STORET No.:	30679	30570	30678
Stream Name:	Hooker & Harvey Drain	Green Lake Creek	Green Lake Creek
Road Crossing/Location:	137th Avenue	142nd Avenue	11th Street
County Code:	03	03	03
TRS:	04N11W35	04N11W18	04N11W19
Latitude (dd):	42.68861	42.72481	42.71375
Longitude (dd):	-85.57057	-85.64399	-85.65395
Ecoregion:	SMNITP	SMNITP	SMNITP
Stream Type:	Coldwater	Warmwater	Warmwater
USGS Basin Code:	4050003	4050003	4050003

* Applies only to Riffle/Run stream Surveys
** Applies only to Glide/Pool stream Surveys

Table 2b. Qualitative macroinvertebrate sampling results for selected streams in the Rabbit River watershed, Allegan County, MI. August 2008.

TAXA	Hooker & Harvey Drain 137th Avenue 8/13/2008 STATION 1	Green Lake Creek 142nd Avenue 8/14/2008 STATION 2	Green Lake Creek 11th Street 8/14/2008 STATION 3
ANNELIDA (segmented worms)			
Hirudinea (leeches)	1		
Oligochaeta (worms)	5	5	
ARTHROPODA			
Crustacea			
Amphipoda (scuds)	248	135	206
Decapoda (crayfish)		2	26
Isopoda (sowbugs)		3	20
Insecta			
Ephemeroptera (mayflies)			
Baetidae	1	3	
Ephemeridae		1	
Heptageniidae		1	15
Odonata			
Anisoptera (dragonflies)			
Aeshnidae		1	1
Gomphidae		1	1
Zygoptera (damselflies)			
Calopterygidae		1	4
Hemiptera (true bugs)			
Gerridae	1	2	2
Notonectidae	1	1	
Pleidae			2
Saldidae	1		
Veliidae		1	
Trichoptera (caddisflies)			
Brachycentridae		5	12
Helicopsychidae		2	
Hydropsychidae	10	16	10
Leptoceridae		1	
Limnephilidae		3	1
Uenoidae		1	
Coleoptera (beetles)			
Dytiscidae (total)		1	
Psephenidae (adults)		9	
Elmidae	1	26	29
Diptera (flies)			
Chironomidae	46	9	1
Tabanidae		1	
Tipulidae	1		
MOLLUSCA			
Gastropoda (snails)			
Physidae	3	10	
Planorbidae			1
Viviparidae		6	
Pelecypoda (bivalves)			
Sphaeriidae (clams)	1	12	
TOTAL INDIVIDUALS	320	259	331

Table 2c. Macroinvertebrate metric evaluation of selected streams in the Rabbit River watershed, Allegan County, MI. August 2008.

	Hooker & Harvey Drain 137th Avenue 8/13/2008 STATION 1		Green Lake Creek 142nd Avenue 8/14/2008 STATION 2		Green Lake Creek 11th Street 8/14/2008 STATION 3	
METRIC	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	13	0	27	1	15	0
NUMBER OF MAYFLY TAXA	1	0	3	0	1	0
NUMBER OF CADDISFLY TAXA	1	-1	6	1	3	0
NUMBER OF STONEFLY TAXA	0	-1	0	-1	0	-1
PERCENT MAYFLY COMPOSITION	0.31	-1	1.93	-1	4.53	0
PERCENT CADDISFLY COMPOSITION	3.13	-1	10.81	0	6.95	0
PERCENT DOMINANT TAXON	77.50	-1	52.12	-1	62.24	-1
PERCENT ISOPOD, SNAIL, LEECH	1.25	1	7.34	0	6.34	0
PERCENT SURFACE AIR BREATHERS	0.94	1	5.41	1	1.21	1
TOTAL SCORE		-3		0		-1
MACROINVERTEBRATE COMMUNITY RATING		ACCEPTABLE		ACCEPTABLE		ACCEPTABLE

Table 3a. Habitat evaluation for selected streams in the Rabbit River watershed, Allegan County, MI. August 2008.

	STATION 4 Red Run Drain 142nd Avenue GLIDE/POOL	STATION 5 Red Run Drain 20th Street RIFFLE/RUN	STATION 6 Black Creek 34th Avenue GLIDE/POOL	STATION 7 Black Creek 139th Avenue GLIDE/POOL
HABITAT METRIC				
Substrate and Instream Cover				
Epifaunal Substrate/ Avail Cover (20)	2	6	9	4
Embeddedness (20)*		4		
Velocity/Depth Regime (20)*		11		
Pool Substrate Characterization (20)**	11		10	7
Pool Variability (20)**	11		9	5
Channel Morphology				
Sediment Deposition (20)	6	2	10	2
Flow Status - Maint. Flow Volume (10)	8	8	9	5
Flow Status - Flashiness (10)	10	4	6	2
Channel Alteration (20)	10	10	7	12
Frequency of Riffles/Bends (20)*		1		
Channel Sinuosity (20)**	10		2	5
Riparian and Bank Structure				
Bank Stability (L) (10)	9	4	6	3
Bank Stability (R) (10)	9	4	6	3
Vegetative Protection (L) (10)	6	5	6	7
Vegetative Protection (R) (10)	6	5	6	9
Riparian Veg. Zone Width (L) (10)	3	3	3	9
Riparian Veg. Zone Width (R) (10)	3	3	4	9
TOTAL SCORE (200):	104	70	93	82
HABITAT RATING:	MARGINAL (MODERATELY IMPAIRED)	MARGINAL (MODERATELY IMPAIRED)	MARGINAL (MODERATELY IMPAIRED)	MARGINAL (MODERATELY IMPAIRED)

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).

Date:	8/15/2008	8/14/2008	8/15/2008	8/12/2008
Weather:	Partly Cloudy	Sunny	Sunny	Sunny
Air Temperature:	78 Deg. F.	75 Deg. F.	61 Deg. F.	83 Deg. F.
Water Temperature:	65 Deg. F.	61 Deg. F.	63 Deg. F.	63 Deg. F.
Ave. Stream Width:	5 Feet	15 Feet	15 Feet	15 Feet
Ave. Stream Depth:	1.5 Feet	0.67 Feet	1 Feet	0.75 Feet
Surface Velocity:	0.5 Ft./Sec.	1.7 Ft./Sec.	0.8 Ft./Sec.	1.25 Ft./Sec.
Estimated Flow:	3.75 CFS	17.085 CFS	12 CFS	14.0625 CFS
Stream Modifications:	Dredged, Canopy Removal, Relocated	Dredged	Dredged, Canopy Removal	Dredged
Nuisance Plants (Y/N):	N	N	N	N
Report Number:				
STORET No.:	30675	630674	30602	30672
Stream Name:	Red Run Drain	Red Run Drain	Black Creek	Black Creek
Road Crossing/Location:	142nd Avenue	20th Street	34th Avenue	139th Avenue
County Code:	03	03	03	03
TRS:	04N12W11	04N12W16	04N13W05	04N13W30
Latitude (dd):	42.725046	42.73312	42.76033	42.70243
Longitude (dd):	-85.688821	-85.74183	-85.88018	-85.89977
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

Table 3b. Qualitative macroinvertebrate sampling results for selected streams in the Rabbit River watershed, Allegan County, MI. August 2008.

TAXA	Red Run Drain 142nd Avenue 8/15/2008 STATION 4	Red Run Drain 20th Street 8/14/2008 STATION 5	Black Creek 34th Avenue 8/15/2008 STATION 6	Black Creek 139th Avenue 8/12/2008 STATION 7
PLATYHELMINTHES (flatworms)				
Turbellaria	3		2	
ANNELIDA (segmented worms)				
Hirudinea (leeches)	1		2	
Oligochaeta (worms)	19	14	14	8
ARTHROPODA				
Crustacea				
Amphipoda (scuds)		69	12	17
Decapoda (crayfish)			3	5
Isopoda (sowbugs)		28	57	73
Arachnoidea				
Hydracarina		2		
Insecta				
Ephemeroptera (mayflies)				
Baetidae		23	2	5
Ephemeridae				1
Heptageniidae				2
Odonata				
Anisoptera (dragonflies)				
Aeshnidae			1	6
Gomphidae				1
Libellulidae			1	
Zygoptera (damselflies)				
Calopterygidae		8	6	13
Coenagrionidae	6		2	
Hemiptera (true bugs)				
Belostomatidae			1	
Corixidae	1	1	22	15
Gerridae	2	1	1	5
Notonectidae	1	1		1
Pleidae	1		1	
Saldidae	1	2		
Veliidae			1	
Megaloptera				
Corydalidae (dobson flies)			1	1
Trichoptera (caddisflies)				
Brachycentridae		1		4
Hydropsychidae		40	38	30
Limnephilidae				1
Polycentropodidae				1
Coleoptera (beetles)				
Dytiscidae (total)			3	
Gyrinidae (adults)	1			1
Haliplidae (adults)	1	1		
Hydrophilidae (total)	1		2	7
Noteridae (adults)				3
Scirtidae (adults)			1	
Dryopidae			3	
Elmidae		1	32	31
Diptera (flies)				
Athericidae				1
Ceratopogonidae	12		1	
Chironomidae	146	43	47	14
Culicidae			1	
Simuliidae	2	21	1	8
MOLLUSCA				
Gastropoda (snails)				
Ancylidae (limpets)	3			1
Hydrobiidae			14	
Lymnaeidae	1			
Physidae	105		4	2
Planorbidae	12			1
Pelecypoda (bivalves)				
Sphaeriidae (clams)			3	1
Unionidae (mussels)			1	
TOTAL INDIVIDUALS	319	256	280	259

Table 3c. Macroinvertebrate metric evaluation of selected streams in the Rabbit River watershed, Allegan County, MI. August 2008.

	Red Run Drain 142nd Avenue 8/15/2008 STATION 4		Red Run Drain 20th Street 8/14/2008 STATION 5		Black Creek 34th Avenue 8/15/2008 STATION 6		Black Creek 139th Avenue 8/12/2008 STATION 7	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	19	1	16	0	31	1	29	1
NUMBER OF MAYFLY TAXA	0	-1	1	-1	1	-1	3	0
NUMBER OF CADDISFLY TAXA	0	-1	2	0	1	-1	4	0
NUMBER OF STONEFLY TAXA	0	-1	0	-1	0	-1	0	-1
PERCENT MAYFLY COMPOSITION	0.00	-1	8.98	0	0.71	-1	3.09	0
PERCENT CADDISFLY COMPOSITION	0.00	-1	16.02	0	13.57	0	13.90	0
PERCENT DOMINANT TAXON	45.77	-1	26.95	0	20.36	0	28.19	0
PERCENT ISOPOD, SNAIL, LEECH	38.24	-1	10.94	-1	27.50	-1	29.73	-1
PERCENT SURFACE AIR BREATHERS	2.82	1	2.34	1	11.79	0	12.36	0
TOTAL SCORE		-5		-2		-4		-1
MACROINVERTEBRATE COMMUNITY RATING		POOR		ACCEPTABLE		ACCEPTABLE		ACCEPTABLE

Table 4a. Habitat evaluation for selected streams in the Rabbit River watershed, Allegan County, MI. August 2008.

	STATION 8 Miller Creek 16th Street RIFFLE/RUN	STATION 9 Bear Creek Hopkins Village Park GLIDE/POOL	STATION 10 Rabbit River 12th Street GLIDE/POOL	STATION 11 Rabbit River End of 132nd from East GLIDE/POOL
HABITAT METRIC				
Substrate and Instream Cover				
Epifaunal Substrate/ Avail Cover (20)	14	8	3	9
Embeddedness (20)*	13			
Velocity/Depth Regime (20)*	14			
Pool Substrate Characterization (20)**		10	8	11
Pool Variability (20)**		2	11	13
Channel Morphology				
Sediment Deposition (20)	8	2	2	2
Flow Status - Maint. Flow Volume (10)	8	7	8	7
Flow Status - Flashiness (10)	2	5	2	1
Channel Alteration (20)	18	10	11	17
Frequency of Riffles/Bends (20)*	16			
Channel Sinuosity (20)**		5	10	14
Riparian and Bank Structure				
Bank Stability (L) (10)	2	5	2	2
Bank Stability (R) (10)	3	5	3	2
Vegetative Protection (L) (10)	3	4	5	9
Vegetative Protection (R) (10)	6	3	8	9
Riparian Veg. Zone Width (L) (10)	2	2	4	10
Riparian Veg. Zone Width (R) (10)	3	2	8	10
TOTAL SCORE (200):	112	70	85	116
HABITAT RATING:	GOOD (SLIGHTLY IMPAIRED)	MARGINAL (MODERATELY IMPAIRED)	MARGINAL (MODERATELY IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)

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).

Date:	8/13/2008	8/13/2008	8/14/2008	8/14/2008
Weather:	Cloudy	Cloudy	Sunny	Cloudy
Air Temperature:	70 Deg. F.	72 Deg. F.	73 Deg. F.	73 Deg. F.
Water Temperature:	66 Deg. F.	62 Deg. F.	62 Deg. F.	64 Deg. F.
Ave. Stream Width:	12 Feet	10 Feet	19 Feet	25 Feet
Ave. Stream Depth:	0.7 Feet	0.5 Feet	2 Feet	2.5 Feet
Surface Velocity:	1.7 Ft./Sec.	1 Ft./Sec.	1 Ft./Sec.	1 Ft./Sec.
Estimated Flow:	14.28 CFS	5 CFS	38 CFS	62.5 CFS
Stream Modifications:	None	Dredged, Canopy Removal, Sangging, Relocated	Canopy Removal	None
Nuisance Plants (Y/N):	N	N	N	N
Report Number:				
STORET No.:	30577	30683	30680	30677
Stream Name:	Miller Creek	Bear Creek	Rabbit River	Rabbit River
Road Crossing/Location:	16th Street	Hopkins Village Park	12th Street	End of 132nd from East
County Code:	03	03	03	03
TRS:	03N12W26	03N12W20	04N12W36	03N12W17
Latitude (dd):	42.61725	42.62935	42.68216	42.65313
Longitude (dd):	-85.70201	-85.76173	-85.66239	-85.74864
Ecoregion:	SMNITP	SMNITP	SMNITP	SMNITP
Stream Type:	Warmwater	Warmwater	Coldwater	Coldwater
USGS Basin Code:	4050003	4050003	4050003	4050003

* Applies only to Riffle/Run stream Surveys

** Applies only to Glide/Pool stream Surveys

Table 4b. Qualitative macroinvertebrate sampling results for selected streams in the Rabbit River watershed, Allegan County, MI. August 2008.

TAXA	Miller Creek 16th Street 8/13/2008 STATION 8	Bear Creek Hopkins Village Park 8/13/2008 STATION 9	Rabbit River 12th Street 8/14/2008 STATION 10	Rabbit River End of 132nd from East 8/14/2008 STATION 11
PLATYHELMINTHES (flatworms)				
Turbellaria	1	1		
ANNELIDA (segmented worms)				
Oligochaeta (worms)	3	1	1	1
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	1	165	188	68
Decapoda (crayfish)	1	3	4	4
Isopoda (sowbugs)		1		12
Arachnoidea				
Hydracarina	1	1		
Insecta				
Ephemeroptera (mayflies)				
Baetidae		14		2
Ephemeridae	4			
Heptageniidae	19	1	6	41
Isonychiidae	4			
Polymitarcyidae	1			
Odonata				
Anisoptera (dragonflies)				
Aeshnidae			4	7
Gomphidae	1		1	7
Zygoptera (damselflies)				
Calopterygidae	3	10	6	2
Plecoptera (stoneflies)				
Perlidae	1			7
Hemiptera (true bugs)				
Belostomatidae			1	
Corixidae			1	1
Gerridae	1	2		
Mesoveliidae				1
Notonectidae		1		1
Pleidae				2
Saldidae			1	
Veliidae		1		
Trichoptera (caddisflies)				
Brachycentridae	3	4	11	15
Glossosomatidae	5			
Helicopsychidae	5			
Hydropsychidae	34	10	5	6
Leptoceridae	7			2
Limnephilidae	1	1	1	11
Molannidae	1			
Uenoidae	4			
Coleoptera (beetles)				
Dytiscidae (total)			1	
Gyrinidae (adults)		1		1
Hydrophilidae (total)		1	1	1
Psephenidae (adults)	1			
Scirtidae (adults)		1		
Dryopidae				1
Elmidae	66	8	12	28
Diptera (flies)				
Chironomidae	40	106	1	7
Dixidae				1
Simuliidae	18	26	1	1
Tabanidae				1
Tipulidae	8			
MOLLUSCA				
Gastropoda (snails)				
Ancylidae (limpets)	4			
Hydrobiidae				9
Physidae	8	3		
Pleuroceridae	1			
Viviparidae	2		8	
Pelecypoda (bivalves)				
Sphaeriidae (clams)	8	1		13
TOTAL INDIVIDUALS	257	363	254	253

Table 4c. Macroinvertebrate metric evaluation of selected streams in the Rabbit River watershed, Allegan County, MI. August 2008.

	Miller Creek 16th Street 8/13/2008 STATION 8		Bear Creek Hopkins Village Park 8/13/2008 STATION 9		Rabbit River 12th Street 8/14/2008 STATION 10		Rabbit River End of 132nd from East 8/14/2008 STATION 11	
METRIC	Value	Score	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	31	1	23	0	19	0	28	1
NUMBER OF MAYFLY TAXA	4	1	2	0	1	-1	2	0
NUMBER OF CADDISFLY TAXA	8	1	3	0	3	0	4	0
NUMBER OF STONEFLY TAXA	1	1	0	-1	0	-1	1	1
PERCENT MAYFLY COMPOSITION	10.89	0	4.13	0	2.36	-1	17.00	0
PERCENT CADDISFLY COMPOSITION	23.35	0	4.13	0	6.69	0	13.44	0
PERCENT DOMINANT TAXON	25.68	0	45.45	-1	74.02	-1	26.88	0
PERCENT ISOPOD, SNAIL, LEECH	5.84	0	1.10	1	3.15	1	8.30	0
PERCENT SURFACE AIR BREATHERS	0.78	1	1.93	1	1.97	1	2.77	1
TOTAL SCORE		5		0		-2		3
MACROINVERTEBRATE COMMUNITY RATING		EXCELLENT		ACCEPTABLE		ACCEPTABLE		ACCEPTABLE

Table 5a. Habitat evaluation for selected streams in the Rabbit River watershed, Allegan County, MI. August 2008.

	STATION 12 Rabbit River 26th Street GLIDE/POOL	STATION 13 Rabbit River Downstream 30th Street GLIDE/POOL	STATION 14 Rabbit River 36th Street GLIDE/POOL	STATION 15 Rabbit River Walnut Street (downstream of M-40) GLIDE/POOL
HABITAT METRIC				
Substrate and Instream Cover				
Epifaunal Substrate/ Avail Cover (20)	7	2	8	7
Embeddedness (20)*				
Velocity/Depth Regime (20)*				
Pool Substrate Characterization (20)**	7	7	11	11
Pool Variability (20)**	15	11	15	11
Channel Morphology				
Sediment Deposition (20)	6	3	5	6
Flow Status - Maint. Flow Volume (10)	8	8	8	8
Flow Status - Flashiness (10)	2	2	6	3
Channel Alteration (20)	17	17	16	18
Frequency of Riffles/Bends (20)*				
Channel Sinuosity (20)**	13	7	16	18
Riparian and Bank Structure				
Bank Stability (L) (10)	3	2	6	4
Bank Stability (R) (10)	3	5	6	4
Vegetative Protection (L) (10)	9	5	8	9
Vegetative Protection (R) (10)	9	5	8	9
Riparian Veg. Zone Width (L) (10)	9	4	9	8
Riparian Veg. Zone Width (R) (10)	9	4	9	9
TOTAL SCORE (200):	117	82	131	125
HABITAT RATING:	GOOD (SLIGHTLY IMPAIRED)	MARGINAL (MODERATELY IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)	GOOD (SLIGHTLY IMPAIRED)

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).

Date:	8/12/2008	8/12/2008	8/15/2008	8/13/2008
Weather:	Sunny	Sunny	Sunny	Partly Cloudy
Air Temperature:	75 Deg. F.	82 Deg. F.	68 Deg. F.	61 Deg. F.
Water Temperature:	63 Deg. F.	64 Deg. F.	63 Deg. F.	63 Deg. F.
Ave. Stream Width:	20 Feet	54 Feet	42 Feet	55 Feet
Ave. Stream Depth:	2 Feet	4 Feet	3 Feet	3 Feet
Surface Velocity:	1.25 Ft./Sec.	0.6 Ft./Sec.	1 Ft./Sec.	1 Ft./Sec.
Estimated Flow:	50 CFS	129.6 CFS	126 CFS	165 CFS
Stream Modifications:	None	None	None	Impounded
Nuisance Plants (Y/N):	N	N	N	N
Report Number:				
STORET No.:	30654	30676	30673	30682
Stream Name:	Rabbit River	Rabbit River	Rabbit River	Rabbit River
Road Crossing/Location:	26th Avenue	Downstream 30th Street	36th Street	Walnut Street (downstream of M-40)
County Code:	03	03	03	03
TRS:	04N13W36	04N13W27	04N13W30	03N14W06
Latitude (dd):	42.69305	42.70348	42.70023	42.67409
Longitude (dd):	-85.80104	-85.84187	-85.89895	-86.00517
Ecoregion:	SMNITP	SMNITP	SMNITP	SMNITP
Stream Type:	Coldwater	Coldwater	Coldwater	Coldwater
USGS Basin Code:	4050003	4050003	4050003	4050003

* Applies only to Riffle/Run stream Surveys

** Applies only to Glide/Pool stream Surveys

Table 5b. Qualitative macroinvertebrate sampling results for selected streams in the Rabbit River watershed, Allegan County, MI. August 2008.

TAXA	Rabbit River 26th Street 8/12/2008 STATION 12	Rabbit River Downstream 30th Street 8/12/2008 STATION 13	Rabbit River 36th Street 8/15/2008 STATION 14	Rabbit River Walnut Street (downstream of M-40) 8/13/2008 STATION 15
PLATYHELMINTHES (flatworms)				
Turbellaria	1		1	
ANNELIDA (segmented worms)				
Hirudinea (leeches)		1	1	5
Oligochaeta (worms)	9	75		5
ARTHROPODA				
Crustacea				
Amphipoda (scuds)	71	79	50	9
Decapoda (crayfish)	7	1	3	1
Isopoda (sowbugs)	13	9	162	18
Insecta				
Ephemeroptera (mayflies)				
Baetidae	6	16	3	15
Caenidae		1		1
Ephemeridae		1		2
Heptageniidae	5		3	5
Isonychiidae	1			
Leptophlebiidae		1		
Odonata				
Anisoptera (dragonflies)				
Aeshnidae	5			
Gomphidae	3	2	1	
Zygoptera (damselflies)				
Calopterygidae	2	5	1	2
Coenagrionidae	1	3		1
Plecoptera (stoneflies)				
Perlidae	10		11	
Hemiptera (true bugs)				
Belostomatidae		1		1
Corixidae		78		23
Gerridae	1			1
Notonectidae		6	1	
Veliidae		2		
Megaloptera				
Corydalidae (dobson flies)	1			
Sialidae (alder flies)		2		6
Trichoptera (caddisflies)				
Brachycentridae	45	2	9	14
Hydropsychidae	18	1	13	46
Leptoceridae	2	1		2
Limnephilidae	1	1	1	
Polycentropodidae		7		3
Psychomyiidae	1			
Coleoptera (beetles)				
Dytiscidae (total)		3	2	1
Haliplidae (adults)				1
Hydrophilidae (total)		2		1
Dryopidae			1	
Elmidae	16	4	5	1
Diptera (flies)				
Athericidae	11		1	
Chironomidae	8	51	6	86
Empididae				1
Muscidae				1
Ptychopteridae	1			
Simuliidae	7		2	2
Stratiomyidae		1		
Tabanidae	2	1		
Tipulidae	3			
MOLLUSCA				
Gastropoda (snails)				
Hydrobiidae		3		
Physidae	5	5	8	2
Planorbidae				2
Viviparidae		1		
Pelecypoda (bivalves)				
Sphaeriidae (clams)	1	2	1	
TOTAL INDIVIDUALS	257	368	286	258

Table 5c. Macroinvertebrate metric evaluation of selected streams in the Rabbit River watershed, Allegan County, MI. August 2008.

METRIC	Rabbit River 26th 8/12/2008 STATION 12		Rabbit River Downstream 30th 8/12/2008 STATION 13		Rabbit River 36th 8/15/2008 STATION 14		Rabbit River Walnut Street (downstream of M-40) 8/13/2008 STATION 15	
	Value	Score	Value	Score	Value	Score	Value	Score
TOTAL NUMBER OF TAXA	29	1	32	1	22	0	29	1
NUMBER OF MAYFLY TAXA	3	0	4	1	2	0	4	1
NUMBER OF CADDISFLY TAXA	5	1	5	1	3	0	4	0
NUMBER OF STONEFLY TAXA	1	1	0	-1	1	1	0	-1
PERCENT MAYFLY COMPOSITION	4.67	0	5.16	0	2.10	-1	8.91	0
PERCENT CADDISFLY COMPOSITION	26.07	0	3.26	-1	8.04	0	25.19	0
PERCENT DOMINANT TAXON	27.63	0	21.47	0	56.64	-1	33.33	0
PERCENT ISOPOD, SNAIL, LEECH	7.00	0	5.16	0	59.79	-1	10.47	0
PERCENT SURFACE AIR BREATHERS	0.78	1	25.27	-1	1.05	1	10.85	0
TOTAL SCORE		4		0		-1		1
MACROINVERTEBRATE COMMUNITY RATING		ACCEPTABLE		ACCEPTABLE		ACCEPTABLE		ACCEPTABLE

Table 6. Location information for observation and water chemistry stations. Rabbit River watershed, Allegan County, Michigan. August, September, and October 2008.

Station	STORET #	Waterbody	Site Location	TRS	Township	Latitude	Longitude
NPS-1	none	Unnamed Tributary to Miller Creek	12th Street	04N12W01	Hopkins	42.6173	-85.7022
NPS-2	none	Winks Brook	138th Avenue	04N12W30	Dorr	42.6963	-85.7768
NPS-3	30601	Black Creek	140th Avenue	04N13W19	Overisel	42.7096	-85.8987
NPS-4	30605	Red Run Drain	14th Street (North of 144th Avenue)	04N12W11	Dorr	42.7401	-85.6828
NPS-5	30604	Red Run Drain	16th Street	04N12W23	Dorr	42.7124	-85.7021
NPS-5	30686	Red Run Drain	downstream of 16th Street	04N12W22	Dorr	42.7118	-85.7023
A	30524	Red Run Drain	downstream of 144th Avenue	04N12W13	Dorr	42.7388	-85.7023
B	30684	Red Run Drain	14th Street (South of 144th Avenue)	04N12W13	Dorr	42.7401	-85.6828
C	30685	Red Run Drain	18th Street	04N12W22	Dorr	42.7149	-85.7218
C	30687	Red Run Drain	downstream of 18th Street	04N12W22	Dorr	42.7150	-85.7225
5	30674	Red Run Drain	20th Steet	04N12WS16	Dorr	42.733	-85.7420
5	30688	Red Run Drain	downstream of 20th Street	04N12W17	Dorr	42.7331	-85.7422

- stations are located upstream of road crossing unless noted otherwise
- NA = not available at time report was written

Table 7. Water sample analysis results for Red Run Drain, Allegan County, Michigan. August, September, and October 2008. Station numbers noted in Figure 1.

	Station #	NPS-4	A			B	4			
	Location	u/s of 14th North of 144th	d/s of 144th			u/s of 14th and south of 144th	u/s of 142nd Avenue			
	Date	9/22/2008	9/24/2008	9/30/2008	10/13/2008	9/22/2008	8/26/2008	9/22/2008	9/30/2008	10/13/2008
	Storet #	30605	30524			30684	30675			
Ammonia	mg N/L	<0.1	<0.01	0.08	<0.01	0.2	< 0.1	0.1	0.51	0.08
CBOD-5 day	mg/L	--	< 2	4	3	--	--	--	13	12
Conductance	umhos/cm	836	903	--	--	869	--	812	--	--
Dissolved Oxygen	mg/L	--	9.8	6.8	7.2	--	--	--	--	--
TOC	mg/L	13	--	--	--	12	13	15	--	--
COD	mg/L	35	--	--	--	35	52	49	--	--
Nitrogen, Total Kjeldahl	mg N/L	1.5	1.4	1.9	1.3	1.5	2.3	2	2.9	1.8
Nitrate + Nitrite	mg/L	3.6	4.3	6.8	4.1	3.3	8.3	5.6	5.7	5.4
Nitrite	mg N/L	0.04	0.04	0.11	0.03	0.04	--	0.06	0.1	0.06
Phosphorus, Total	mg/L	0.21	0.2	0.26	0.15	0.23	0.45	0.33	0.42	0.21
Ortho-Phosphate	mg P/L	0.13	0.11	0.15	0.09	0.12	--	0.18	0.24	0.13
Residue SS	mg/L	6	13	12	12	16	--	12	14	9
Residue TDS	mg/L	550	600	--	--	570	--	540	--	--
Copper, Total	µg/L	--	--	--	--	--	2.1	--	--	--
Zinc, Total	µg/L	--	--	--	--	--	< 10	--	--	--
E. coli Sample 1	CFU/100 mL	710	--	--	--	2500	--	2300	--	--
E. coli Sample 2	CFU/100 mL	640	--	--	--	2100	--	2200	--	--
E. coli Sample 3	CFU/100 mL	570	--	--	--	1100	--	1600	--	--
E. coli Geometric Mean	CFU/100 mL	637	--	--	--	1794	--	2008	--	--

-- Not analyzed
d/s = downstream
u/s = upstream

Table 7 continued. Water sample analysis results for Red Run Drain, Allegan County, Michigan. August, September, and October 2008. Station numbers and locations noted in Figure 1 and Table 6.

Station #		NPS-5			C	C			5	5		
		d/s 16th			u/s of 18th	d/s of 18th			u/s of 20th	d/s of 20th		
Date		9/24/2008	9/30/2008	10/13/2008	9/22/2008	9/24/2008	9/30/2008	10/13/2008	9/22/2008	9/24/2008	9/30/2008	10/13/2008
Storet #			30686		30685		30687		30674		30688	
Ammonia	mg N/L	<0.1	0.12	<0.01	<0.1	< 0.1	0.06	<0.01	0.1	0.1	0.08	0.06
CBOD-5 day	mg/L	2	4	3	--	< 2	3	2	--	3	2	2
Conductance	umhos/cm	665	--	--	659	656	--	--	665	666	--	--
Dissolved Oxygen	mg/L	9	7	7.4	--	7	7	7.1	--	7.6	7.2	8
TOC	mg/L	--	--	--	7.7	--	--	--	8.4	--	--	--
COD	mg/L	--	--	--	22	--	--	--	25	--	--	--
Nitrogen, Total Kjeldahl	mg N/L	1	1.4	1.1	0.78	0.66	0.66	0.62	0.78	0.68	0.77	0.57
Nitrate + Nitrite	mg/L	4.2	3.8	3.5	2.8	2.7	2.7	2.4	1.89	1.91	1.88	1.83
Nitrite	mg N/L	0.05	0.07	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Phosphorus, Total	mg/L	--	0.2	0.13	0.1	0.08	0.08	0.08	0.08	0.07	0.08	0.06
Ortho-Phosphate	mg P/L	0.08	0.1	0.07	0.05	0.03	0.03	0.04	0.04	0.07	0.04	0.03
Residue SS	mg/L	5	8	9	<4	6	5	6	4	6	8	7
Residue TDS	mg/L	410	--	--	440	440	--	--	450	450	--	--
Copper, Total	µg/L	--	--	--	--	--	--	--	--	--	--	--
Zinc, Total	µg/L	--	--	--	--	--	--	--	--	--	--	--
E. coli Sample 1	CFU/100 mL	--	--	--	310	--	--	--	280	--	--	--
E. coli Sample 2	CFU/100 mL	--	--	--	410	--	--	--	310	--	--	--
E. coli Sample 3	CFU/100 mL	--	--	--	240	--	--	--	310	--	--	--
E. coli Geometric Mean	CFU/100 mL	--	--	--	312	--	--	--	300	--	--	--

-- Not analyzed
d/s = downstream
u/s = upstream